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Quantifying the Roman Economy: Integration, Growth, Decline?

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I. INTRODUCTION

The programme of research which this volume introduces is concerned with the fundamentals of the Roman imperial economy and will attempt detailed analysis of major economic activities (agriculture, trade, commerce, mining), utilizing quantifiable bodies of artefactual and documentary evidence and placing them in the broader structural context of regional variation, distribution, size and nature of markets, supply and demand. The chronological parameters are 100 BC–c. AD 350, covering the period of greatest imperial expansion and economic growth (to c. AD 200), followed by a century conventionally perceived as one of contraction or decline.\(^1\) Geographically, we will draw on material selected from all over the Mediterranean world: Egypt, North Africa, Spain, and Italy will be our most fruitful sources of data, which will be gleaned almost entirely from published archaeological and documentary sources. The project will provide a detailed basis for assessing the rate and volume of economic growth in the earlier empire and the extent of contraction after AD 200. We will also consider to what extent the Roman economy was integrated

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1 We had originally specified the terminal date as c. AD 300, but we are persuaded that the quantity and quality of the evidence from the first half of the fourth century makes it perverse to exclude this period arbitrarily. The dates in any case are only approximate.
across the whole empire rather than a number of disparate but linked regional economies; and how far it was structurally integrated—that is, were state mechanisms of economic control and the behaviour of ‘free market’ local economies part of a coherent economic ‘system’? In addressing these general questions we will focus on several underlying issues which will, in combination, offer a set of carefully framed definitions. These include: the constituents of economic growth; levels of sophistication and rationality in ancient economic strategies; inter-operation of regional markets; the extent to which recent analysis of economic institutions and behaviour is applicable to the Roman economy, in terms of intensity of production in agriculture and manufacture, markets, supply and demand, movement of goods over what distances, distribution of population and the effects of urbanization, behaviour of currency and prices, institutional control and free markets, and the application of developments in ancient technology which we believe to be much more significant than is generally recognized.

Not long after we began to compile the material for the present volume, *The Cambridge Economic History of the Greco-Roman World* was published. Chapters 19–27 of this work cover the period on which we focus, from the late Republic to the later empire, with a combination of chronological, thematic, and regional treatments. As the work of many hands, this volume does not provide a single, unified vision of the economic history of the Mediterranean and north-west Europe under Roman rule and it does not conceal differences of emphasis or interpretation between the authors. But it does provide an excellent context in which to ground our own quantitative approach and it relieves us of the need to attempt or duplicate surveys of this sort. Furthermore, the Introduction (ch. 1) sketches the outlines of debate about the nature of the ancient economy and chapters 2–6, grouped under the rubric ‘Determinants of Economic Performance’ analyse many of the topics which we discuss in this volume (demography, urbanization, the agrarian regime, technology). Along the way, we are presented with a plethora of detail and with both old and new concepts and tools (such as ‘New Institutional Economics’) for analysing and interpreting it. In

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summarizing what they believe they have achieved, the editors conclude their introduction thus (pp. 11–12):

This emerging account of the Greco-Roman economy, we believe, is an advance over twentieth-century interpretations. It improves on substantivist approaches by providing crude statistics on economic performance, but it also goes beyond both sides in the old primitivist–modernist debate by developing general theoretical models of ancient economic behaviour and putting them in a global, comparative context. It recognizes that classical antiquity saw one of the strongest economic efflorescences in premodern history but keeps this in perspective, refusing to confuse the ancient economy with the modern. In short, it takes seriously Douglass North’s injunction to explain the structure and performance of economies through time.

This is not the place to examine the validity of this claim, which will undoubtedly be scrutinized in detail by reviewers, but a few comments are in order. The editors identify some long-term trends some of which will not provoke serious disagreement (pp. 9–11): that there was a significant rise in per capita consumption over the period covered by the volume; that the population of the Mediterranean classical world greatly increased (perhaps doubled) over the period between c.800 BC and AD 200; that there was clearly significant economic growth over this period. Underlying these general statements there are, however, some uncertainties which we intend to address in more detail in this and in subsequent volumes. The statistics they offer are useful to us but in many ways, as they admit, crude. The population increase from 20 to 40 million over a millennium is posited with an assurance we do not share and conceals many major uncertainties. Per capita estimates for income and consumption are, we think, capable of further refinement, at least for some regions and periods. We offer some suggestions for ways in which this might be done. Following their lead more positively, we are certainly fully aware of the desirability of assessing the performance of the Roman economy in a comparative context and we certainly take seriously the need to address the structure and performance of economies over time (on all this more below).

The work will be characterized throughout by commitment to integrate or correlate archaeological and documentary evidence
where possible—the chosen topics are not all equally represented but there is sufficient complementarity to make this attempt worthwhile. Our chosen method is to take four key subject areas, widely recognized as diagnostic for the Roman imperial economy, for which we can compile, update, and exploit quantifiable data and rigorously analyse and define what each subject area can contribute to our key themes and questions. A crucial first phase will be to select the most appropriate datasets and test their potential. The data compilation will comprise *inter alia* aggregation of specific features and assemblages from published archaeological reports, documentary evidence for agricultural yields, prices of commodities and labour, census data and units of habitation, and capacities of technological ‘devices’ (e.g. oil-presses, water-mills). Much of the work will consist of revising, updating, expanding, and synthesizing existing published datasets but we emphasize that none of these has been fully exploited by the potential of modern computing power. The potential of the data to generate, for example, comparative distribution patterns of ceramics or changes in the configuration of land tenure and use can be tested.

We have identified four key subject areas to focus on where there is useful evidence: demography and urbanization; agriculture; trade; metal supply and coinage. We are aware of the need to emphasize our recognition of the fact that such an undertaking can be neither definitive nor comprehensive. It is bound to omit some other important topics and sources of data such as osteoarchaeology which lack correlative documentary evidence, though we would certainly hope to take some account of results derived from such data. It is also impossible to attempt comprehensive treatment even of the selected topics across the whole period and the whole Mediterranean region. We will be satisfied if we can establish a framework and a methodology for suggesting how the evidence might address the crucial questions and issues, along with some detailed illustrations of how we might hope to make this work in the key subject areas for some periods and for some regions of the Roman empire. In sum, the subjects and the objectives we have identified will not yield clear-cut

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3 Cf. Jongman 2007: 193–5 on femur length as reflection of stature and thus as an index of economic prosperity.
and simple answers to questions about growth and decline over the whole empire in a period of nearly half a millennium. Our aim is rather to explore the complexities and suggest the trends. Explicit recognition that there is far more material than we can hope to exploit even in five years will, we hope, encourage further enhancement and analysis of economic data.

II. DEFINITIONS, METHODS, AND APPROACHES

Inevitably, the subject raises a number of general issues which will recur throughout the programme. There now appears no need for us to revisit the old ‘primitivist–modernist debate’ in detail. As regards the comparative context, we will certainly keep in mind the features of what are generally characterized as ‘pre-capitalist’ economies which existed in areas that were eventually to fall under Roman rule and consider whether that effected a fundamental transformation of their economic character. Whether or not we think that the Roman economy was a mixture of pre-capitalist and capitalist features (such as long-distance trade and production of goods for markets), the analysis of transformation and integration, such as might have occurred under the influence of Roman rule in large areas of the ancient Near East, is crucial and needs to take into account a more gradualist or developmental perspective, laying emphasis on the continuity rather than the watershed. This in turn will feed into analysis of the impact of institutional frameworks and structures which may be seen as central to economic growth when they were strong at the height of the empire and, conversely, crucial to economic decline if and when they weakened. Put another way, we need to consider whether we can meaningfully regard the Roman

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4 Several are usefully discussed by Morley 2007.
5 Pleket 1993.
6 So Davies 2001: 13–14 noting that the Achaemenid empire shows ‘a stupefying range of economic and fiscal patterns and systems’, continuing into the Seleukid and Ptolemaic periods with the partial exception of monetization (on the latter see now von Reden 2007).
7 North 1990; see also Saller 2002.
empire as a single unit or entity for any or all of the period encompassed by this study, which includes episodes of growth, contraction, and political fragmentation, as well as greater or lesser degrees of administrative control over time and space. An obvious focus of debate will be the question of whether it is useful or essential to study the empire region by region, which will inevitably reveal both differences and similarities over a huge range of geographical and institutional characteristics. A study of mining in Spain or agriculture in Egypt will tell us a lot about Spain or Egypt but little of more general importance about the empire as a whole, save perhaps what we already knew, that Spanish silver production underpinned the coinage, or that Egyptian grain fed a significant proportion of the population of the city of Rome. In other words, a micro-regional approach shines only very narrow beams of light and no one would think it feasible (if only because of the very uneven spread of evidence and the huge gaps in our knowledge) to combine these narrow beams into one vast flood of illumination. At the other end of the scale of generalizability, we might be urged to consider the usefulness of world-systems analysis, of which Wallerstein was a leading proponent.\(^8\) This was fashionably broad a decade ago and has indeed been discussed with reference to ancient Rome, but it has the crucial drawback that it tends to obscure or suppress the differences between regions which we must regard as vitally important characteristics of the various parts of the Mediterranean world and north-western Europe under scrutiny. To suppress them would from our point of view be very damaging, precisely because among the things we want to know about the Roman Mediterranean over time are the key similarities, differences, and connections from region to region, as part of a single economy or economic system, or simply as a number of small ‘economies’ linked to a greater or lesser degree. This debate cannot be concluded here but it is worth indicating briefly: (1) that we think it is important to make economic sense of something which clearly was in many respects one political entity or ‘system’ which included Britain, North Africa, and Syria, without having to decide which was more or less ‘typical’; and (2) that the links and connections (or perhaps now ‘connectivities’) between the

different parts (conceived both geographically and structurally) of the Mediterranean will inform our understanding of the sense in which we can talk of unity, a single empire or diverse regions as part of a single political and economic system.\footnote{Cf. Horden and Purcell 2000. We do not think that the debate about the usefulness of the term ‘Romanization’ is relevant to this, see Mattingly 1997; 2004; Webster 2001.}

Second, asking how far one part of the Roman empire might be compared with another naturally leads us to reflect on the benefits of comparing the Roman empire with other political states, empires, and periods. We are in no doubt that in principle this must be potentially useful and failure to do it would rightly invite criticism. There are various ways in which we might do this. Broad comparisons between Rome and other examples are not exactly a new phenomenon, although most have focused on political structures, imperialism, colonialism, and the like rather than the economy.\footnote{For comparative studies see now Bang 2006, Meyer 2006; also Van der Spek 2006 on Babylonia.}

Economically, an obviously attractive comparison has been that between Rome and Mughal India, recently revived by Peter Bang;\footnote{See Bang 2002 and cf. Bang 2006, Bang and Bayly 2003.} the evidence for Han China is less easily accessible to those who cannot read Chinese or Japanese. Egypt over the longue durée, and particularly in the nineteenth century, offers some promise (though rarely unequivocal or universally accepted).\footnote{This is implicit in the approach of Bowman and Rogan 1999. An example is cited by van Minnen 2000, n. 4.} We might anticipate that it would be illuminating to compare empires in respect of taxation policies and mechanisms, distribution of wealth, technological development, size of different sectors (agriculture, trade, services, etc.), growth and decline. Implicit in such exercises is always the question of how exactly such comparisons help us. Simple juxtaposition for similarity or contrast is always intriguing but that hardly counts as analytical. We need to go further and determine how analysis of another imperial economy might fill gaps in our knowledge of the Roman economy, or how it might suggest different questions which can be put to the evidence we have. It seems to us that it is possible to gain some insight from other periods and areas.
into the level and nature of economic performance in the Roman Mediterranean in the period under consideration: for example, to highlight what structural features of the Roman economy might be typical of large pre-industrial economies and, conversely, what aspects might be peculiar to the Roman world.

A third general consideration concerns the dialogue between different kinds of evidence. We have had sufficient warning of the dangers of using statistical evidence from ancient literary sources, where figures are notoriously unreliable and modern scholars often seem inclined to trust figures they can find which suit their prejudices and reject those which do not.\textsuperscript{13} Such evidence may sometimes find support, or the opposite, in documentary or archaeological sources. But our evidence is in general so lacunose and random that, more often than not, individual items are isolated and cannot be checked against a context. Once again, however, there are some exceptions and one of the themes which runs through the present programme is an attempt to create where possible a dialogue between archaeological and documentary evidence. This is, of course, not a new idea and there is a fairly recent scholarly literature which has reviewed progress and suggested ways forward.\textsuperscript{14} This has proved, perhaps surprisingly, difficult to achieve very effectively.\textsuperscript{15} Reconstruction of the physical configuration of landholdings, an urban landscape, or a network of village settlements can be a frustrating exercise and it is striking how often such attempts result in virtual or relative topographies which cannot actually be pinned down to coordinates on a map, even when we have relevant documents;\textsuperscript{16} even straightforward lists of artefacts too often fail to harmonize with classifications based

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\item \textsuperscript{13} E.g. Szaivert and Wolters 2005, see Scheidel 1996. Jones 1948: 10 considered Josephus’ figure for the population of Egypt (\textit{BJ} 2.385) the only reliable statistic in a literary source but many have rejected this as far too high (e.g. Rathbone 1991, Bagnall and Frier 1994).
\item \textsuperscript{14} See Ørsted 1994, Hitchner 1995\textit{a}, and Storey 1999.
\item \textsuperscript{15} For a useful survey see Storey 1999, noting (206) that ‘a balanced, dependable method for integrating textual and archaeological data is still lacking’. See also Hitchner 1995\textit{a}. An example is MacKinnon 2004, who concludes (243) that ‘perhaps the greatest value of integrating zooarchaeological and textual data comes in terms of the analysis of animal breeds and the recognition of breeding improvement’; it is relevant that the textual evidence available to him is literary, not documentary.
\item \textsuperscript{16} Examples include an attempt to identify buildings under repair at Hermopolis in the 260s (van Minnen 2002), a map of villages in the Oxyrhynchite Nome
\end{enumerate}
on archaeological evidence.\textsuperscript{17} There are, however, also some data which allow us to make a direct \textit{rapprochement} between documents which relate to domestic housing and the archaeological evidence for houses. In 1985 Hobson was able to examine the evidence of excavated structures in Fayum villages and to show that private houses in these communities were small, with about 60 m\textsuperscript{2} of floor space per storey.\textsuperscript{18} She proceeded to argue, on the basis of census documents and the like, that the density of occupation in these rural communities was ‘remarkably consistent with the figures given for Egypt in 1979, which show that in rural areas the average occupancy is 3.5 people per room, or 10.5 people per average 3-room house’.\textsuperscript{19} In general, we might expect it to be much easier to make these connections for urban structures or for villas than for agricultural land.\textsuperscript{20}

A slightly different and more promising approach is to treat, where possible, the documents themselves as artefacts in their archaeological context.\textsuperscript{21} Comparison of time series data for archaeological and documentary evidence for the same phenomenon can be instructive in illuminating possible biases in the data, as discussed below for two case-studies involving water-mills and water-lifting devices (pp. 33–8).

The overarching aim here, then, is a series of studies which will suggest how we might identify major structural features, behaviour, and performance of the Mediterranean economy over 450 years of Roman domination, which can be compared with other periods and
areas, by collecting and analysing quantifiable documentary and archaeological evidence for key areas and economic activities. The objectives are to compile datasets of evidence for each of the four diagnostic areas and to produce synthesizing studies for each area, plus an overview addressing the general and structural issues through the key areas. Quantification studies on the Roman economy are not simply about counting and aggregating. Analysis of the data ought to enable us to measure change and variability—developments over time, variation across space, similarities with and differences from other cultures at different times. Despite the slightly more optimistic view of the value and robustness of our data which we implied above, we cannot expect to derive a series of straightforward and unambiguous results from the data we have. At best, we may expect to identify a number of measurable indicators of trends that might tell us about different aspects of the economy. We attempt in the remainder of this Introduction to point out what we see as some of the major issues and questions we face, and to offer some examples of approaches to and methods of using archaeological and documentary data.

The main general issues we need to address are the following:

● The utility of estimates of GDP.\(^{22}\) We will need to consider whether we can estimate aggregate GDP (i.e. the sum of the value of all goods and services) for some places and some periods and what useful conclusions we might derive from that in relation to economic growth or contraction. We remain sceptical about estimating per capita GDP because of our uncertainty about population figures but we might suggest proxy data which might offer some indications of per capita levels of income and expenditure.

● We can attempt to identify drivers of growth including but not only those enumerated by Saller (trade, intensification of capital investment, improved technology, education of the workforce, institutional attitudes and stimuli, increased division of labour, etc.).\(^{23}\) We also need to consider whether their absence (or opposite trends which might be postulated such as a decline in literacy,

\(^{22}\) See Temin 2006a.  
\(^{23}\) Saller 2002 = 2005.
or a decrease in volume of shipping) is necessarily an indicator of decline.
• We can also attempt to identify phenomena that are likely to be reflections of (rather than criteria for) growth, such as urbanization, import replacement, increased consumption, improved standards of living.

The project relies on the collation of datasets which can then be analysed, and one of its key components is therefore the creation of a series of databases with appropriate query tools, ultimately to be made available on the internet for the use of other researchers at the end of the project, both in online searchable form and as static tables in a stable archive format to be archived with the Archaeology Data Service.24 This will involve a large amount of collation of material from published sources, but where possible, we would also want to make use of existing online database projects such as the epigraphic corpora of inscriptions from Heidelberg,25 the various papyrological databases brought together in the Trismegistas project and elsewhere,26 Roman Amphorae: A Digital Resource, etc.27 There is a growing research need, not currently met, for the development of data mining technologies to exploit the increasing mass of data—e.g. archaeological finds, inscriptions, or papyri—held in numerous different databases generated by different projects and hosted on different servers. This would require, on the one hand, the development of middleware search layers and thesauri (to translate, for example, between different classification systems for the same type of amphora: Dressel 12 = Augst 22 = Beltrán 3 = Ostia 52 = Peacock and Williams 14), and, on the other, greater interoperability between websites, so that one could link an epigraphic corpus to a mapping project for a visual distribution map of e.g. all fourth-century AD building inscriptions. The use of interoperable web-based database and GIS architecture could enable the daunting task of updating archaeological distribution maps (below, pp. 26–7) to be done as a collaborative venture between several projects, distributing the

24 http://ads.ahds.ac.uk/.
26 http://www.trismegistas.org/.
workload and facilitating future updates by allowing individual excavators to report their new finds or to link their databases of finds from different sites together. The comprehensive resolution of these issues is beyond the scope of the present project, but we hope to contribute to thinking and debate on the question and influence the development of such technologies.

For the analysis of the data, we need to identify appropriate statistical techniques for quantification. As regards specific methods and approaches, we rely essentially on a familiar repertoire of simple statistical tests, such as regression analysis which evaluates the likelihood that there is a relationship between one set of data (e.g. commodity prices) and another (e.g. distance from a major market or consumer centre); or the application of the Gini coefficient (or Lorenz curve) to accumulated data to measure the degree of inequality of distribution expressed as a decimal figure from 0.1 (complete equality) to 1.0 (complete inequality).

Studies of this sort inevitably rely to some extent on modelling the social and economic structures under scrutiny and looking for goodness-of-fit in the evidence. We need to consider how we might best do this. The benefits and the pitfalls of such model-based approaches are obvious. As existing examples of good practice, we can cite the use of demographic models and life-tables to describe the structural features of ancient populations which fit the items of evidence available to us; that is, they are based on empirical data. Other examples of models which have been widely used include those which proceed from assumptions which are strictly unverifiable but judged likely to be in the correct range (e.g. that the population of the empire was 50 or 70 million) to conclusions which may be judged

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28 This possibility is envisaged in the aims and the structure of the project 'A Virtual Research Environment for the Study of Documents and Manuscripts' (see http://www.bvreh.humanities.ox.ac.uk), supported by JISC as part of Phase 2 of its Virtual Research Environments programme. It will be realized through collaboration with the database structure developed in the Silchester Roman Town project, see http://www.ahessc.ac.uk/all-hands-2006.

29 These techniques and tests, e.g. Spearman's rank correlation coefficient, are described in standard handbooks such as Hudson (P.) 2000. Some of the simpler tests are available online (e.g. http://mercury.soas.ac.uk/users/sm97/teaching_intro_qm_notes_gini_coefficient.htm). For examples in the present subject area see Kessler and Temin 2008, Bowman 1985, and Bagnall 1992.
more or less plausible, or more or less consistent with a range of ‘known’ phenomena (e.g. tax-rates or calorie requirements for human subsistence). Our approach to economic data more naturally leads us in the first direction than the second, but it is inevitable that our inability to be certain about some of the crucial facts will sometimes force us to derive alternative models to be tested for goodness-of-fit.

We have used and continue throughout to use the terms ‘integration’, ‘growth’, and ‘decline’, and we now need to say what we mean by these in the context of the ancient Mediterranean, to identify the key indicators of these phenomena and the means of quantifying them.

III. AN INTEGRATED ECONOMY?

The task we have outlined requires analysis of the nature and extent of the integration of the economy of the Mediterranean world under Roman rule. We need to say what we understand by the term ‘economic integration’, how we identify the key diagnostic features of an integrated economy and how we propose to measure or quantify the degree of integration (not a simple matter in the case of a process or a number of connected processes). First, to what extent was the Roman economy integrated across the whole empire rather than a number of disparate but linked regional economies (‘a system of interconnected sub-economies’)? What is the extent of geographical integration, that is essentially but not only the progressive integration of the gradually acquired provinces? We also need to consider the well-attested economic contacts beyond the territories under direct control (a particularly important issue for Roman imperial rule in which a degree of suzerainty or control was often claimed for territories not under direct governance or

30 For examples relevant to the Egyptian agricultural economy, see Bagnall 1992, 2005, van Minnen 2000, and Bowman (this volume); for demography and social history, Bagnall and Frier 1994, Tacoma 2006. The model developed by Hopkins 1980 for taxes and trade is based on unverifiable assumptions. For further examples of models in ancient economic history see Manning and Morris 2005.

These considerations will naturally demand that we keep in mind: (1) that the gradual transformation of the Hellenistic kingdoms, north Africa, and western Europe into a Roman empire inevitably involves greater economic integration than had existed earlier, and (2) that the processes of integration into an empire were not only economic processes; we have in mind, for example, the multifarious relations implied by the concept of ‘connectivity’ and ‘globalization’ (if applicable). There are both quantitative and qualitative issues. Does the economically integrated area shrink (pari passu with the reduction of the extent of territorial control)? Does the nature of integration change? Crudely put, is the Roman economy more integrated in the second century AD, less so in the third, and more so again in the fourth (following the rather simplistic but often cited cycle of growth to climax, decline, and recovery)? How do we describe regional differences and the links between regions? Are newly incorporated regions brought into the integrated structures to the same level and at the same pace (self-evidently not), or are some more integrated than others (we would naturally suppose so)?

Second, how far was it structurally integrated—that is, are state mechanisms of economic control, and the behaviour of ‘free market’ local economies part of a coherent economic ‘system’? We can easily identify central features of both ‘sectors’ (on the one hand, regulation of currency, taxation levels, direct ownership of production, some areas of price control; on the other, local fluctuation of supply and demand, of prices, entrepreneurial activity). But what exactly are the economic structures or frameworks that would effectively weld these into a system (e.g. imperial policies, which have proved hard to identify convincingly, but perhaps include Diocletian’s Currency Reform and Price Edict, laws such as those affecting landownership or navicularii, practices such as the mixture of state and private

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32 For Rome’s eastern trade see the collection of evidence by Raschke 1978, with more recent archaeological work by Begley 1993; Will 2004; Peacock and Blue 2006; Peacock and Williams 2007. Evidence is now growing for Saharan trade, especially with the Garamantes of the Libyan Fazzan: Mattingly 2003; Wilson 2012.

33 Erdkamp 2005: 203 citing J. K. Davies to the effect that ‘The Hellenistic Economy’ was not integrated.

34 Horden and Purcell 2000.
activity in transport services, ‘tools’ such as taxation and currency)?

On the one hand, we can attempt to identify specifics which have this integrative effect; on the other, we can attempt to infer them and attribute to them a greater or lesser degree of deliberate manipulation, such as is implicit in the much-cited ‘taxes-and-trade’ model developed by Keith Hopkins.

Third, we need to consider how to locate the processes of economic integration in relation to other processes and developments which are central to the debate about the character of the Roman empire. The two which most readily spring to mind are ‘Romanization’ and ‘globalization’. It is possible to indicate our approach to these issues without indulging in lengthy debate about the merits of the different labels. Both of these portmanteau terms conceal the combination of a number of complex processes. The use of the term ‘Romanization’ has recently been subjected to severe criticism, but whatever term one uses to convey the facts, it is undeniable that the growth and development of the empire involved the spread of institutional, linguistic, cultural, economic, and religious phenomena which were in some important sense ‘Roman’ or promulgated by Rome (that wider definition will allow us to include in our purview Hellenistic and Graeco-Roman constituents too, as we certainly need to do). Archaeological assemblages in the provinces as well as Italy frequently reflect a kind of Roman consumption package—amphorae for wine, olive oil, and fish products, and red gloss table pottery; a qualitative perspective on the perceived integration of the Roman economy at least insofar as products from all over the empire were held to be widely available is provided by the verse inscription on the Mausoleum of the Flavii at Kasserine, which characterizes different provinces by the products for which they are famous. Likewise, there are some definitions of ‘globalization’ that

35 See Paterson 2004. These issues are well analysed by Harris 2003.
38 We do not seek to avoid the use of the term ‘Roman’, cf. Barrett 1997. Analogous issues have arisen over the use of the term ‘Graeco-Roman’, see Lewis (N.) 1968.
are effectively restricted to an economic perspective, pointing to the
global interdependence of countries through increasing volume and
variety of cross-border transactions in goods and services, free inter-
national capital flows, rapid and widespread diffusion of technology,
and so on. It is, however, more common now to regard globalization
as a complex concept which certainly also encompasses major polit-
ical and institutional aspects, intertwined with economic, cultural,
and technological elements. Without adopting the extreme posi-
tion that all history is economic history, we certainly regard eco-
nomic integration as central to the complex of processes which hide
behind these labels without wishing to suggest that economic inte-
gration is a sufficient definition of either, nor do we attempt to assert
its necessary primacy, for such an assertion cannot rest on quantita-
tive studies of the kind we propose.

Naturally, we cannot at this stage attempt a full analysis of the
constituents or criteria of economic integration, but it is worth
sketching out the areas which we think are important, with some
indication of our approach to them.

III.1. Economic policy

If we could demonstrate that Rome’s political leaders developed and
implemented a coherent economic policy at any or all parts of the
period under review, we would have a powerful argument for inte-
gration. Unsurprisingly, this is not easy to do, not least because we
would hardly expect a consistency of economic policy over four
centuries and ancient sources are in general notoriously lacking in

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40 Morley 2007: 90–102; Jones (A.) 2006: 2: ‘the growing interconnectedness and
interrelatedness of all aspects of society’, a process that ‘can be identified in almost
every dimension of contemporary life’, ‘However, its profile as a keyword springs
largely from a more specific association with changes in the world economy in recent
decades (and since the end of the Cold War in particular). For most non-academic
commentators, globalization is first and foremost about the development of a global-
scale, capitalist free-market economy that is entwining activity across national bor-
ders in new and unprecedented ways. From an academic perspective, however, it has a
plethora of further usages. It is applied to various different dimensions of social life in
the contemporary world, spanning cultural, technological, informational, environ-
mental and political transformations—to name but a few of the more significant
spheres of its conceptual reach.’
any sort of description or analysis of what the modern world (since Adam Smith) would regard as ‘economic policy’. It is much less hard to find modern statements about the ‘economic policy’ of particular emperors, notably Augustus (encouraging trade), Vespasian (belt-tightening reorganization as in Suetonius), Trajan (building/trade), and Diocletian (economic revival) but these tend to be fairly narrow in focus.41 Roman economic policy is sometimes identified or implied at a more general level, e.g. in the Red Sea/eastern desert, where its major constituents include improvement of military control and communications, thus creating better conditions for trading. There can be no doubt at all that at least in the earlier empire the imperial house engaged directly in trade, agriculture, and manufacture over the whole empire in ways which must have had some direction from the top and invariably included interaction with private individuals.42 But the nature of the imperial acquisition of, for example, the major marble quarries, remains unclear. So too, although we can trace the imperial acquisition of major senatorial olive-oil producing estates in Istria in the first century AD, or the acquisition in the course of the second century of the main brickyards in the Tiber Valley and the suburbium of Rome, it remains uncertain how far these processes reflect a deliberate and planned policy, and how far a more casual agglomeration of landholdings through marriage or confiscations.43 Nonetheless, ownership and direct management of land and other wealth-creating activities by the imperial authority, the level of which varies over time, must be an integral component of economic policy; by the same token, the decrease in direct ownership and management which is evident at least in Egypt after Diocletian must also be deliberate and strategic.44

There are, of course, a number of economically related measures taken by the emperor or the state which are recorded in the historical sources. These include the annona, the free distribution of quantities of grain to citizens at Rome, to which were added, progressively, pork (early second century), olive oil (under Severus), and wine

41 E.g. Paterson 2004.
42 Harris 2003; Bowman 2008.
The evidence of centralized olive amphora discard at Monte Testaccio and the control inscriptions on Dressel 20 amphorae from south-west Spain suggest state intervention in the olive oil supply of Rome long before the inclusion of oil in the annona, presumably with the aim of ensuring price stability through reliable supply by bulk state purchase and resale. By the third century AD some larger provincial towns had established their own annona schemes for the distribution of grain to a portion of the citizen body. But as far as our present evidence goes these measures all affect particular regions only—Rome, certain other towns, and their main regions of supply (Egypt and North Africa in the case of the grain supply for Rome; Spain and North Africa in the case of olive oil supply). More promising perhaps are the second-century AD Lex Hadriana de rudibus agris encouraging development of marginal, uncultivated land in North Africa, or a statement in the Historia Augusta to the effect that Probus’ investment in public building works brought about an economic return: ‘In Egypt there are works of his, which he had built by the soldiers, in many cities. But around the Nile he did so much that he singlehandedly augmented the grain tribute. He built bridges, temples, porticoes, and basilicae by military labour; he opened up the estuaries of many rivers, and drained several swamps, and established cornfields and arable land in them.’ Yet the Historia Augusta is a notoriously unreliable source, and both of these instances seem to be regional rather than universal measures.

None of these examples is in itself invalid or useless, but we struggle to find some overarching conceptual vision which encompasses the economy of the empire as a whole and is not so general as to be completely banal, nor can we find explicit recognition of the need for budgeting on a macro-economic scale until the

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45 Rickman 1980.
46 On Monte Testaccio see e.g. Rodriguez Almeida 1984; Blázquez Martinez and Remesal Rodríguez 1999; Étienne and Mayet 2004, vol. 1: 23–39; Aldrete and Mattingly 1999 though none of these authors actually goes so far as to attempt to explain the state connection in the manner suggested here.
47 See P.Oxy. vol. XL.
49 HA, Prob. 9.3–4.
post-Diocletianic empire when, according to Jones, the praetorian prefects estimated the annual needs of the state and calculated the rates of levy required to meet them.\textsuperscript{50} Various possible explanations of this silence suggest themselves. We are asking the wrong question(s). Lack of explicit articulation does not mean that it was not somehow institutionally embedded. There was no overarching economic policy for the empire—just a series of measures to meet current needs, whatever they might be. We do not need a single explicit ‘policy’ or a consistent direction of policy to demonstrate integration, merely an array of integrated economic institutions or patterns of behaviour. This last is the direction in which we are heading.

III.2. Coinage and monetization

This might appear to be the most straightforward of our diagnostics of integration but the appearance is somewhat deceptive. It would be good to be able to begin with the simple assertion that the monetary system, regulated through the imperial mints, achieved an extremely high degree of coherence and integration in a world which was to all intents and purposes highly monetized.\textsuperscript{51} Mines were perhaps not all in direct imperial ownership but this is certainly an area in which we should look for integration in the form of a high degree of state control complemented by private exploitation.\textsuperscript{52} In reality, the pattern of currency is much more complex.\textsuperscript{53} We must allow for significant differences between west and east. In the former, although there are signs of residual non-Roman coins (except in Britain), Roman denominations quickly became universal. In the east, Rome took over areas with a multiplicity of existing local coinages which continued to circulate in a heavily monetized environment and the move to an almost wholly single Roman denomination (the radiate) was not achieved until the middle of the third century AD.\textsuperscript{54} The cases of Syria and Egypt are instructive. In the former, there is room for

\textsuperscript{50} Jones 1964: 449. \textsuperscript{51} Howgego 1992.
\textsuperscript{52} Hirt 2004; 2010.
\textsuperscript{53} For a good summary see Burnett \textit{et al.} 1992: 6–9.
\textsuperscript{54} Butcher 2004: 253–6.
doubt whether SC issues were freely used between cities or whether cities acquired them purely for local use. In local bronze coinage there was not a regional system: that is, coins found in one region originating in other regions in the province are no commoner or rarer than those originating in regions which were not part of the province.\footnote{Butcher 2004: 176.} Egypt’s so-called ‘closed currency’, which continued until the Diocletianic reform of AD 296, may have coexisted with the circulation of gold aurei, although this is not certain. It has been shown that the Alexandrian mint made coins for Syria and cooperated with other mints, and was part of an overall imperial scheme, all of which made it in effect no more closed than other monetary areas.\footnote{Burnett 2005; Andreau 2005. Gara 1976 attempts to fit the Egyptian evidence into a framework of Roman monetary domination. For the movement of Roman coinage to India via the Red Sea ports see Andreau 2005: 331–2, Rathbone 2001a; Bowman 2009.} In order for these currencies to function in cooperation, which they clearly did, there must have been arrangements for exchange, small-scale examples of which we know where surtaxes were imposed or a premium was charged for commercial exchange; but we do not know the mechanisms which allowed this to work at provincial level (e.g. at Alexandria).\footnote{Pergamum inscription, OG\textit{IS} 484. As Andreau 2005: 330 says, at Alexandria the exchange must have been done through the public banks, which are attested though not in detail (Bogaert 1994, 1995). For a hypothesis as to the mechanism see van Minnen 2000: 208–10. The supposed equivalence of the \textit{denarius} and the Alexandrian \textit{tetradrachma} will have simplified matters but that too is not unproblematic (see Andreau 2005: 332–3).} We might reasonably postulate that a move to single currency would of course lower transaction costs, but one would guess that it would be difficult to demonstrate this for the east in the period after AD 250. At all events, despite the complexity of the patterns, the effective integration of the functioning of the currency and the monetary system seems beyond doubt and is fundamental to the phenomena described in the three following sub-sections.

\section*{III.3. Commercial institutions}

Coin was one of the vital instruments in moving goods and services across the whole empire but it is vital to recognize (1) that coin is not
the only form of money and (2) that money is not the only mechanism for creating integration of movement. For money in non-coined form it will be sufficient to refer to the recent detailed article by William Harris, emphasizing the importance of credit, *inter alia*, as a form of money.\(^{58}\) Other vital institutions, with which this is linked, include banks and the various ways in which commercial transactions were documented and recognized as valid. A full appreciation of the complexity of this aspect of integration would require detailed discussion of the legalities of Roman contractual obligations and the increasing interpenetration of Roman and peregrine legal instruments (which is also closely connected to the important subject of social integration). This cannot be attempted here and we will be content with the proposition that even the superficialities of commercial and financial documents show how they underpin and validate the movement of goods and services across huge tracts of the empire.\(^{59}\) More specifically, however, we might note and explore the tendency under Roman rule towards greater uniformity of interest rates and the mechanisms of applying them. This phenomenon seems clear when one compares loan contracts in Ptolemaic and Roman Egypt and it is our impression that ‘standard’ Roman terms and rates became widespread elsewhere too.\(^{60}\) If this were sound, it would certainly be another diagnostic feature of economic integration.

### III.4. Movement and trade

The ability of the Roman imperial economy to move goods and services across huge distances in the empire and beyond its borders

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\(^{58}\) Harris 2006.

\(^{59}\) *e.g.* *TPSulp*. 14 (Camodeca 1992), a *vadimonium* made in Rome between C. Sulpicius Cinnamus and an Alexandrian; Rhodian bank drafts, *P.Oxy*. I. 3593–4.

\(^{60}\) Most obviously the explicit stipulation of interest charges which are at other times and places sometimes concealed in the capital loan and the rate of 12% per annum; proof that this was enforced as a maximum is lacking, see Andreau 1999: 90–9, esp. 92. For some interesting observations on the history and economic significance of interest rates over the *longue durée* see Hudson (M.) 2000.
is not in any doubt at all. Therefore, if we feel the need to demonstrate how that was done (see above) we do not feel the need to demonstrate that it was done. In this area of our inquiry, we will focus more on the range and scale of movement and the relationship between the constituent parts of the empire: movement of goods over the whole empire and beyond its borders, movement between regions, movement within regions (defined as provinces or geographical ‘units’ such as Africa, Asia Minor, the Iberian peninsula), local movement between towns and villages. Naturally this also involves issues relating to the organization of production (both agricultural and ‘manufactured’) at the highest level (e.g. the imperial house) and at the lowest (e.g. the local farmer or artisan). Crucially, trade is the category of evidence which has been most heavily exploited in order to demonstrate growth and decline in the Roman economy. So one of the central features of the supposed economic ‘decline’ in the third century is thought to be the reduction in the volume, kind, and quality of goods moved over distance.\textsuperscript{61}

\textbf{III.5. Markets}

All of the topics discussed above are closely related to the major issue of the nature and structure of the market or markets in the empire. This is crucial to any definition of economic integration and is here singled out for discussion not least because it has been highlighted in recent studies many of which have come close to making it a sufficient condition of integration. Thus, the characterization of this aspect of the economy as a network of interconnected ‘free’ markets in which the levels and movement of prices are in economic terms rationally determined (e.g. obeying the laws of supply and demand, reflecting costs of transport over distance) has been powerfully propounded.\textsuperscript{62} It is argued that for the eastern Mediterranean there is no comparable level of market integration


\textsuperscript{62} Temin 2001, Rathbone 1997, but the quantity of evidence for price levels is rather less than one would ideally want. Market integration for the grain trade is well discussed by Erdkamp 2005: 143–205.
in the economies of the Hellenistic period and the Roman domination will therefore mark a very important change in this respect. On this view we would expect to see increasing market integration over the period from c.100 BC to AD 200 and we will then have to test the hypothesis that this began to break down and become fragmented, as did the political unity of the empire, over the course of the next century.

These broad brushstrokes conceal a plethora of detailed questions and issues. Foremost among the indicators of the behaviour and structure of the market(s) is the level and movement of prices over space and time. It is true that, as far as our data will take us, the general stability of price levels over the Roman Mediterranean seems to have endured for a quite remarkably long time in the first two centuries AD, despite some incidences of coinage debasement which might naturally lead us to expect marked fluctuation of prices. On the other hand, the amount of usable evidence at our disposal is not great or densely clustered and the calculations based on rather thin evidence for grain prices cry out for some further testing and focus closely on the relationship of prices in the capital and those places from which its grain supplies were derived (principally Egypt). It is nevertheless useful, we think, to exploit indicators of comparative value across time and place (such as the ratio of value/cost of wheat to barley). It is our impression that other scattered bodies of data present a much less tidy and ‘economically rational’ picture, in which there might be marked regional differences, or specific local conditions might cause fairly violent deviation from postulated ‘normal’ prices or market transactions. Possible factors which influence such distortions might be, for example, famine or crop failure, disruption of productive or supply processes by civil or military unrest. We also need to take account of systemic factors which might be broadly classified as governmental controls of market structure and functions. In a very general but nonetheless powerful way, this is one major impact of a taxation system of the sort which existed in the Roman Mediterranean. At a more specific level, the institutionalized

63 Bowman 2006: 85, a value/cost ratio of 3:1 for wheat:barley in Britain c. AD 100; according to Bagnall 1993: 25 in fourth-century Egypt the ratio was normally about 2:1.
practice of control of supply and prices of goods can be seen in
the imposition of requisitions for military or other governmental
purchases which do not fit the free market pattern. Third, and less
systematically, price and market controls (e.g. strictures on grain
hoarding or the requirement to declare stocks and prices) can be
imposed to meet particular needs created by local shortages. This
might suggest that we need to distinguish between a government-
regulated and a free market sector, to elucidate the relationship
between them and to see whether that changed over time. Within
that spectrum, it is also possible to discuss whether we are dealing
with short-range (i.e. local) or medium-range (regional) or long-
range (empire-wide) integration and whether there might be distinc-
tions according to the commodities in the market.\footnote{Cf. Hopkins 1983.}
The question of market integration may be further complicated by the existence of
‘mass’ markets, which we take to mean the very few really large
conurbations in the Roman Mediterranean,\footnote{Cf. Erdkamp 2005: 177–81.}
where the demands for basic commodities (grain, some other foodstuffs, slaves) might
suggest a high degree of integration over long distances.

This issue of local versus long-distance trade is taken up in
Fulford’s response to Wilson’s paper on trade in this volume, stress-
ing the potential of archaeology to illuminate the impact of transport
networks. In particular, he contrasts the access that coastal cities had
to imports with the relatively restricted distribution of certain types
of imported cooking wares in inland zones, arguing that the relatively
low costs of maritime transport created almost an extended ‘local’
zone for trading, but there was a sharp drop-off in penetration of
goods inland. If the distinction is as sharp as Fulford suggests, we
ought to see marked differences in economic development between
coastal zones and inland ones. Much more work is certainly needed
systematically to analyse the now massive quantity of archaeological
data for traded artefact distribution to explore this phenomenon; a
major research desideratum would be the updating of distribution
maps for some of the most common amphora forms and pottery
types.\footnote{For early amphora distribution maps, see e.g. Riley 1979; Peacock and Williams
1986; for a more recent update, of Republican wine amphorae in Gaul, see Loughton 2003.}

This would be a truly massive task, but the use of
interoperable web-based database and GIS architecture, as discussed above, could facilitate this.

III.6. Social integration

We might also ask to what degree the Roman economy was integrated across society. Were peasants integrated into a market economy, or not? Were the state and the army actors, or separate sectors? What role did the elite play, not merely in consumption, but in production? There are signs of elite and probably senatorial involvement in the level of investment of productive infrastructure in, e.g. olive oil and wine production in North Africa and Istria. At a municipal level, we have evidence for local elites involved in the production of salted fish products and fish sauce, in the case of A. Umbricius Scaurus at Pompeii. What was the nature of imperial ownership and involvement?

III.7. Integration within industrial sectors

Finally, it is worth exploring the evidence in particular sectors for a level of integration implied by supplier relationships between specialist stages of production, each occurring in separate, dedicated establishments. Such vertical specialization is one of the characteristics of an industry; the textile industry at Pompeii, for example, shows specialist wool-scourers, dyers, fullers, who must have been integrated with the spinners and weavers through a highly organized supply chain. Vertical specialization is also apparent within the fish-salting industry, to the extent that fish-salting factories are found in relatively close regional association with evidence for salt production and amphora production, although usually the three activities occur in separate, specialist facilities which must have been vertically connected through supplier relationships. We do not, however,

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68 Wilson 2008a.
70 Wilson 2006. On the fish-salting industry in the Iberian peninsula generally, and the various activities related to it, see Étienne and Mayet 2002. Cf. Étienne and
frequently see the vertical integration of such different stages of production within a single enterprise.

IV. ECONOMIC GROWTH

IV.1. Extent and nature

When and how intensive growth has been generated is the central question of development economics. The extent and nature of economic growth achieved in antiquity continues to provoke debate. Hopkins argued that the period from 200 BC to AD 200 had seen some modest growth. Some historians have tended to downplay the significance or extent of such growth as they may admit, emphasizing relative stagnation over the longue durée; others, and notably some archaeologists, are more optimistic about seeing growth in the material record.

It is important to distinguish between two types of growth: aggregate or extensive growth, in which a simple increase in population leads to an increase in total GDP, and per capita or intensive growth, in which greater efficiency in production means that each worker is producing more. In reality, per capita growth and aggregate growth might occur together, and may be difficult to disentangle, but per capita growth is the more significant in demonstrating economic progress, and it is this issue which is most at stake in the debate. Few would deny the possibility, even the likelihood, of some aggregate growth in the Roman empire in the first century BC and the first century AD as a result of demographic growth, even though the extent and the regional distribution of any demographic growth are


debatable. As Bruce Frier puts it: ‘If we assume, as assume we must, very low levels of per capita income in the early Roman empire, it is nonetheless true that population growth could well have contributed far more than any other single source to any overall increase in the Roman empire’s economy during this period.’ Frier has even raised the possibility that demographic growth may have led at times to overpopulation, leading to a drop in per capita income (from the diminishing returns of labour input into marginal lands) and reduced standards of living.

Per capita or intensive economic growth may take one of two main forms: so-called ‘Smithian’ growth, in which growth in the extent of trade and the size of markets facilitates increased division of labour; and sustained intensive or ‘Promethean’ growth, based on fossil fuels and continuing technological improvement, which is characteristic of industrialized economies. Wrigley emphasizes that before the exploitation of fossil fuels, all economies were ‘organic’ in that they depended almost entirely on organic products not only for food and subsistence, but also for all energy, whether heat or mechanical, involved in the production of goods. Sources of energy (even wind- and water-power, through the sun’s determination of climate) ultimately depended on the sun; most importantly plants harnessed solar energy by photosynthesis, and these might be used directly as fuel, or eaten by animals or humans as nutrition to support the application of muscle power. Land-use choices were therefore a trade-off not only between different ways of feeding the human population, but also between different modes of energy production (e.g. forestry for timber vs. pasture for draft animals); and these constraints set limits to the possibilities for growth, exacerbating the negative feedback constraints formulated by Malthus. The exploitation first of coal and later of other fossil fuels enabled an escape from the Malthusian trap in which the inelasticity of land as a production factor determined a negative feedback between population growth and standards of living. Wrigley notes that the use of one ton of coal per year releases for other purposes about 1 hectare of

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78 Wrigley 2004, esp. 29–35.
forest otherwise needed to provide fuel.\textsuperscript{79} It is the new energy sources of fossil fuels (coal, and later oil/petroleum) which could release stored solar energy accumulated over millennia, that enable sustained, intensive, technologically based growth, sometimes called ‘Promethean’ growth because its basis is new means of producing fire. By contrast, ‘Smithian’ growth is the only type of per capita growth we should expect to find in pre-industrial, organic economies. That is not to deny the potential importance of technology in antiquity; merely to stress that sustained technological growth on the level of modern economies is a recent phenomenon.

How, then, might one demonstrate, or even measure, per capita economic growth in the Roman world? There are two possible approaches. The first is to identify the existence in antiquity of drivers of economic growth, to demonstrate that the conditions existed which would have made growth possible. Among those listed by Saller,\textsuperscript{80} one can identify archaeological evidence for: trade, intensification of capital investment, improved technology, increased division of labour. The other factors—education and institutional attitudes and stimuli—are not so easily identifiable from the material remains, but may be approached to some extent through documentary and epigraphic evidence, especially in the case of education or rather literacy. The second approach is to identify symptoms that might suggest growth did indeed occur. Such indicators would include urbanization, import replacement, increased consumption, and higher standards of living.

\textbf{IV.2. Trade and manufacture}

Increased trade contributes to economic growth through increasing the effective size of markets reached by producers, enabling economies of scale and division of labour; and also by enabling distributed and more complex manufacturing, so that a wider range of goods may be produced at a given place using a mixture of local and imported materials or components. It also facilitates urbanization

\textsuperscript{79} Wrigley 2004: 39 n. 61. \hspace{1cm} \textsuperscript{80} Saller 2002: 261–2 = 2005: 232.
and the growth of cities beyond the capacity of their immediate hinterlands to supply them. Key issues to consider include the distances and distribution patterns over which goods were moved, and how these were affected by the technologies and costs of maritime, riverine, and road transport; the extent to which the movement and exchange of goods represented market trade, or extraction as rents or taxes, or state-mandated supply of the court or the army. For many purposes it is likely to be more profitable to break the somewhat vague concept of ‘trade’ down and view the phenomenon through the lenses of production, distribution, and consumption. Some of the methodological problems involved in assessing the scale and nature of ancient trade are discussed in the chapters by Wilson, Fulford, and Harris below.

IV.3. Intensification of investment

Investment in productive techniques or infrastructure is a critical driver of growth; but there is debate over whether it happened to any real extent in antiquity; and the question became one of the key issues in the debate about economic rationality. Literary and juridical sources tend to focus more on leasing and tenancy than on capital investment in the productivity of estates; documentary papyri from Egypt may, however, be read as reflecting capital investment.81 But the clearest evidence for large-scale investment in productive capacity is archaeological.82 It can be seen most obviously in the provision of batteries of olive or wine presses at large agricultural facilities in North Africa, Spain, and even Istria;83 in the large factories for fish-salting along the Iberian and North African coasts and in Brittany;84 in the adoption of water-mills and of new irrigation machinery;85 in the creation of irrigation schemes and channels;86 and in the creation of large-scale pottery production facilities (La

82 Wilson 2008a, for a synthesis.
83 Mattingly 1988a; 1988b; Wilson 2008a.
84 Wilson 2006.
85 Wilson 2002a; see also below, pp. 33–7.
86 See also now the Hadrianic Lex Rivi Hiberiensis, Beltrán Lloris 2006.
Graufesenque, Le Rozier, Scoppieto), some of which seem to have been leased by landowners to potters. Investment in such large-scale plant or in machinery improved productivity through economies of scale and more efficient use of labour. But investment is present, and probably widespread, lower down the productive scale as well. The almost routine equipping of many villas in the western and central Mediterranean with one or more oil or wine presses is an indicator of this. Indeed, the very spread of the villa system, which underpinned the organization of much agricultural production at least in the western empire, represents an intensification of investment in market-oriented agriculture. The analysis of some of these indicators of investment will be a core part of our work on the agricultural sector of the economy.

IV.4. Division of labour

Little systematic research has yet been done on the extent of division of labour in the ancient world. However, plenty of evidence exists, and a study by Wilson focuses on the substantial archaeological evidence for division of labour in large-scale and mass production in the Roman period, notably in large urban bakeries and fulleries, in the large pottery production centres as at La Graufesenque, Le Rozier, and Scoppieto, and in the textile industry, where extreme division of labour (separate establishments at Pompeii for wool-scouring, spinning, dyeing, weaving, and fulling) was coupled with vertical specialisation. Such division of labour should in Smithian terms reflect an increased size of market (and therefore increased trade), and should also achieve greater per capita labour efficiency in the sectors in which we can identify it. Attempts have also been made to quantify the evidence for urban craftsmen in Egyptian towns (and the comparison or contrast with rural villages is also relevant). The

87 Wilson 2008a.
89 Wilson 2008a.
90 van Minnen 1987, using Weberian terminology and noting the estimate of 30–50% of the population of Byzantine Oxyrhynchus involved in urban crafts. It is important to bear in mind, however, that ‘urban craftsmen’ might also be involved to some extent in agricultural activity, if only as the small landholders who appear in land- and tax-lists and the like.
results may tell us something about local supply and demand, measured against import over greater distances, and could help to refine our notions of cities and towns as economic ‘producers’ or ‘consumers’. This is certainly an area where more research and systematic analysis could prove productive.

IV.5. Technology and development: archaeological and documentary sources

The last twenty-five years have seen a radical overhaul of views on the level and importance of technological development achieved in the Roman world. From the 1960s to the 1980s the view prevailed that ancient technology in general, and Roman technology in particular, was stagnant and contributed little to the economy. Since then a number of studies have argued for a much higher level of ancient technological development, and a more rapid and widespread uptake of that technology. Ancient technology has re-entered the debate on the economy, and the task is now to assess what contribution technological developments might have made to economic growth.

Our project aims to compare archaeological and documentary sources, and one of the things we might hope to get out of that is a better understanding of the nature and utility of those sources. This is illustrated in a striking way in a preliminary analysis of the uptake of certain mechanical technologies.

Case study 1: The water-mill

The water-mill is one of the earliest examples of human efforts to harness natural forces to do mechanical work, and stands as the ancestor of a long line of machines. Water-milling greatly increased per capita productivity in the time-consuming and widely needed grinding of grain into flour, and enabled greater specialization in labour, with the water-miller (molendinarius) emerging as a separate

92 e.g. Wikander 1984; Greene 2000; Wilson 2002a; and the various papers in Lo Cascio 2006.
figure from the miller-baker (pistor) of the earlier Roman period. The spread and uptake of the water-mill is therefore important to questions of economic development and the relationship of capital investment in technology to economic growth.\footnote{On the origin and spread of water-mills, see e.g. Wikander 1980; 1984; 2000; Lewis 1997; Brun and Borréani 1998; Wilson 2002a; Brun 2006.}

In 1984 Örjan Wikander published a brief but important landmark study which overturned the commonly accepted idea that although the ancient world knew the water-mill, it was not until the early Middle Ages that its use became common.\footnote{Wikander 1984.} He showed that the large number of references to early medieval water-mills in surviving documents is a function of the nature of our sources. Much surviving Graeco-Roman literature is epic, didactic or elegiac poetry, narrative history, tragedy, or philosophy, none of which is likely to spend much time discussing water-mills. The bulk of the references that we do have come from scientific, technical, or encyclopaedic writings, which are comparatively rare. The massive increase in the rate of references to water-mills in written documents of the fourth and fifth centuries AD is a product of the introduction of new genres of writing—legal codes, hagiography, and monastic charters, all of which are much more likely to refer to such relatively mundane devices. By contrast, the bulk of the archaeological material known in 1984 came from the second and third centuries AD, when no literary sources refer to water-mills at all—a reflection of the relatively small number of texts that have survived from this period (Fig. 1.1). Pictorial representations of water-mills are very rare—only two.

In the 22 years following Wikander’s publication, our knowledge of ancient water-mills increased dramatically (Fig. 1.2). Some earlier written evidence dating back to the third century BC has now been identified, but while otherwise the number of known literary sources remains similar and the number of iconographic representations the same, the numerous archaeological discoveries have changed the overall picture. The number of archaeologically known sites has increased threefold. The second- and third-century AD peak is now much more pronounced, with appreciable numbers of water-mills.
Quantifying the Roman Economy

Fig. 1.1. Number of attestations of water-mills by century in archaeological finds, ancient representations, and literary sources, as known in 1984

Source: Data in Wikander 1984.

Fig. 1.2. Number of attestations of water-mills by century in archaeological finds, ancient representations, and literary sources, as known in 2006
now apparent also in the first and fourth centuries AD. The slight rise in the seventh century is principally due to a number of discoveries of wooden tidal mills in Ireland. The Roman-period peak would appear even sharper still if it were possible to distribute the six sites in the far right-hand column of Fig. 1.2, which are dated only as ‘Roman’ (in these cases, probably first century AD to fourth century AD), among the centuries in which they really belong.

Two conclusions follow from the different pictures presented by the documentary and archaeological sources. First, the documentary sources do not by themselves provide a guide to the relative frequency over time of the use of water-power. The archaeological evidence offers the best potential for assessing the comparative use of water-power over time, as it is the category least affected by biases in the evidence. Secondly, the large number of documentary references to water-mills in the early Middle Ages, a time when the archaeological record is sparse, indicate that the archaeologically identified record must represent only a very small fraction of the original total.

Case study 2: Water-lifting machines

Interestingly, a similar picture is suggested by the literary and archaeological evidence for water-lifting devices (Fig. 1.3)—similar both in terms of the difference between the two categories of evidence, and in terms of the archaeological peak in the first to third centuries. For this to be useful, we need to do more work on breaking the graph down by category of device—bilge pumps, irrigation devices, mine drainage, supply for urban baths, etc., and also to see how the literary and archaeological evidence compares with the papyrological evidence which is not graphed here. But this is work in progress; at the moment, we may note a correlation between uptake and use of—for the time—complex technology and the period most usually assumed to represent the height of the empire’s prosperity, in the first to third centuries AD.

What did such technological development mean in economic terms? Saller estimated that the adoption of animal- and water-powered mills could at most have contributed to a growth at a rate of 0.025% per annum, and regards this as unimportant. However,
since he guessed that the growth postulated by Hopkins might amount ‘to perhaps as much as 25%’, which he considered to be spread over three centuries and ‘which would amount to less than 0.1% per year’ (the true figure would actually be 0.0747% compound per annum),\(^{96}\) the implication is that the adoption of new milling technologies alone could have contributed up to a third of the total annual growth of the empire. Both figures, 0.0747% and 0.025%, result from highly dubious guesses and could be contested on any number of counts; the point is simply that on Saller’s own figures the possible maximum contribution of milling technologies seems staggeringly important to the economy as a whole. Add to this technological improvements and

\(^{96}\) Saller 2002: 259–60 = 2005: 231 confusingly spreads this 25% growth over three centuries in his text (thus equating to 0.0747% compound p.a.), but the graph (Saller 2002, fig. 12.2 = 2005, fig. 11.2) which he purports to construct on the basis of Hopkins’s 1995/6 article (with just four data points!) actually shows this growth occurring over only the last two centuries \(\text{BC}\), which would equate to 0.1125% p.a. The graph in any case has no value as evidence.
innovations in mining, agriculture (notably irrigation devices), and the building industry (ubiquitous use of cranes, the development of labour-efficient modes of construction using bricks and concrete), and it looks increasingly difficult to deny the importance of technological developments to the achievement of per capita economic growth.

IV.6. Education of the workforce

Investment in human capital—the skills and knowledge of the workforce—is today recognized as a major factor in intensive growth since the twentieth century. To what extent could this have been at all important in antiquity? Evidence for ancient education in general is poor, and tends to relate principally to the elite; direct evidence for education of the workforce is rare, and it is often assumed that ordinary workers were uneducated. However, occasional but unquantifiable hints suggest that the issue is at least worth considering. The *Lex Metalli Vipascensis*, regulating a mining community at Vipasca (Aljustrel, Portugal), contains a provision exempting schoolmasters from taxes levied by the procurator of the mine;\(^97\) they can hardly have taught anyone other than the children of miners, smelters, and the workforce engaged in ancillary services to the mining settlement.

Overall, our best hope of approaching the issue in any quantifiable way is by looking at literacy. The positive role that literacy will have played in connection with the economy is well described in general terms by Keith Hopkins:

The productivity of labour grew, as did total population and aggregate product. The surplus grew. There was a greater division of labour and more and bigger towns. The growth in literacy was both a consumption good—a way of integrating more people within a larger society—and a necessity. A larger-scale society needed (or operated better with) more writing.\(^98\)


Literacy rates in antiquity are notoriously difficult to determine, though Harris doubts that levels reached even 5–10%.

One might expect literacy rates among non-agricultural workers, however, to be higher than in the agricultural sector. Suggestive evidence is provided by the characteristically Roman habit of stamping certain products—bricks, transport amphorae, table pottery, lead pipes, even pastries or loaves of bread. Since brickstamps and stamps on amphorae and other pottery were applied before firing, they must relate to the organization of production. In many cases it is likely that they may relate to locatio/ductio contracts between a landowner and a workshop manager who may be renting the production facilities. Similarly the charge-lists of La Graufesenque (bilingual in Latin and Gaulish), itemizing the numbers of vessels produced by individual potters which were loaded into massive shared kilns for firing, are documents reflecting cooperation and division of labour between potters and kiln masters in a large-scale industry. Literacy here enables a more complex and sophisticated production system with greater specialization of labour. The overall frequency of stamping bricks reflects the general fortunes of the building industry as a whole in the area around Rome—epigraphic stamps start in the first century AD, increase in quantity and frequency (and complexity) in the second century, and then stop abruptly after the Severans, with simple anepigraphic stamps only in the middle of the third century. Epigraphic stamps at Rome reappear with Diocletian’s reorganization of the brick industry, and continue in the west until Constantine, after which they stop. In the east, at Constantinople the practice of stamping bricks commenced in the late fourth century AD and continued until the early seventh century, again closely connected with the intensity of public building there.

We should also consider two further aspects of literacy and documentation. The first is the effect of the bureaucratic practices

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imposed by government through the mechanisms of record-offices and the like. We might reasonably suppose that the documentation of economic activities enabled the government to reap fiscal benefit in the form of higher taxation and that this would be a stimulus to higher productivity and economic growth. In some areas, such as Egypt, these practices were already widespread when the Romans annexed but they may well have intensified under Roman rule;\textsuperscript{102} in others they were no doubt introduced, as was the provincial census. The ceremonial burning of records of debt which took place under the eye and the presidency of the emperor Hadrian was heavily symbolic, but its economic implications were presumably the opposite of stimulating.\textsuperscript{103} The second point focuses more directly on quantification. We can get a good sense of the great quantity of such archival material in a far smaller place, the Egyptian village of Tebtunis in the Arsinoite Nome for which we have abstracts of contracts deposited in the registry (\textit{grapheion}) during specific years of the reign of the emperor Claudius (the last four months of AD 41/2, the whole of AD 45/6 and the first four months of AD 46/7). These records show the care with which contracts were summarized and catalogued and yield, by a simple calculation, the mean volume of such contracts (most in Greek but some few in demotic Egyptian), which is 58 per month for the periods represented.\textsuperscript{104} These are not simply dead letters but are documents which were frequently consulted and played a large role in the regulation of the social and economic relations of the villagers. A further simple calculation reveals that over the course of a single year about 350 different people, male and female, appear as parties to written contracts. At a rough estimate this is likely to constitute about 20\% of the adult population.

\textsuperscript{102} See e.g. the edict of the provincial governor Mettius Rufus, issued in AD 89 (\textit{P.Oxy.} II 237.27–34): ‘Claudius Arius the strategos of the Oxyrhynchite Nome has informed me that neither private nor public business is receiving proper treatment owing to the fact that for many years the abstracts in the property record-office have not been kept in the manner required, although the prefects before me have often ordered that they should undergo the necessary revision, which is not really practical unless copies are made from the beginning. Therefore I command all owners to register their property at the property record-office within six months, and all lenders the mortgages which they hold, and other persons the claims which they possess.’

\textsuperscript{103} Boatwright 1987, pl. 41.

population of the village. The importance of this figure is not so much as a demonstration of rates of literacy, for we do not of course know how many of these individuals wrote or could have written their own contracts, but as an indication of the minimum proportion of people whose socio-economic relations in so-called ‘private’ affairs were recorded and regulated by bureaucracy and written documentation. We cannot conclude that these were just people of higher social status for about one-third of the individuals have Greek names (generally an indication of higher social status) and about two-thirds Egyptian names (generally an indication of lower status). The direction in which this argument leads (which will need further detailed exposition) is that the individuals who document their economic activities either themselves or vicariously, are likely to be more economically productive. If this amounts to around one fifth of the adult population of a first-century Egyptian village, it renders the assertion of low literacy rates much less significant.

It is more difficult to judge possible fluctuations in levels of literacy over time. It is tempting to compare the Leuven Database of Ancient Books, which lists instances of surviving copies of literary texts in Egypt between the third century BC and the eighth century AD, and shows a marked peak in the second and third centuries AD in the sample of 14,246 texts on papyrus and parchment (Fig. 1.4). This of course represents something more than basic literacy, and may also be held in part to reflect variations in expenditure on literature. More seriously, however, it broadly corresponds to the survival rates of all papyri over time and may also be biased by finds at sites such as Oxyrhynchus where literary texts are for whatever reasons very heavily represented. A better sense of the relationship between literary texts and documentary material is offered by the evidence from the Fayum villages and other sites but this also has to be assessed against the survival patterns of the Greek papyri as a whole.

105 Harris’s view (1989) of a decline in late antiquity has not found general acceptance, see below, n. 140.
IV.7. Institutional incentives and stimuli

Institutional incentives to investment or to greater economic efficiency are likely to prove the most difficult to quantify. The evidence for them is exclusively documentary in forms which are not very amenable to quantification—chiefly in juridical writings, or anecdotally in literary sources. Nevertheless, we can at least demonstrate the existence of some incentives—the various state encouragements, through exemptions from munera, to merchants who put ships of a certain capacity at the service of the annona.\(^{109}\) Other examples are the first-century AD Lex Manciana, governing share-cropping so long as estates were continuously cultivated, and the Lex Hadriana de rudibus agris, encouraging the development of marginal land on imperial estates in North Africa by exemptions from rent on land newly brought under cultivation until the olive or fruit trees planted had come to maturity.\(^{110}\) Field survey around

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\(^{109}\) Claudius: Gaius, Inst. 1.32c. Second century AD: Dig. 50.5.3, Scaevola. See Wilson, Ch. 9 below, n. 29.

\(^{110}\) CIL 8.24953 (Aïn el-Djemala); cf. Kehoe 1984; 1988: 61–3. The Romans were not, of course, alone in such measures; there are institutional incentives for the
Kasserine in Tunisia has demonstrated the intensive terracing and cultivation of marginal land between the first and fifth centuries AD which looks like a response to these sorts of legal incentives coupled with market opportunity.\textsuperscript{111} Also relevant is the decrease in direct ownership and management of land by the imperial authority in the later empire.\textsuperscript{112}

**IV.8. Symptoms of growth**

In addition to the drivers of growth, we can also seek indicators that may be a reflection of economic growth, or symptoms that it was occurring. These would include: increasing levels of urbanization, whose value as a proxy measure for growth is discussed by Lo Cascio in this volume; signs of import replacement as local provincial economies develop and begin producing goods that were formerly imported (see Wilson’s chapter on trade); increases in the consumption of material goods; and standards of living (discussed below in the chapters by Rathbone, Scheidel, and Allen).

There is much current interest among economic historians of medieval and later periods in comparing living standards across different pre-industrial societies,\textsuperscript{113} but ancient historians and archaeologists have only recently begun thinking about how to apply such analysis in any systematic way to the classical world. One approach has been suggested through analysis of house sizes and house contents, but this suffers from a number of limitations.\textsuperscript{114} Standards of living might be assessed through consumption patterns—reviews have recently been attempted by Jongman and Ward-Perkins, the latter contrasting the material culture of the Roman empire of the first to third centuries AD with that of early medieval western Europe.\textsuperscript{115} Biological standards of living offer excellent potential for comparison over long time periods,

development of uncultivated land in the Achaemenid empire, where the construction of qanats in the desert zone at the foot of the Taurus mountains is said to have been fuelled by the grant of land for five generations to anyone who invested in the necessary irrigation technology (Polybius 10.28).

\textsuperscript{111} Hitchner 1988; 1990; 1993.
\textsuperscript{112} Rowlandson 1996: 70–101.
\textsuperscript{113} For a collection of recent work, see Allen, Bengtsson, and Dribe 2005.
\textsuperscript{114} E.g. Morris 2005 for the Archaic to Hellenistic Greek world, with discussion of methodological limitations.
\textsuperscript{115} Jongman 2007; Ward-Perkins 2005.
as the systematic collection of osteological data from burials allows an assessment of variation in stature as a reflection of lifetime nutrition.\(^{116}\)

In addition to large-scale anthropometrical projects attempting such comparisons over several thousand years of human history, a project directed by Jongman is analysing femur length over the Roman and late Roman period. Early results from this show a dramatic increase in average femur length for skeletons over the course of the first century \(\text{AD}\), with a significant drop again in the second century, a slight recovery in the third and early fourth centuries, and a steep decline again in the later fourth and fifth centuries.\(^{117}\)

Further ways to compare standards of living involve comparisons of wages and prices, as the papers by Rathbone, Allen, and Scheidel in this volume discuss. Allen’s approach in particular lends itself to cross-cultural comparisons, by establishing a ‘basket’ of prices which can be compared to wages. On his measure, the Roman labourer of the early fourth century \(\text{AD}\) earned a wage whose purchasing power compares with that of workers in eighteenth-century Europe and Asia, but was behind that of fifteenth-century Europe (a period of high real wages).

**IV.9. Contextualizing growth in the *longue durée***

Our hope is that by the accumulation of various indices of the kinds discussed above, we might be able to produce a more robust idea of the shape of likely growth in the Roman world than, say, the highly impressionistic graph in Saller’s article on economic growth, which appears to be based on wholly spurious premises.\(^{118}\) Saller’s source, Lucas, attempted to assess the impact of the Industrial Revolution, comparing it to the long history of pre-industrial societies that had gone before.\(^{119}\) As is not uncommon in works of economic history covering a long time span, the supposed data on ancient economic


\(^{118}\) Saller 2002, fig. 12.1 = 2005, fig. 11.1.

\(^{119}\) Saller 2002 = 2005 cites a working paper by Lucas as his source for the graph. We have not been able to trace the work referred to, but an internet publication with the same title is presumably much the same as the work cited by Saller: Lucas 2004 (http://minneapolisfed.org/pubs/region/04-05/essay.cfm#fig2).
performance are found to be shaky when interrogated. Lucas had no reliable figures for either GDP or population for the first millennium AD, so it is unclear how he thought he was calculating GDP per capita. It appears that he assumed that all pre-industrial societies were pretty homogeneous and that per capita income could fluctuate only within narrow bands. His paper makes a number of assumptions, among which are that all pre-industrial societies had a similar level of per capita income, and did not experience significant growth:

For poor societies—all societies before about 1800—we can reliably estimate income per capita using the idea that average living standards of most historical societies must have been very near the estimated per capita production figures of the poorest contemporary societies. Incomes in, say, ancient China cannot have been much lower than incomes in 1960 China and still sustained stable or growing populations. And if incomes in any part of the world in any time period had been much larger than the levels of the poor countries of today—a factor of two, say—we would have heard about it. If such enormous percentage differences had ever existed, they would have made some kind of appearance in the available accounts of the historically curious, from Herodotus to Marco Polo to Adam Smith.120

This latter point is optimistic to the point of naivety. Ancient authors writing between Herodotus and Marco Polo were notoriously uninterested in standards of living; and our sources are in any case scanty and disjointed. Their silence means very little. Moreover, a recent survey shows that incomes in pre-industrial societies could in fact vary from near-subsistence to about three times subsistence, thus allowing the potential for 100% more growth than Lucas would admit.121 The guess that growth over the period 200 BC to AD 100 might have amounted to some 25% is just that—a guess.122

120 Lucas 2004 (see above, n. 119). As it happens, Adam Smith does in fact stress the vast disparities possible between different societies in standards of living at the bottom of the social scale: ‘and yet it may be true, perhaps, that the accommodation of an European prince does not always so much exceed that of an industrious and frugal peasant, as the accommodation of the latter exceeds that of many an African king, the absolute master of the lives and liberties of ten thousand naked savages’: Smith 1776, ch. 1 = 3rd edn., 1811: 17.
121 Jongman 2007: 185, based on papers in Allen, Bengtsson, and Dribe 2005; several series show at least a threefold variation in real wages; cf. Allen in this volume.
Moreover, the idea of a linear progression in aggregate (but not per capita) growth is apparent in the following passage, conceding some technological improvement:

our increasing mastery of our environment is reflected in accelerating population growth over the centuries. Between year 0 [sic!] and year 1750, world population grew from around 160 million to perhaps 700 million (an increase of a factor of four in 1,750 years). In the assumed absence of growth in income per person, this means a factor of four increase in total production as well, which obviously could not have taken place without important technological changes. But in contrast to a modern society, a traditional agricultural society responds to technological change by increasing population, not living standards.\textsuperscript{123}

We might question: (1) the lack of growth in per capita income in the Roman period; (2) the implied idea that population growth up to 1750 was steady and uniform—in the Mediterranean and north-west Europe there are, to the contrary, signs of growth in the Roman period followed by shrinking in the early medieval period (and again in the fourteenth century as a result of the Black Death), followed by growth again;\textsuperscript{124} (3) the notion that increased population and higher living standards are alternative responses to technological change in a traditional agricultural society. This model suggests sharper periodic growth rates sustained over two to three centuries, and also decline at other periods. We could not currently exclude the possibility that per capita income in the second century AD might have been double what it was in the sixth century AD in north-west Europe.

V. DECLINE

To what extent can decline simply be measured by the absence or reversal of the indicators of growth discussed above?\textsuperscript{125} This would

\textsuperscript{123} Lucas 2004.
\textsuperscript{125} For a later period, cf. Wilson 2006 on construction techniques and the collapse of the building trade in the late antique west. In general we are not addressing the issues presented and analysed by Ward-Perkins 2005 and Wickham 2005 which concern the period after AD 400.
be a relatively straightforward approach. Without making any assumptions as to what the answers might be, we can at least identify what we would be looking for and this would certainly go some way towards answering the question. Whether it would provide a complete answer will need to be assessed in the light of considerations about 'steady state' and the balance of change in different regions at different times. Although most readers will naturally assume that in dealing with 'decline' we are looking at the period after c. AD 200, we should note, for instance, the implication of the view that the major period of growth was in the second to first centuries BC, with only limited growth in the principate, the implication of which is that it may have ceased before AD 200.\textsuperscript{126}

V.1. Trade and manufacture

The following bleak statement by Amanda Claridge about the marble trade is representative of widely held views:

The heyday was over by the middle of the third century. The market shrinks, the quarries wind down; highly experienced sculptors become fewer and fewer; the accumulated skills of thirty generations of unbroken tradition are less and less in demand. The marble was still there, stock-piled in Rome and abroad, and stock-piled in the quarries as well. But there were also armies of statues ready made to be re-used…\textsuperscript{127}

We might be able to demonstrate a decrease in the \textit{volume} and value of goods being made and traded; a decline in the quality of the manufactured objects (which might indicate a stagnating or declining technology and also a reduction in ‘standards of living’?); a reduction in the geographical range of trading, with shrinkage of long-distance trade, although the wide distribution in the east Mediterranean of African manufactured goods in the third and fourth centuries AD is well recognized. But there are complications, discussed further in Wilson’s chapter on trade in this volume. The disappearance of imports is not a straightforward indicator—import replacement by local production may be a sign of local economic

\textsuperscript{126} Morley 2007: 98. \textsuperscript{127} Claridge 1988: 152.
growth (see above, p. 43); but if imports are not replaced, and overall consumption levels drop, this would suggest decline.\textsuperscript{128} Equally, while an increase in the number of known shipwrecks between the second century BC and first century AD probably does reflect an increase in trading activity in this period, a variety of factors including the increasing use of barrels as containers means that a stagnation and then decrease in these numbers thereafter does not necessarily translate simply into a parallel reduction of trading activity.

Depending on what the evidence shows, we might deduce ‘decline’ at least as measured in terms of aggregate value of economic activity; measuring that in per capita terms is, of course, subject to the uncertainties in the demographic picture which we must constantly bear in mind.

\textbf{V.2. Stagnation of capital investment}

Stagnation or decline in the level of investment and in productivity can be sought both in agriculture and in manufacture (see above). For the former, the interlinked factors which we might consider would include the amount of land under cultivation and its productivity: what, for example, would be implied by a shift in the balance of cereal crops and viticulture,\textsuperscript{129} how significant is the phenomenon of declining rural communities, \textit{agri deserti} and its distribution?\textsuperscript{130} Is there a widening gap between rich and poor which would affect investment (making the wealthy wealthier stimulates investment?), forcing out the self-sufficient middle cohort, stimulating a move towards the ‘colonate’ with a reduction in the amount of slave labour (which might be either cause or effect), a decrease in division of labour?\textsuperscript{131} And if these are real phenomena, in any way measurable, are they necessarily constituents of or proxies for decline?\textsuperscript{132}

\textsuperscript{130} Whittaker 1993, ch. 3; Bagnall 1985.
\textsuperscript{131} Bowman 1985; see Bowman in this volume.
\textsuperscript{132} Wickham 2005: 411–28 discusses the later evidence for Aphrodito and Jeme, noting the different patterns in different Egyptian villages.
V.3. Institutional stimuli and attitudes

Institutional stimuli and attitudes are key factors which have to be contextualized in our general notions of the political and economic character of the later empire. It seems obvious enough that if the creation of military security and the encouragement of urbanization in the earlier empire encouraged economic growth, the state could have failed to continue or could have reversed these processes by choice or necessity, largely the latter one supposes, in the case of military security. The power of fiscal controls, particularly changes in the methods and levels of taxation and the monetary policy, or better ‘strategy’, will have had profound effects (higher taxes, more requisitions, changes in methods of collection, more in kind and less in cash, etc.) and the state could also have suppressed or reduced free market enterprise by other direct means (legislation affecting trade associations etc.). Thus, set against the picture of the prosperity of the ‘high’ empire to c. AD 200, we have the supposed Diocletianic ‘recovery’, a more oppressive fiscal regime, a free population overburdened by tax demands largely generated by the need to maintain an overblown military and bureaucratic establishment and collected via the wealthy landowners.\(^{133}\) On the other hand, it may be that the burden of taxation was systematized rather than increased, that the state machinery became less directly involved in the major productive processes and that, at least in some regions, communal responsibility for ensuring key socio-economic activities was more marked (in contrast to the earlier culture of public service and euergetism), if not necessarily easy to put into effect.\(^{134}\)

V.4. Specialization of labour and education of the workforce

One could imagine a measure of the decrease of different types of productive labour in urban centres as demonstrated by ‘industrial’ sites, fitting a picture of a return to reliance on local supply and a

\(^{133}\) This more or less standard view is summarized by Tate 1992: 1, but it can be found in many scholarly accounts.

\(^{134}\) Lepelley 1979, vol. 1: 59–73.
shrinking communication network. The latter would have to include some estimate of a declining standard of literacy and education which, as already noted, is difficult to achieve in quantified terms. Harris’s views of the constraints imposed by technology and of a declining literacy in the early Christian period have not proved very persuasive and are particularly hard to uphold for the eastern empire.135

However, if we look at stamps on Dressel 20 olive oil amphorae from south-west Spain during the first to third centuries AD, we note in the third century a much higher incidence of stamps with the occasional retrograde letter in an otherwise left-to-right text. This would appear to reflect a decreasing competence in writing on the part of the potters or workshop managers producing the stamps.136 Then, after the cessation of production of the Dressel 20 form c. AD 267, its replacement, the Dressel 23, does not carry stamps, suggesting a simpler and smaller-scale organization of production. Although there may not be a direct causal connection, there does appear to be a broad correlation between a decrease in the volume of Spanish oil exports and the use of literacy in the bottling plants for this oil.

V.5. Urbanization, demography, and settlement patterns

Here we might investigate the possibility of decreasing or shrinking urban centres, the counterpart of which might or might not be an increase in rural settlement which we would need to take into account in any estimate on an overall change in population levels. It is likely that such macro-estimates will prove elusive, but we might hope to gain some idea of the sizes and survival of settlements over time in selected areas where there have been reasonably systematic surveys. If those proved real, would we regard them as indicators of decline? The logic of taking urbanization as a proxy for economic growth would suggest that we ought to, but changes in settlement patterns and/or shrinkage of population are not necessarily incompatible with a steady state or

increased prosperity, which might be postulated for some areas in the third and fourth centuries, notably Syria. The building industry provides a perspective here: at Rome there are almost no large-scale building projects between the reigns of Alexander Severus and Diocletian, with the notable exception of the Aurelian Walls. In the provinces, public building activity (whether funded by imperial benefaction, municipal funds, or private euergetism) declines sharply after Alexander Severus for the rest of the third century. In view of this, it might seem somewhat paradoxical that at least in Egypt and Asia Minor there are clear signs of communal civic pride, matched by some expenditure, in the second half of the century.

Even if these attempts at measurement were per impossibile to prove robust and decisive, they would still not encompass the full complexity and nuances of the processes under scrutiny in the period up to c. AD 350. It might be possible to agree with a straightforward assertion of decline, at least in the west, from c. AD 400 onwards, but in contrast to an earlier communis opinio of decline from c. AD 200, there is now much less of a consensus about ‘crisis’ and more of an inclination to emphasize changes and regional differences. In conformity with our general approach to the subject and the evidence, it seems reasonable to state the premiss that there was considerable regional diversity across the Roman Mediterranean, the nature and extent of which we would hope to illuminate by quantitative methods.

Some positive results emerging from such investigations would enable us to test, at least for the earlier part of the period, current notions about the decline of the empire such as the cautiously expressed view of McCormick:

The overall economic trend of the Roman world from c. 200 to 700 was downward. This is not to say that decline prevailed everywhere, all the time: far from it. But within these chronological limits, the overarching pattern is now clear, even if the details are sometimes sporadic and even contradictory.

The notion of a drastic empire-wide economic decline in the third century (where, incidentally, the Egyptian evidence has played a

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137 Tate 1992.
140 McCormick 2001: 30.
central role in the collapsing economy view even for those who would insist on Egypt’s atypicality) and its antithesis might now seem like straw men, but the former is tenacious and has often been generalized on the basis of insufficient detailed evidence. Central to it is the undeniable notion of collapse and debasement of the imperial currency and the more debatable one of rampant inflation.\footnote{See Rathbone 1996a.} For Egypt, at least, we now have the benefit of some up-to-date analysis of series of price data which shows convincingly that the ‘price-inflation’ of the later third century can to a significant extent be explained by re-monetization.\footnote{Rathbone 1997, improving on Drexhage 1991.} This removes our reliance on an oft-cited Oxyrhynchus papyrus of AD 260 which has been thought to show the government refusing to accept its own coinage as a sign of a collapsing currency.\footnote{P.Oxy. XII 1411.} We also need to take into account the evidence, admittedly patchy and by no means totally unambiguous, of a certain vigour in civic aspirations and culture in some of the Egyptian \textit{metropoleis} in the later third century which suggests that it is too simplistic to characterize the period as one of ‘economic collapse’.\footnote{Above, n. 139.} On the other hand, it is reasonably taken as a clear indication of economic trouble that in Africa and the western provinces new public building programmes decline dramatically after Alexander Severus until well into the fourth century (and even in Africa a very large number of the fourth-century building inscriptions probably record repairs in the wake of earthquakes in the 360s).\footnote{Fentress 1981: 199–201; Wilson 2007b: 293. But see Lepelley 1979 on the post-Diocletianic prosperity and building in the fourth century (I, 59–120), although, curiously, he seems to ignore seismic activity in the 360s as a factor in the peak in repair inscriptions under Valentinian I (364–75).} These somewhat inconclusive indications suggest two further questions which we should address. We have a significant quantity of dated documents and of other evidence, particularly numismatic, for the period c. AD 260–90 which reflect both communal (particularly at Oxyrhynchus and Hermopolis) and private economic activity in that period. They ought to reveal any significant changes in patterns of economic behaviour on a communal or private level and thus suggest whether we are right to envisage a degree of abnormality. An answer to that question will form at least
part of our characterization of the ‘third-century crisis’ by indicating whether or not people behaved in ways which suggest they believed that their prosperity or subsistence was in jeopardy because of systemic or structural collapse (rather than incidental or occasional difficulty). If we can do this, however incompletely or provisionally, for Egypt, we will still be aware of the need to show whether or how we can extrapolate to other areas. At the very least, greater scepticism about this kind of generalization is required.

The second question is related, but looks ahead to the longer term. If the economy ‘recovered’ after c. AD 300 what was the basis of that recovery and was it equally effective everywhere? One aspect of this will be the re-stabilization of the currency, on the basis of a reformed gold coinage, which was clearly effective to a significant degree and (amongst other important features) terminated the use in Egypt of the Alexandrian-minted tetradrachma. There were clearly hugely important changes in the ways in which fiscal administration, with stimuli and deterrents, operated after AD 300. Some studies of Egypt from the fourth century onwards have emphasized that this period laid new and different foundations for agrarian vitality and prosperity at least in the east, others more negatively that it did not see the creation of conditions for a ‘Byzantine feudal system’. Re-analysis of shipwreck data also suggests a slight—and unsustained—rise in the number of known wrecks in the early fourth century, which may reflect some recovery in levels of trading activity (see Wilson’s chapter on trade in this volume). Our perspective here will not take us beyond the middle of the fourth century, but there is still a good deal of useful evidence available which may well make us feel uncomfortable about postulating universal decline in the period AD 300–50, whatever we may think ensued after the beginning of the fifth century.

VI. AREAS FOR ANALYSIS

The four main areas in which it seems to us most fruitful to attempt to quantify and compare both documentary and archaeological

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evidence for the Roman economy are demography (including settlement patterns and urbanization); agriculture; production and trade; and the relationship between mining, metal supply, and coinage. Within these areas we should be able to look for the indicators of integration, growth, and decline discussed above.

VI.1. Demography, settlement, and urbanization

‘The primordial element is population size, because in a pre-industrial society, the aggregate amount of wealth produced is directly connected with the numbers of people working.’\(^{148}\) Size, distribution, and movement of population are clearly crucial to economic performance, especially in relation to the ability of the land to support the population and the scale and concentration of ‘production’ within settlements. The question of economic growth and contraction is closely tied to questions of demographic change; and the question of per capita growth is closely connected with the proportion of the population engaged in non-agricultural activities, for which a proxy may be urbanization rates.

We recognize the force of these observations but, as anyone familiar with the spate of recent studies on the demography of the Roman world will realize, we are in severe difficulty from the outset. We do not debate here the plausibility of the Beloch/Brunt estimates of a total population of 55/60 million for the whole empire in the Augustan period, which many still regard as the best guess-estimate, and their close relatives for the total size of the high empire population, but note only the continuing vitality of the debate about widely varying high and low counts for various parts of the empire at various times (notably Italy and Egypt, where no consensus has emerged) and the fact that what some scholars have proposed as ‘least worst’ hypotheses still produce major implausibilities and inconsistencies even where we do have some figures and (at least in the case of Egypt) one methodologically exemplary study for an area which has very rich (by ancient standards) evidence.\(^ {149}\) For rural

\(^{148}\) McCormick 2001: 30.

\(^{149}\) Morley 2001; Scheidel 2001a; Lo Cascio and Malanima 2005; Kennedy 2006; for Egypt, Bagnall and Frier 1994. The figures given by Josephus for the total
areas, large-scale reliable statistics of any kind are notoriously
difficult to obtain for anywhere except Egypt.150 Some well-informed
discussion of these difficulties and possible approaches (hardly solu-
tions) to them are included in this volume (Fentress, Lo Cascio), but
we are not optimistic about the possibility of obtaining a significant
consensus or a firmer foundation than exists at present, nor are we
enthusiastic about simply constructing alternative scenarios on more
or less flimsy premisses and testing them by the relative strength or
weakness of the consequences which flow from them. We can neither
offer a top–down approach of this sort, although it is difficult to
avoid being influenced to some extent by the figures which are
routinely bandied about; nor could we possibly hope to reach a
reliable conclusion by aggregating figures (even if we had them) for
all the constituent parts of the empire over the whole period.

What, then, can we do? The contributions of Fentress and Lo
Cascio to this volume, and the associated discussions, indicate the
importance we attach to estimating the levels of urbanization across
the empire and attempting to relate survey data to population trends.
Neither of these approaches is straightforward. Apart from the vari-
ability in the quantity and reliability of the evidence, there are
fundamental issues to be resolved. On urbanization: what thresholds
do we envisage (and are they the same for all places?—evidently not)
in deciding whether a settlement is urban or not, in the grey areas
populated by what might with equal plausibility be described as small
cities or large villages? Criteria (none of them hard and fast) include
size, legal status, institutional and physical infrastructure. It is inter-
esting, and significant not only in social, but also in economic terms,
that a nucleated community of only 2,000 people might possess
a forum, basilica, several temples, entertainment buildings, an
aqueduct and street drainage system, together with a level of self-
government and administration. This is a considerable per capita
‘monumental overhead’ representing an expenditure of surplus that
is comparatively larger than in some other pre-industrial societies.151

population in the first century AD were regarded by Jones as reliable, but many have
rejected them as too high (above, n. 13).

150 For a later period see Wickham 2005, ch. 8.
151 For comparison, Ragusa (Dubrovnik), whose population in the mid-fifteenth
century was perhaps 5,000–6,000, was unusual for a late medieval town in acquiring
To regard that expenditure of surplus simply as ‘consumption’ is facile; both the physical and institutional infrastructures enabled the development of larger markets, offering opportunities for increased division of labour, and lowered transaction costs. Second, the extrapolation of population trends from systematic surface survey is a relatively recent activity and the data derived therefore are subject to various important caveats.\textsuperscript{152} Not only does one have to make decisions about what population multipliers to apply to different settlement categories (villages, villas, farms, etc.) in a particular region, but there are also wider issues of survey comparability and of possible differences in site detection rates caused by a variety of factors (fieldwalking intensity, modern land use and visibility conditions, post-antique alluviation, erosion, etc.).\textsuperscript{153}

Nevertheless, by way of a brief sketch of the agenda for a future volume, the direction of recent work in demography suggests the potential value of quantitative data for some places and periods on the following topics:

- Numbers and distribution of settlements classified by size and rank. We can, for example, compile and compare the evidence for settlements in particular areas, some of which will encourage us to bring documentary and archaeological evidence into relation. The increasing amount of archaeological evidence from survey and excavation in Egypt (the Delta and the Fayum in particular) is complemented by a wealth of documentary detail which may yield both actual and virtual maps of particular areas.\textsuperscript{154} Well-published archaeological evidence for Syria in the later Roman period, where there is clearly a high level of prosperity, can provide interesting material for comparative trends.\textsuperscript{155}

an aqueduct-fed running water supply as early as 1438, which fed only two fountains. The city of Cambridge received a running water supply only in 1610 with the construction of ‘Hobson’s Conduit’ (or the ‘New River’) from Nine Wells near Shelford: Bushell 1938.

\textsuperscript{152} Sbonias 1999; Witcher 2005; Fentress in this volume.

\textsuperscript{153} Wilson 2008b.


\textsuperscript{155} Tate 1992; Gatier 1994.
Evidence for survival of settlements over time. For Egypt in particular we can use the documentary evidence to trace the survival of town and village names over time and to estimate the correlation between the survival of names in documents and the actual survival of settlements.\footnote{156 Based on toponyms collected for regions of Egypt, Drew-Bear 1979; Pruneti 1981; Falivene 1998.}

Physical dimensions of urban and rural settlements. Actual sizes of sites can be collated and the simple scaling of site plans and other (comparatively objective) physical data will contribute to the realization of valid comparisons across regions, which will take account of regional variation (meaning that we will not assume that a 10 ha site in Spain must have the same population as a 10 ha site in Syria).\footnote{157 For city sizes in Spain, see Carreras Monfort 1995–6.} It is striking, for example, that in Egypt villages of 20–50 ha are not uncommon—comparable with cities like Thugga in Tunisia (25 ha), Italica in Spain (41.5 ha), or even Turin in Italy (47 ha). Clearly, estimates based on walled area are crude and may ignore suburbs; they also tend to produce a snapshot at a single, and often poorly dated, moment in time. Nevertheless, this approach does enable some very broad-brush comparisons across time or between different cultures which may be illuminating: seventeenth-century Ragusa (Dubrovnik) is about two-thirds the size of first-century Pompeii (and had substantially less ‘monumental overhead’). Size data could be used to produce basic rankings of settlements by area, which in turn could be cross-checked against a likely hierarchy of functions or services provided by these cities.

Numbers of living units and density of habitation. We can experiment with approaches that might allow some extrapolation from sizes of urban and non-urban settlement to populations. We prefer approaches based on population densities per hectare, and on numbers of dwellings per settlement, to approaches based on floor area of houses, which for our period tend to be vitiated by uncertainty over the existence, extent, and numbers of upper storeys. Nevertheless, the density- or dwelling-based approaches are not at all straightforward; comparative evidence from other...
societies suggests that a wide range of urban population densities per hectare are theoretically possible, while dwelling-based estimates are confused by uncertainty over how many slaves to allow for each household and above the nuclear family unit that comparative anthropology frequently suggests might be in the range of 4.5–5 people per unit. Comparisons of census data with known plans suggest that medieval European cities commonly had densities of 100–120 people per hectare, with densely populated cities perhaps up to around 200/ha; but calculations for ancient Mesopotamian cities suggest 300–500/ha, and Zorn, using a series of converging indicators, makes a strong case for 470–590/ha in the Iron Age II phase of Tell en-Nasbeh in Israel. Comparisons with urban densities of other cultures or periods serve simply to show the range of the possible; they cannot be used as arguments for choosing a particular figure for Roman cities since urban population densities and living patterns may be culturally specific. However, in some extensively excavated cities (Ostia, Pompeii, and to some extent also for Timgad, Sabratha, and other cities) it is possible to estimate numbers of living units or households, and these may be able to provide a cross-check against density per hectare calculations. Figures of c.175/ha for first-century AD Pompeii, c.200/ha for second-century Sabratha, and c.360/ha for the Trajanic colony at Timgad look plausible on these grounds. We would expect Rome, Ostia, and some other large cities with evidence for multi-storey insula housing to reach substantially higher densities. The Egyptian evidence may prove particularly valuable in enabling comparisons of site sizes and documentary figures for population. Clearly there is going to be considerable variation over time, between regions, and even between towns in the same region (densities in second-century AD Ostia will differ considerably from those in first-century AD Pompeii). Nevertheless, assessing the extent of such differences is valuable; and we may be able at least to establish possible ranges

158 This approach was used by Beloch 1886, notably for Roman Italy. For more recent discussions of population estimates for ancient settlements, see e.g. Zorn 1994; Carreras Monfort 1995–6.

159 Zorn 1994.
(not absolute figures) for a set of urban populations. These in turn could be fed into debates about the urban population as a proportion of the empire’s total population.\textsuperscript{160}

- Public building activity, as recorded by, \textit{inter alia}, documents and inscriptions recording or commemorating construction and repair. Collections of building inscriptions, though not comprehensive, are available and seem to us (as they have to others) to be testable and useful proxy evidence for growth or shrinkage.\textsuperscript{161} This is a particularly vital issue since the notion of a severe decline in the quantity and quality of public building, accompanying a decline in the incidence of euergetism, is still a tenacious element in notions of economic decline in the period after AD 200.\textsuperscript{162}

- Identification of ‘units of production’ for specific artefacts and commodities. As Wilson has pointed out elsewhere, there is a significant amount of published archaeological evidence for ‘manufacturing’ sites in towns and cities which has not yet been fully aggregated and quantified.\textsuperscript{163}

There is a growing body of evidence which will allow us to analyse a relatively small number of individual communities in detail, and to estimate fluctuations in size over comparatively long periods and large distances. Much of this relates to Egypt and the Near East and will be discussed in detail in a subsequent volume (we note in passing the opinion that it is no longer intellectually respectable to dismiss Egyptian evidence as having no significance or value for demographic patterns in the ancient Mediterranean).\textsuperscript{164} The village of Philadelphia in the Egyptian Fayum may stand as an illustration. Its population in the first century AD can be calculated with some precision since we know from tax documents that the number of adult males between the ages of 14 and 60 who paid poll-tax was between 900 and 950 in the period c. AD 50–100.\textsuperscript{165} To arrive at the total population we need to estimate and add the number of exempt

\begin{itemize}
\item Wilson 2011.
\item Contrast Lepelley 1979 on fourth-century Africa.
\item Wilson 2002b.
\item Bagnall and Frier 1994: 173.
\end{itemize}
persons (mainly Roman citizens) and use the multiplier which represents the proportion of adult males in the population as a whole.\textsuperscript{166} These figures may be subject to some margin of error but there can be little doubt that the total population lay in the range of 3,000–3,500 in this period. From that relatively secure base, we might then adduce evidence which relates to: the physical size of the settlement; the size of the population in relation to the early Ptolemaic period (the Zenon archive) and the later Roman period; comparison with other villages in the Fayum; the sizes of houses and households in the first century; the configuration of landholding in the region of the village.

It would be foolhardy to predict that the results of such research will produce a more reliable or robust version of the Brunt/Beloch estimates, or even a confident conclusion for any single province, city, or area that we do not already have (few enough). We might, however, hope to contribute something robust to the debate on levels of urbanization in the empire and in its different regions, an issue of general significance both for the fact that ‘urbanization’ is often claimed as one of the hallmarks of Roman imperial culture and for its potential value as an indicator of economic performance (Lo Cascio, this volume). This too involves problems in the overall demographic picture which will probably not admit simple solutions—for example, the probable incompatibility of a total population estimate of the order of 55/60 million and an urbanization rate of c.10\%, preferred by some.\textsuperscript{167} If the population is of the order of 60 million then the corollary may be a rate of urbanization significantly higher than 10\%. We would hope, however, to be understood as sidestepping the insoluble problems and practising the art of the possible, in the present state of evidence. The gains should be significant, if only in providing some basis for undermining the tendency to be too reliant on exemplary or anecdotal items of information.

\textsuperscript{166} There is no universally agreed figure. Those most commonly used fall in the range 2.9 to 3.5. Further discussion is postponed to the next volume.

\textsuperscript{167} Hopkins 1980; 1983: 85; Temin 2006a, b but cf. Pleket 2006: 320: ‘It would not be irresponsibly audacious to posit a population of, say, 65 or 75 million’. See also Lo Cascio, this volume, and Wilson 2011.
VI.2. The agrarian economy

It is common ground that agriculture was the dominant economic activity throughout the Mediterranean world in classical antiquity. We would not, at the outset, propose to quantify this in terms of the proportion of gross product which it represented and we deliberately eschew any approach based on any dichotomy between urban and rural economies or the notion that the urban centres parasitically absorbed the wealth produced by agriculture without reciprocity. Likewise, we are suspicious of overarching generalizations, such as those which propose the growth of Italian latifundia in the second century BC, the dominance of agricultural slave labour, or the development of a ‘feudal’ system in later antiquity. Equally, we avoid simply adopting the perspective of the literary sources (which is not the same as asserting that they have no value), whether the ‘manuals’ of Cato or Columella, or the anecdotal evidence of writers such as Pliny the Elder.

Three general observations, to begin with. First, it would be obviously absurd to attempt a quantified study of the whole agrarian economy of the Roman Mediterranean in a project of the scale we envisage, even had we much more hard evidence than is the case. Apart from the enormous regional diversity, it involves an extremely complex interplay of different activities and factors: not merely cultivation of the Mediterranean triad, cereal, vine, and olive (along with fruit, vegetables, and pulses), but also pastoralism, animal husbandry, fish-farming, wild plants, salt-mining, and so on. Effective exploitation of the natural ecology to feed the population and to produce surpluses which can be transformed into other forms of wealth for the state (tax) and the individual is underpinned by modes of deployment of labour (slave and free, waged and tenancy-based), use or absence of technology, methods of transport, and redistribution over local and regional networks, all of which would need somehow to be costed or given a value. We suspect that any general statement which tried to capture the sum of the dimensions or values of such elements and activities would be fragile to the point of uselessness. This is of a piece with our reservations about estimates of GDP (see above). However, it

does not mean that we completely reject the utility of models such as
the ‘taxes-and-trade’ model, but we cannot see how calculations of,
for example, the income of Ptolemaic Egypt in the last century BC and
the whole empire in the first century AD can help us very much.\textsuperscript{169}

Second, the one and only area where we have sufficiently detailed
evidence to attempt a quantified study with any confidence at all is Egypt (see Bowman’s chapter, below, for possibilities and qualifications).\textsuperscript{170} Here we have the basis, however patchy the evidence may be, for some speculative models which might be applied to modes of activity (land distribution, crop-yields, food-supply, labour) or to particular ‘communities’ (family, village, local region). Whatever conclusions we derive from such attempts certainly cannot simply be mapped on to other regions. Cursory and random survey of recent research which has attempted analysis of the economics of agriculture in different regions other than Egypt reveals that even the best examples tend to be micro-regional, far from comprehensive, and reach conclusions which are much more qualitative than quantitative. Two examples: Kehoe on African estates in the Bagradas Valley cannot produce estimates even of the areas of land under cultivation.\textsuperscript{171} Duncan-Jones, on investment in viticulture, uses evidence from literary sources which he had to adjust in order to reach conclusions which the author himself could regard as economically plausible.\textsuperscript{172} Third, what can we do, therefore? We believe that there is now a sufficient quantity of reliable, widespread, and detailed studies for particular regions or categories of activity, spread across the Roman Mediterranean chronologically and geographically, which will either serve as proxies for quantifying agricultural economics or will in the aggregate suggest similar trends or divergences. Examples include: olive oil production in Africa and elsewhere, irrigation technology, land distribution in Asia Minor, field survey evidence on rural settlement patterns and villa systems.\textsuperscript{173} The difficult part

\textsuperscript{170} For a robust statement of this position see van Minnen 2000.
\textsuperscript{171} Kehoe 1988.
\textsuperscript{172} Duncan-Jones 1982: 31–59.
will, once again, be to see what conclusions of general significance we can coax out of these micro-examples, both in relation to agricultural activity in its narrower sense and in terms of the relationship of agriculture to the other economic aspects which we are considering. Let us suppose, however, that we might be able to compare patterns of land-ownership in fourth-century Egypt, Asia Minor, and rural Syria, or production capacities of processing ‘plants’ for fish, olives, or wine in relation to the physical size of the settlements in which they were located. It is our hope that a sufficient number of such comparisons or proxies (more than we could ourselves generate) will make a significant contribution to our understanding of the broader economic infrastructures and trends, as might comparison with evidence from somewhat later periods.

VI.3. Production and trade

Papyri and other documentary sources provide abundant evidence for commerce and trade. Archaeologically, there is an abundance of physical material that has clearly been produced in one place and consumed in another; problems and pitfalls of analysing this are explored in Wilson’s chapter below. We hope to examine trends in rising and falling market shares across the Mediterranean of different ceramic classes and products shipped in amphorae, and we propose to pursue the suggestion by Fulford in his contribution to this volume of using artefact distribution to examine to what extent the different costs of land, river, and sea transport in practice constrained distribution of different categories of goods. We will focus on:

- The production of certain kinds of goods where data lend themselves to quantification of production infrastructure, e.g. the salted fish industry and related by-products of garum, liquamen, etc.\(^{174}\)
- The movement of ceramics (including finewares and amphorae), plotting provenance against quantified distribution of finds. To what extent does the distribution of imports drop off with distance from the sea and from major river corridors? This will involve the

\(^{174}\) For a first attempt at this, see Wilson 2006; cf. Wilson, this volume.
collation of datasets from various published field survey projects and excavations.

- Comparison of ceramic trends against selected artefacts, notably sarcophagi, decorative marble, and millstones, for which existing petrographic provenancing studies can be synthesized.

- The context in which goods moved, with the caveat that factors biasing wreck discovery make them more useful for indicating typical ship and cargo sizes, than for establishing patterns of trading routes. Reanalysis of the chronological distribution of wreck data, and augmentation of the dataset, may produce new insights (Wilson, this volume). Egyptian papyri and the Vindolanda and Murecine tablets are also promising for illuminating the context in which goods moved.

- Social perspectives of consumption—on what types of sites are different artefacts found, with what implications for access? Is there increased access to mass-produced goods by more of the population and does this reliably indicate ‘economic growth’?

For local commerce and economic activity, we can take the grapheion records from the Fayum village of Tebtunis, with concentrated data for a very large number of contracts of various kinds deposited over a limited period early in the reign of Claudius (see above). From this one can extract not only the numbers and periodic distribution of the contracts but also (in a village whose size we can estimate with some degree of confidence) the number of people involved in written economic transactions, the value of the individual transactions, and accumulated ‘value’ (even if not complete) over the period. Data of this kind might allow us to construct at least a partial picture of the economic activity in such a village which might suggest values of capital assets (property) and of transactions in different ‘sectors’.

VI.4. Mining, metals, and metal supply

The Roman empire made extensive use of coin, and bullion supply was crucial to the highly monetized Roman economy. Archaeological and documentary (principally epigraphic) evidence for mining will be collated with numismatic data, to test the hypotheses that the
exploitation of new sources of metal was to a significant degree responsible for economic growth from Augustus onwards, and that the abandonment or loss of these sources created or exacerbated fiscal problems in the late second and the third century. Key issues are:

- Output of coinage metals (gold, silver, copper), but also other metals whose extraction was important for production of tools, weapons, and other artefacts.

- Utilization of Greenland ice core data on atmospheric pollution as a proxy measure of diachronic production of copper, silver, and lead.\(^{175}\)

- Survey of major mining sites, with dates of exploitation, geographical distribution, and archaeological evidence of workings and output. At some sites, the size of slag heaps (discussed below) can provide quantifiable data on the output of individual mines.

- Estimates of the precious metal content of the coinage, utilizing existing work estimating proportional output of new and re-minted coin. In this context, the new metallurgical analyses by Butcher and Ponting, presented by Ponting in this volume and discussed by Hitchner and Howgego in their contributions, are fundamental.\(^{176}\)

- Estimates of modes and volume of loss of precious metal over the period.

- Examination of archaeological indications for the opening up of new trans-Saharan routes giving access to new, sub-Saharan gold sources.\(^{177}\)

Closely related, of course, to questions of currency and prices are questions of the relationship of money supply and metal supply. In an earlier paper on the metal supply of the Roman empire one of us tried to look at the correlations between, on the one hand, the exploitation of mining resources in the Roman empire and, on the other hand, the precious metal contents of the coinage, as we now


\(^{177}\) Garrard 1982; Wilson 2007a.
understand it principally from the work of Butcher and Ponting (cf. Ponting, this volume). The cessation of most large-scale activity at the major Spanish mines before the end of the second century squeezed the supply of precious metals just as demands for increased military pay rose. An obvious question is: were the mining resources providing the new metal which was still needed even for the much debased and recycled coinage of the third century?

Case study 3: Mining in Upper Moesia

In this regard, Dragana Mladenović has recently drawn attention to some interesting quantitative evidence from the Kosmaj region of Serbia (Upper Moesia), where vast slag heaps of the lead and silver mines near Stojnic cover an area of some 6 km² (Fig. 1.5). She has collected estimates of the amount of slag remaining in the 1960s, totalling over 2 million tonnes, and estimates of the amounts of lead


179 The evidence is treated at greater length in her doctoral thesis, Roman Moesia Superior: the creation of a new provincial entity and processes of multicultural adjustment (2009), and Mladenović forthcoming. We thank Dragana Mladenović both for this information and permission to summarize it here, and for the opportunity to explore the Stojnic slag heaps.
and silver that were likely to have been extracted from that slag using Roman-period technology (Table 1.1). When one adds to the amount remaining in 1966–7 the various amounts of slag known to have been taken away for reprocessing in modern times, especially by the Austro-Hungarians during the First World War, one arrives at over 2.2 million tonnes of slag, from which over 650,000 tonnes of lead, and 5,295 tonnes of silver, had been extracted. Over a period of 300 years of operation, this averages out at at least 2,186 tonnes of lead and 17.65 tonnes of silver per year; real totals will have been higher, perhaps by 10% or more, since the Nazi forces also removed an unknown quantity of slag in the Second World War, which for a variety of reasons is likely to have been more than the Austro-Hungarians did. For comparison, this figure of over 17 tonnes of silver per year is closely comparable with the 20 tonnes per year produced by the Laurion mines at their peak of operation in the fifth century BC.

But the Kosmaj region is not Serbia’s main silver mining resource; it does not even figure on a 1990 map of the Upper Moesian mining regions, which concentrates on the better-known regions of Kosovo and the Upper Timok valley;\(^{180}\) nor does it appear on a modern map of silver deposits,\(^{181}\) perhaps because the Romans worked the deposits out to the water table. The much larger silver mines of Kosovo and the Upper Timok valley should have been even more important, and suggest that we need to think further about the relative

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**Table 1.1.** Estimates of remaining slag, and quantities of lead and silver extracted in the Roman period from the Kosmaj region in Upper Moesia

<table>
<thead>
<tr>
<th>Slag (tonnes)</th>
<th>Pb extracted (tonnes, +/- 10%)</th>
<th>Ag extracted (tonnes, +/- 10%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removed 1880–1905</td>
<td>336</td>
<td></td>
</tr>
<tr>
<td>Removed in WW I</td>
<td>227,686</td>
<td></td>
</tr>
<tr>
<td>Removed in WW II</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>and 1956–66</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Remaining in 1966–7</td>
<td>2,002,750</td>
<td>588,710</td>
</tr>
<tr>
<td>Original total</td>
<td>2,230,772 +</td>
<td>655,737 +</td>
</tr>
<tr>
<td>Annual average over 300 years</td>
<td>2,186 +</td>
<td>17.65 +</td>
</tr>
</tbody>
</table>

*Source: D. Mladenović.*

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\(^{180}\) Parović-Pešikan 1987/90.

importance of the Balkan mines in the changing conditions of metal supply over the imperial period. This is borne out by the fact that, together with Bessa in northern Italy and Dolaucothi in Wales, the Balkans are the only region outside Spain where techniques of hydraulic mining were used to achieve gold extraction on a scale not paralleled again until the nineteenth century—Roman workings of alluvial gold deposits in the valley of the Vrbas river in Bosnia and the valley of the River Zsil in Dacia; and in *stockwerk* (layered vein) deposits in Dacia at Piatra Seaca and at Braza.  

The scale of mining achieved in the Roman world is related not only to the demand for metals for coinage, but also determined by the technology and capital investment available. Recent work has stressed the probable economic impact of the obvious and often spectacular advances in mining technology in the Roman period—the uptake of water-lifting devices for drainage, allowing mining of enriched deposits below the natural water table; and the often massive opencast gold mines worked by hydraulic erosion. However, work remains to be done on the less spectacular advances made in the technology of underground mining, including shoring and enlarged gallery size for ease of ore transport and removal, enabling the use of animals and even wagons in some mines; these advances are important because the majority of mining involved underground tunnelling rather than hydraulic opencast workings, and so advances made in this area could be more widely applied. Clearly, therefore, there is useful research that can be done to relate the archaeology and chronology of different mining areas to the metal production of different provinces at different times, and to developments in coinage and the economy at large.

One question, in the light of the apparent reduction in the number and scale of gold-mining sites by the fourth century AD, is whether the increased purchasing power of gold by that time noted by Rathbone (this volume) might in fact be due to an increase in its relative scarcity.

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182 Davies (O.) 1935: 186, 201, and 203.
183 E.g. Wilson 2002a; Domergue and Bordes 2006.
184 Rosumek 1982 for a preliminary collection of the evidence; cf. also Lewis (M.) 2001 for wagons and even an early mining ‘railway’.
186 Rathbone appears to discount this, but cf. Wilson 2007a.
VII. CONCLUSION

A project like this inevitably needs to concentrate on specifics; in order to quantify, we need particular case studies and areas. We cannot look at the whole economy, nor are we trying to. What we are trying to do is identify a series of indicators that can suggest trends; and these may be different in different regions. We need to break the problem down into constituent parts and analyse in some detail, and then re-aggregate the trends identified. By so doing we hope to obtain a clearer idea of how the Roman economy compares with periods before and after, and with other cultures and periods; and how different provinces or regions performed over time within the Roman period. Most importantly, we hope to move discussion of the Roman economy in new directions, to stimulate debate, and to provide a means of allowing analyses of the Roman economy to be worked into economic histories of the very long run, which until recently have tended to start around AD 1000 for lack of published time series data before this.

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Quantifying the Roman Economy


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Quantifying the Roman Economy


Alan Bowman and Andrew Wilson


