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## Human capital and the growth of the Roman economy

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Abstract: Over the past 50 years economists have increasingly emphasized investment in human capital as a fundamental cause of sustained economic growth, because investments in education, training and health make the labor force more productive. This paper examines Roman education and training, and argues that Roman investment in human capital was higher in the early empire than at any time in Europe before 1500 CE, but noticeably lower than in the fastest growing economies of the early modern era (e.g., the Netherlands).

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This paper takes as a starting point Keith Hopkins' basic article, "Rome, taxes, rents and trade."<sup>1</sup> Walter Scheidel's introduction to the article described it as "...the only comprehensive attempt to explain the dynamics of the Roman imperial economy currently available.... [It] will remain the starting point for further research for the foreseeable future." Hopkins concluded that the Roman empire experienced "modest, though significant, economic growth." For those of us who follow Hopkins, the challenge is to put as much content into the phrase "modest, though significant" as possible within the constraints of the evidence. My paper has two parts: first, some general methodological observations in the hope of promoting clarity, and second, a broad sketch of one principal aspect of economic growth, human capital.

Methodological observations. As we try to build on Hopkins' work, it is worth enumerating explicitly the qualities of "Rome, taxes, rents and trade" that have made it durable and fundamental. In my view, the virtues of that article are that the analytic arguments are systematic and coherent, starting from a broad description of context. Hopkins understood that in the absence of aggregate quantitative data for economic production, the strength of his claims lies in the coherence of the interlocking arguments about population, agricultural and urban production, coinage, taxes, and trade. He was forthright in laying out his assumptions for criticism and ingenious at locating time-series of evidence to reveal trends. In so doing, he accepted Finley's challenge to rise above the anecdotal. Furthermore, his analytic framework about interrelated elements of the imperial economy gave rise to hypotheses about causation—most obviously, the proposition that the imposition of imperial taxes prompted increased agricultural production, urbanization, and the growth of trade.

With these virtues as standards, how can we put more content into "modest, though significant"? The difficulties of measurement, together with the absence of broad aggregate data for population and production, make it impossible to answer directly the question of how fast or how much the Roman imperial economy grew. At best, we can suggest the bounds of the probable. Another, indirect strategy is to look for indicators associated with growth, and then to interpret them by comparison with a set of other pre-industrial economies. A good example of this approach is Peter Temin's paper on financial intermediation in the Roman empire, with comparisons with early modern France, England, and the Netherlands.<sup>2</sup> My offering on human capital is an effort along those lines. It seems to me that such arguments will contribute more to the broader discourse to the extent that the comparison set is explicit, as in Temin's paper, and to the extent that the indicator is interpreted in the context of a theory of economic growth. If a broad range of comparative indicators converges, then we may achieve a more meaningful sense of "modest, though significant."

Another strategy, used by Hopkins and now expanded by Wim Jongman,<sup>3</sup> is to search for a variety of time-series of evidence that reflect economic activity and hence can serve as proxies for growth and decline. Jongman's seven graphs all point to increased economic activity or higher living standards under Roman rule, followed by a decline, but it must also be noted that the peaks in the seven graphs are scattered over two centuries. They do not coincide to tell a simple story of a growing economy and improving living standards

until 150 or 200 A.D., when an exogenous shock such as plague or political crisis reversed an otherwise sustained upward trend. The first three graphs—shipwrecks, lead pollution, and German wood—peak in the first century B.C. Three more graphs—German material remains, Italian animal bones, and average human femur length—peak in the early Principate before 100 A.D. Only the sixth graph of animal bones in the provinces peaks in the early second century A.D. and is consistent with the causal hypothesis that the Antonine plague put a stop to sustained growth.

The time-series depicted in the graphs point to an “efflorescence” in the Mediterranean economy under Roman rule, but the explanation or explanations should be based on careful attention to the chronologies.<sup>4</sup> We need to ask whether the temporal patterns are more consistent with endogenous or exogenous causes of growth and then decline. I raise this question for discussion and further research

The concept of human capital. Human capital has become a central topic in the discipline of economics over the past 45 years. The seminal paper, “Investment in human capital,” was published by the Chicago economist Theodore Schultz in 1961.<sup>5</sup> His starting observation was that economic growth through the 20<sup>th</sup> c. had outpaced the investment in the factors typically considered by economists at the time—land, physical capital, and man-hours. His explanation for this growth was that the labor force was increasingly educated and skilled. It followed that any analysis of economic growth had to take into account the investment in the quality of the human work force. In less developed economies, Schultz noted, the investment in human capital could take the form of expenditure on food and shelter; in more developed economies, it also included investment in training and education and in health care. Another form of investment is migration of labor to a location where it can be more productive.

The basic logic of each of these investments, once stated, is clear. Investment in nutrition and health enables labor to put in the energy needed to produce. Fogel has estimated that perhaps 20% of the population of pre-revolution France was too poorly fed to be able to work full days.<sup>6</sup> More recently, investments in medical research and public health have decreased mortality and morbidity to allow each of us longer, fuller working life. The investment in the education and training of the population has led to a knowledge economy in the late 20<sup>th</sup> c in which there is sustained improvement in the technology of production and workers are educated to use the technology. Reference to the contemporary “knowledge economy” may seem a bit trite, so let me give you a comparison to illustrate the scale of change. Universities today are at the pinnacle of the production of high-end human capital, and hence have become a preoccupation of policy-makers. The growth in the size and complexity of universities has reached the point where my budget of \$400 million as Dean of the School of Humanities and Sciences is about the same magnitude (in wheat or silver equivalent) as that estimated by Hopkins for the expenditures for the entire Roman imperial government, including pay for the army and the imperial staff. Finally, migration provides the fluidity to match workers to their potential for greatest output.

Human capital and Roman growth. How can we use the approaches suggested by the concept of human capital to analyze growth in the Roman economy? This is a rich topic with many dimensions, many of which need more exploration and then integration.

Research done over the past two decades on nutrition, health and mortality is fundamental to economic production.<sup>7</sup> In the course of the 19<sup>th</sup> c. the western European economies began a basic shift toward longer life expectancy through public health improvements, longer working lives, warranting greater investments in the education of fewer children who could be expected to survive.<sup>8</sup> It hardly needs to be said that the Roman empire never experienced this shift, and Walter Scheidel has estimated that the expected working life of a Roman entering adulthood was of the order of 20 years, in contrast with 40 years today. That difference changes the calculation about how many children to bear and how much to invest in the nutrition and education of each. In this respect, Rome was similar to other pre-industrial societies. There are some related microeconomic issues that differentiate Rome, because of the clarity of human capital investments in a slave society. First, there is the phenomenon of the exposure and enslaving of newborns. Why, given the risk of childhood mortality, would anyone have picked up a newborn and invested food and shelter in him or her until the age of productive work? It is possible to use data from Roman Egypt on the cost of wet nurses and food, together with the price of teenage slaves, to calculate that the present value of the investments in a foundling, including the probability of death before adulthood, came close to the market price of a young adult slave.<sup>9</sup> Why choose the foundling? I can think of two reasons: for an owner of modest means the investment was more gradual, and the owner would have the equivalent of a verna who was regarded as more loyal.

Slave owners then had to make decisions about how much to invest in the maintenance of their slaves. For owners like Cato, this was a matter of conscious calculation. His De Agricultura (LVI) advised a greater investment of nutrition in fieldhands during the heavy summer months than in the domestic and supervisory staff—an understanding of the need to invest in the calories necessary for work. And of course, Cato notoriously recommended that old, depreciated slaves be sold in order to off-load the costs of maintenance—to whom is not obvious to me. Varro's De Re Rustica (I.17.3) shows an awareness that the risk of mortality varied by region, and with it, the rate of depreciation of slaves. The recent research of Sallares and Scheidel on the striking effect of malaria in dramatically increasing death-rates in certain regions has important consequences for the returns to human capital—an issue to which I will return in thinking about urbanization.<sup>10</sup>

One final practice under this heading: the deliberate destruction of human capital in the arena. From late in the reign of Marcus Aurelius comes a Senatus Consultum de Pretiis Gladiatorum Minuendis providing information on the sale, taxing, and training of gladiators.<sup>11</sup> The text indicates that Marcus decided to forgo the blood money that had been flowing into the imperial treasury at a rate of 20-30 million HS per year from taxes on the sale of gladiators (25-33%) and revenues from the sale of convicted criminals to be put to death in the arena for the pleasure of the Roman viewing public. Several economic features of these practices warrant attention. First is the implied scale of the business at more than 100 million HS per year to generate this level of taxes, and then the

accompanying level of deliberate destruction of human life in the thousands or possibly even tens of thousands per year, including the condemned criminals. Second is the rather elaborate categorization of gladiators by level of skill and training with prices ranging from 3,000 HS to 15,000 HS for trained combatants and 600 HS for convicts sold for execution in the arena. The irony here to the modern mind is that the Romans had a highly developed hierarchy of investment in human capital precisely in the business of bloody spectacles.

Education and training. What was the level of investment in the education and training of Roman workers? Not to ignore the obvious, the level of education as exemplified by literacy was higher in the Roman empire than at any time before and any time for a millennium after. Having said that, is it possible to get a sense of scale in a comparative perspective?

Since we have no quantitative data, we will need to make estimates based on qualitative descriptions and assumptions about Roman society. First, there are the differences of social class between children of the leisured elite, the free working class, and slaves; and also the difference between rural and urban. I realize that in real life the distinctions were not always clear-cut. Nevertheless, these distinctions are explicit and implicit in the ancient evidence.

In terms of institutional sophistication and size of investment, one may imagine three levels of training and education of children in the skills of production: (1) learning from parents and family, (2) apprenticeship, and (3) formal education. The first level, learning by imitation and instruction within the family, is the one that I would assume to be the earliest in evolutionary terms—in fact, not unique to humans. My understanding of family farming throughout antiquity envisages this as the primary form of training of the next generation. Scattered references in the ancient texts suggest that young children, like old women, were thought suited to light tasks.<sup>12</sup> Presumably as they reached physical maturity, boys learned basic agricultural skills from fathers and other relatives and neighbors. One point I would make from sophisticated studies of peasant agriculture in India is that we should not underestimate the complexity and subtlety of this learning, in which useful knowledge continues to accumulate from experience in later adult years. Mark Rosenzweig found in India that the decline in production in bad years was 40% in households where the head was under 40 years old, in contrast to a decline of only 15% on farms with a head over 60. Similarly, profits were multiples higher on farms with older heads.<sup>13</sup> In other words, human capital from learning from experience continues to grow through the adult years. This has non-trivial implications for the Roman world where youths might lose a decade of learning to army service and where, to overgeneralize from the evidence of Roman Egypt gathered by Bagnall and Frier, less than 20% of households had a head over 60 and 40% had a head under 40.<sup>14</sup> Thus, Roman peasant households were generally held back by the double restraint of a high mortality society: early death both cut short the application of knowledge gained through experience and limited the further accumulation of knowledge.

In large-scale agriculture on the estates of the wealthy, work was more differentiated, though learning took place through imitation and experience. Columella laments the fact that, in contrast to rhetoric, mathematics, surveying and other skills, agriculture “lacks both students and teachers.” (1.praef.5) Whereas there were officinae for the most contemptible vices—e.g., the preparation and serving of luxurious foods—there were no schools dedicated to the dominant form of production, agriculture. The pivotal figure in the production on the estates of the wealthy was the vilicus, who should in Columella’s view be experienced in the work of the farm, but need not be literate or formally educated. Of course, we know from the papyri of Roman Egypt that the skills of literacy and numeracy were deployed in the management of large estates, but it is interesting that Columella does not regard these beginning elements of formal education as essential in a vilicus. Furthermore, the example of Horace’s Sabine estate shows that farm experience was not thought necessary, as trusted urban slaves were sent out to manage the farm.<sup>15</sup> Rosenzweig’s findings about the importance of experience to productivity is worth remembering. My conclusion is that the overwhelming majority of the rural workforce relied on skills and knowledge gained through the first level of learning, and that the learning accumulated through a lifetime.

The urban economy of the empire—craft production, trade, and retail—presents a more varied picture of human capital. Certainly in the cities many children’s education was no more than informal learning from parents. Plato (Republic 467A) referred to sons of potters learning their craft by watching their fathers, and Vitruvius (6.pr.6) alluded to the past practice of architects training their children. But in addition there were institutions of apprenticeship and more formal education in several types of settings.

For apprenticeship the papyri of Roman Egypt gathered by Keith Bradley provide insight.<sup>16</sup> Like Bradley, I assume that the fact that our examples of apprenticeship contracts come from Roman Egypt is a result of survival, not of the original geographical distribution of apprenticeship around the empire.

Why did apprenticeship make sense as an alternative to parent or master training in the household or workshop? For a substantial minority of cases sons would not have had fathers alive to transmit his skills, and slaves did not always have a master with the skills. But the demographic explanation isn’t sufficient, to judge by the Egyptian weaver-father who contracted out his sons as apprentices to other weavers. Cameron Hawkins, in his study of the craft economy, has found that craftsmen were much less likely to receive funerary dedications from sons than other segments of the urban population—a pattern that would be hard to explain on the model of sons perpetually following fathers into their occupations.<sup>17</sup>

Why was apprenticeship used, even in situations where a skilled father existed? I think we need to imagine the variation in conditions that must have existed from one shop to the next. Apprenticeship was a mechanism that allowed labor to be moved from the natal family to a household where it was needed and could be supported with food. The apprenticeship contracts usually included provision for the master craftsman to provide very basic subsistence for the apprentice. Given these terms, a household under financial

pressure—perhaps because of poor sales or seasonal declines or too many children—could unload maintenance costs of a child to a more prosperous craft shop through apprenticeship. And if the prosperous shops were more successful because of better skills or business sense of the master craftsman, then apprenticeship as an institution stood to improve the economy as a whole by allocating more students to the more skillful. But unless we believe that there were large differences in skill levels, economic growth was limited and unsustainable.

The Egyptian contracts provide some insight into the age of the apprentice and the duration of the arrangement. Bradley deduced that apprentices were usually minors in their early teens, and this has a logic based on human capital. In order to derive the greatest return on the investment in training, it should be provided at that developmental moment after the ravages of childhood diseases when the children have the physical and mental capacity to learn the skills and pull their weight in the workshop. An apprenticeship in the early teens fits pretty well with the implications of the schedule of Diocletian's maximum prices that reach a peak value at age 16: this is the moment when the labor skills have been acquired and life expectancy to use those skills is longest.<sup>18</sup>

The extant apprenticeship contracts are varied in their length from a year or less up to six years. Most are for only a year or two. This means that the investment in human capital through apprenticeship was small by both early modern and contemporary standards, both because the duration of training was relatively brief and because the apprentice did not completely forgo wages in the course of training.<sup>19</sup> Contracts were structured so that the compensation—bare subsistence in the first year or two—gradually increased with increased skills and productivity—another reflection of a basic principle of human capital.

The fact that apprentices did not give up income during training distinguishes the economics of apprenticeship from formal education and raises a question. If an apprenticeship transformed an unskilled youth into a skilled artifex and as a result doubled his daily wage, to judge from several broad statements in our sources (e.g., Dig. 17.1.26.8), why didn't more parents and slave masters apprentice their sons and slaves?<sup>20</sup> It would seem that the investment was modest and the returns clear. I have no answer. In later eras guilds restricted the entry into crafts in order to limit supply,<sup>21</sup> but there was no such organizational constraint in the Roman world.

A second question for which I have no answer is why the apprenticeship contracts are so heavily dominated by weaving and cloth production. The 80% or more of apprenticeship contracts in cloth production can't reflect the distribution of workers among skilled crafts.

When economists today calculate the human capital investment in education, one of the biggest costs is that of the student's lost work time—i.e., forgone earnings. The Roman empire did have formal education of several types that took children and youths away from work. The literary and rhetorical education for the elite is best attested and most studied, though that type of education probably didn't take that group away from much

productive work. Indeed, studies of modern education systems and economies argue that such elite education can have a dampening effect on growth. The less elevated types of education that developed basic skills of literacy and numeracy for work as managers, stewards, surveyors, bankers, scribes, shorthand writers, and so on, are far more important as a positive influence on productivity. In the Roman empire this basic education was transmitted in at least three settings. One was apprenticeship, but with the difference that the student paid. One of the contracts from Egypt apprenticed a male slave to a shorthand writer for a fee. The fee compensated the notarius for his time lost in the course of teaching, in contrast to the master weavers who were able to use the apprentice's labor productively. The second setting was the class of the magister, who derived an income from teaching, sometimes in physical spaces as makeshift as the street. Alan Booth described the arrangement in the following terms: "there is cause to believe that in first-century Rome the ludi magister (the calculator and notarius too) ran a lowly type of technical school which peddled craft literacy to children, slave and free, to enhance their employability, but that the elements were usually acquired elsewhere by children embarking upon a liberal education."<sup>22</sup> Booth's language here reflects an aristocratic point of view; from the viewpoint of ordinary working Romans, such formal education, even if meager, was not "lowly." To judge by the Price Edict it would have cost a laborer two day's worth of wages per month to have one child taught for a month. It would have been beyond the means of most working class families to have more than one child in a class of this type for any length of time.

The third setting was the paedagogium of the great aristocratic houses, where urban slave children were taught the elements of letters and numbers, as well as the finer arts of elegant domestic service. The institution of the paedagogium made economic sense in two ways. First, it was the great houses of the Roman empire that had a clear need for the skills of reading, writing, and arithmetic for purposes of management of a large organization. The large domus were the largest private productive units in the early empire, requiring coordination, monitoring and record-keeping. Second, wealthy masters used slaves in managerial roles, and for good reason. Not only could slaves be held accountable through painful physical coercion, but they were not free to walk off with the human capital invested in them. One of the dilemmas faced by modern corporations is that if they invest in training their workers and raising the value of their skills, it is difficult to prevent those workers from taking that investment away to a competitor who has not borne the costs. Ownership of human chattel avoided that dilemma in Rome. As Sandra Joshel's tabulation of occupations by slave, freed, and freeborn status in funerary dedications shows, slaves are most overrepresented in administrative positions; freedmen are most overrepresented in manufacture; and the freeborn are most overrepresented in building occupations.<sup>23</sup>

A master could reap a profit from raising his slave's education level either by directly employing him or by selling him. In the late Republic both Crassus and Atticus were known for investing in this sort of human capital. Indeed, Plutarch writes of Crassus, "though he owned numberless silver mines, and highly valuable tracts of land with laborers upon them, nevertheless one might regard all this as nothing compared with the value of his slaves; so many and so capable were the slaves he possessed—readers,

amanuenses, silver-smiths, stewards, table-servants; and he himself directed their education, and took part in it himself as a teacher, and, in a word, he thought that the chief duty of the master was to care for his slaves as the living implements of household management.” Plutarch’s phrase “*organa empsucha*” might be translated, with only slight license, as “human capital.” My interpretation of this passage is that Plutarch wanted to acknowledge Crassus’ appreciation of the value of human capital investment, and regarded Crassus as unusually shrewd in this regard.

The inclusion of “table-servants” in the list of educated slaves, alongside stewards and readers, might seem a bit out of place, but it is a reminder that the *paedagogium* trained slaves not only in what we would consider basic productive skills, but also in the skills that supported the luxurious lifestyle of the grand *domus*—that is, the vices denounced by Columella in his lament over the lack of schools of agriculture.

So far, my account has been focused on slaves and sons—an implicitly male orientation. But the potential for economic growth depends on the configuration of investment in women as well as men. The evidence from the city of Rome and from Roman Egypt suggests to me that women were not completely barred from the training and education that enhanced men’s life chances; on the other hand, they seem to have received much less training than males. From the list of Egyptian contracts, Bradley made an important point about the absence of freeborn women in apprenticeships. Though there is some argument about a couple of cases, I think he is right and certainly his general point stands. The contrast with female slaves is noteworthy: as many female slaves as male slaves appear on the list—a reminder that owners were willing to develop the value of their slaves, female or male. This is an illustration of how the institution of slavery allowed fuller exploitation of female human capital as compared with later Europe when apprenticeship was an exclusively male institution.<sup>24</sup>

If the rarity of freeborn women in apprenticeships was also true of Rome, it would provide one reason why women appear in so many fewer occupational categories in Roman funerary dedications: only 35 as compared with more than 200 for men.<sup>25</sup> One might argue that this is an illusion of funerary representation that preferred to refer to women as wives, but the heavy underrepresentation of women in jobs requiring education is corroborated by Setala’s brickstamp catalogue of 335 *officinatores*, only 20 of whom were women.<sup>26</sup> On the other hand, the number of women is not zero, and we know that some women did learn letters and numbers, and more.

What does all of this add up to in participation in education and investment in human capital? There cannot be any doubt that the levels of literacy and education were higher in the Roman empire than before or after for a millennium, just as the early imperial economy was more productive than before or immediately after. To assess the impact on the economy, it is useful to estimate how much more. There is a rich debate over the causal relationship of education to economic growth. Clearly, the relationship is complex and not monocausal. And yet, it is also clear that broad formal education is generally a prerequisite for sustained growth. There is a strong correlation between the breadth of primary education in Europe between 1600 and 1900 and growth. In the early modern

era the Netherlands was the leader in economic growth with an annual rate of 0.2% in the 17<sup>th</sup> c. and in literacy with rates of the order of 60-70% of adults, male and female.<sup>27</sup> The reason for the very high rate of education is that the Reformed Church mandated universal education and made provision to pay for poor orphans. Similarly, a new study of Prussia argues that Protestant counties experienced faster growth than Catholic counties in the 19th c. precisely because of the Protestant emphasis on universal education for purposes of literacy to read the Bible.<sup>28</sup>

In assessing the educational level of European countries in the early to mid-nineteenth century, Easterlin used the measure of proportion of the total population in primary school at any given time. Countries with low levels of education had less than 4% in primary school, whereas those with high levels were in the range of 10-20%, yielding literacy rates in excess of 70%.<sup>29</sup>

For the sake of comparison, today the leading economies have average education levels of up to 12 years per person and per capita GDPs of more than \$25,000 per year. Countries such as India and Pakistan have levels of education in the range for 4-5 years and per capita GDPs in the range of \$2-3,000. The poorest countries of sub-Saharan Africa have education levels of 1-3 years and per capita GDPs of \$700-1,400.

Let me offer a tentative estimate of Roman education levels based on some rough assumptions. I welcome discussion of the assumptions, but with the Hopkinsesque proviso that the assumptions would have to be wildly wrong to change the general conclusion. First, I assume that formal education was largely the preserve of the cities and that the cities accounted for 15% of the population (following Scheidel). Second, I assume that in the cities the skilled class of craftsmen and merchants had a basic education, but the unskilled did not because they could not afford to pay for it. And I further assume that the skilled artisanal class amounted to half of the urban population. In addition, I assume that a basic education in letters and numbers could be acquired in three years. Finally, I assume that all members of the senatorial, equestrian, and curial orders received at least a basic education. These assumptions both underestimate and overestimate. They underestimate in the sense that the rural population was not utterly illiterate. They overestimate to the extent that no discounting is done for girls, though it is clear that they received less schooling than boys. My hope is that all of this is roughly offsetting. The chief point is that the Romans did not attempt mass publicly-funded education, restricting basic education to children of families with some surplus income to pay teachers.<sup>30</sup> Much of the public support for education went to the more refined levels which did not contribute much to economic production.

On these assumptions, I estimate that the average number of years of formal education across the whole population was less than 0.5 years per person and that at any given time perhaps 0.6% of the population over the age of five were receiving basic education. That is, Roman levels of formal education were more than an order of magnitude lower than in developed countries today and, more telling, a fraction of the levels seen in the least developed countries today and the fastest developing countries of the early 19<sup>th</sup> c. And,

finally, the breadth of basic education and literacy was probably markedly lower than the Netherlands in the 17<sup>th</sup> c. with its 60% literacy rate.<sup>31</sup>

How great was the investment in basic education in the empire? Setting aside elite education in literature and rhetoric, I would very roughly estimate on the basis of these assumptions a student population in any given time in the range of 200,000 taught by 10,000 teachers (or 0.1% of the urban population). If these teachers had incomes at roughly the level of skilled craftsmen as suggested by Diocletian's Price Edict, then the total expenditure in the empire for basic education would have been of the order of ten million sesterces per year, or about 0.5% of the minimum GDP estimated by Hopkins. This very crude estimate could be multiplied several times and still lead to the same conclusion: Roman investment in education, and the resulting literacy, were high by pre-modern standards, but lower than those of the early modern economic leaders (and exceedingly low by contemporary standards).

Urbanization and human capital. The level of urbanization of a society is a broad indicator of economic development insofar as part of the population is engaged in non-agricultural production beyond subsistence. Urbanization in Europe, which peaked in the pre-modern era under the Pax Romana, also had diverse and cross-cutting implications for human capital.

Cities facilitate education and, more generally, the exchange of information and ideas, because denser populations generate more interactions. To take an illustration, Augustine's education progressed through a hierarchy of larger towns and cities, as his training advanced to higher levels of specialization. The letters of Pliny suggest that his hometown, Como, was of a size to be on the cusp of having enough children from families of sufficient means to employ a teacher (praeceptor) whereas much larger cities such as Rome, Alexandria, Antioch, and Carthage brought together enough teachers and students to generate the most sophisticated level of intellectual discourse of classical antiquity.<sup>32</sup> The larger cities also housed the large urban familiae with their paedagogia to train slaves. Only these very large domus would have had an urban slave staff of a size to warrant a paedagogium.

Beyond formal education, cities were sites of concentrated demand that encouraged the development of specialization and subspecialization. Given the limits of formal education and information technology, most skills had to be transmitted by face-to-face interaction, which were facilitated by concentrations of population. Thus, the urban setting stood to increase the stock of human capital.

Here the insights of Jane Jacobs's classic book, The Economy of Cities (1969), are worth exploring. Her fundamental point is that "economies that do not add new kinds of goods and services, but continue to repeat old work, do not expand much nor do they, by definition, develop" (p. 49). This process of "new work" being added to "old work" "is of the essence in understanding cities because cities are places where adding new work to older work proceeds vigorously" (p. 50). In a sense, Hopkins was using this insight when he noted the differentiation of labor reflected in the number of occupational titles in the

inscriptions from Rome and other cities (more than 200 from Rome, according to Susan Treggiari).<sup>33</sup>

This seems to me to be an area that would repay further research. How much growth does the Roman occupational inventory represent over the occupational lists from the ancient Near East? In what sectors does “new work” appear? In analyzing the occupational structures of Roman cities, we should remember Jacobs’s further observation about division of labor. “Division of labor, in itself, creates nothing.... [It] is a device for achieving operating efficiency, nothing more. Of itself, it has no power to promote further economic development.... All further increases in efficiency, once existing work has been suitably divided into tasks, depend upon the addition of new activities” (p. 82). In this respect, it is not immediately clear to me how to evaluate, say, the *fabri ocularii* (makers of eyeballs for statues) as evidence for “new work” in a growing economy. In any case, a systematic comparison of the Roman imperial occupational inventory with those of earlier and later pre-industrial economies might yield valuable qualitative insights about the stock of human capital, and the inventories will be centered, not coincidentally, on cities.

But if Rome and other major cities were generators of development of human capital, they were also heavy consumers of human capital. Dense concentrations of population facilitated the transmission of knowledge and productive skills, and also the transmission of infectious diseases in an era before effective public health infrastructure. Walter Scheidel has estimated, based on the extraordinarily high excess seasonal mortality found in Roman funerary inscriptions, that mortality in the capital was 50% higher than in the population as a whole (60 per 1,000 per year, as opposed to 40 per 1,000 per year).<sup>34</sup> For a slaveowner Rome might be there place where her artisanal slave could earn the highest wages as a return on the investment in skills, but also the place where the life expectancy of the slave was shortest. Sachs and Malaney (2002) have noted with respect to contemporary sub-Saharan Africa that “the impact of malaria on economic growth rates through the mechanism of depressing the rate of human capital accumulation could be considerable” (p. 683). The possibility of a similar phenomenon should be taken into account in considering the human capital dimension of the demography of ancient Mediterranean cities. Not until the 19<sup>th</sup> c. did the public health revolution liberate humanity from the terrible contradiction that the same urban concentrations that enabled efficient exchange of ideas and skills also enabled efficient exchange of microbes.<sup>35</sup>

Obviously, the above is a very preliminary foray into the analysis of the Roman imperial economy in terms of human capital, based on the proposition that human capital is both a basic cause of economic growth and a proxy for it. There are strong reasons to think that human capital investments in formal education increased with urbanization during the Pax Romana, but that they did not reach a level found in the most advanced early modern states, which institutionalized universal education and achieved literacy rates above 60%. It will be interesting to see whether this is consonant with other indicators of economic development.

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<sup>1</sup> Kodai: Journal of Ancient History, 6-7: 41-71 (1995/96). Reprinted in Walter Scheidel and Sitta von Reden (eds.), The Ancient Economy (Edinburgh: Edinburgh University Press, 2002), pp. 190-230.

<sup>2</sup> “Financial intermediation in the early Roman empire,” The Journal of Economic History (2004), 64: 705-733.

<sup>3</sup> “Gibbon was right: the rise and fall of the Roman economy,” forthcoming.

<sup>4</sup> Jack A. Goldstone, “Efflorescences and economic growth in world history: rethinking the ‘Rise of the west’ and the Industrial Revolution,” Journal of World History 13(2002), 323-89.

<sup>5</sup> “Investment in human capital,” American Economic Review 51 (1961) 1-17.

<sup>6</sup> Robert Fogel, The escape from hunger and premature death, 1700-2100 : Europe, America, and the Third World (Cambridge: Cambridge University Press, 2004).

<sup>7</sup> E.g., Peter Garnsey, Famine and Food Supply in the Graeco-Roman World: Responses to Risk and Crisis (Cambridge: Cambridge University Press, 1998).

<sup>8</sup> David O. Meltzer, Mortality Decline, the Demographic Transition, and Economic Growth, Ph.D. Dissertation, University of Chicago 1992.

<sup>9</sup> Though the prices for sale of slaves in Roman Egypt are scattered and do not amount to a meaningful series, it appears that prices for a young female slave (outside Alexandria) centered around 1200 dr. If so, to spend 204 dr. (8.5 dr/mo X 24 mos, including the oil allowance) to nurse a foundling would make sense on the following calculation. The investment entailed a substantial risk (ca. 50%) that the child would not survive to productive or reproductive adulthood; that sum, invested in loans at interest would have roughly doubled in value over the 12-14 years of rearing; and the child would have required an additional investment of ca. 50 dr./year in maintenance after infancy. During the later years of childhood, enough return on the investment could have been realized in the form of household service to offset the cost of food (to judge by the apprenticeship contracts). The resulting total value of the investment ([204 dr. X 2 (for risk) X 2 (for forgone interest)] + [50 dr./yr (maintenance) X 5 years X 1.5 (forgone interest)]=1191 dr.) is comparable to the cost of an adult female slave. Of course, this calculation is extremely crude, but it does answer the argument of some historians that it would have made no financial sense to raise foundlings, especially females. For wetnursing contracts, M. Manca Masciardi and O. Montevecchi, I contratti di baliatico. Corpora Papyrorum Graecarum 1 (Milano: Azzate, Varese: Tipolitografia Tibiletti, 1984), pp. 32-35; for slave prices, H.-J. Drexhage, Preise, Pieten/Pachten, Kosten und Loehne im Roemischen Aegypten bis zum Regierungsantritt Diokletians (St. Katharinen: Scripta Mercaturae Verlag, 1991), pp. 249-79; Johnson, Roman Egypt, pp. 279-81, especially P. Bour. 16 and P. Oxy. 95, and for wages, pp. 306-10, especially P. Oxy. 736 and BGU 894.

<sup>10</sup> Robert Sallares, Malaria and Rome: A History of Malaria in Ancient Italy (Oxford: Oxford University Press, 2002); Walter Scheidel, “Germs for Rome,” in C. Edwards and G. Woolf (eds.), Rome the Cosmopolis (Cambridge University Press, 2003); Jeffrey Sachs and Pia Malaney, “The economic and social burden of malaria,” Nature 415 (February 2002), 680-85.

<sup>11</sup> CIL II.6278=ILS 5163=FIRA I.295-97 with discussion by Michael Carter, “Gladiatorial Ranking and the ‘SC de Pretiis Gladiatorum Minuendis (CIL II 6278 = ILS 5163),” Phoenix 57 (2003), pp. 83-114.

<sup>12</sup> Thomas Wiedemann, Adults and Children in the Roman Empire 1989, pp. 153-55.

<sup>13</sup> “Human capital accumulation, the family, and economic development,” in Sisay Asefa and Wei-Chiao Huang (eds.), Human Capital and Economic Development (Kalamazoo, Michigan, W.E. Upjohn Institute for Employment Research, 1994), pp. 63-90.

<sup>14</sup> The Demography of Roman Egypt (Cambridge: Cambridge University Press, 1994). From the appendix, I surveyed the ages of the oldest males in complete household returns: of 109 households, 49 had an oldest male under age 40, and 19 had an oldest male over the age of 60.

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- <sup>15</sup> For the qualities sought in estate managers, see Jesper Carlsen, Vilici and Roman Estate Managers until 284 A.D., *Analecta Romana Instituti Danici. Suppl. XXIV.* (Rome, 1995), pp. 59-63.
- <sup>16</sup> Discovering the Roman Family (Oxford, 1991), pp. 103-124.
- <sup>17</sup> Cameron Hawkins, Work in the city : Roman artisans and the urban economy, University of Chicago Ph.D. Dissertation, 2006.
- <sup>18</sup> Walter Scheidel, "Reflections on the Differential Valuation of Slaves in Diocletian's Price Edict and in the United States," Munstersche Beitrage zur antiken Handelsgeschichte 15 (1996): 67-79.
- <sup>19</sup> Wendy Smuts and Thorsten Stromback, The Economics of the Apprenticeship System (Edward Elgar 2001) discuss evidence for early modern apprenticeships ranging from three to four years in Germany to seven years in England.
- <sup>20</sup> As a point of comparison, Smits and Stromback report that in 18thc. England, the ratio of wages of apprentices to unskilled labor to journeymen craftsmen was 40:70:100 with apprentices at bare maintenance for one person (*ibid.*, p. 9).
- <sup>21</sup> *ibid.*, p. 9.
- <sup>22</sup> "The schooling of slaves in first-century Rome," TAPA 109 (1979), p. 19. See also C.A. Forbes, "The education and training of slaves in antiquity," TAPA 86 (1955), 321-60.
- <sup>23</sup> Sandra R. Joshel, Work, Identity, and Legal Status at Rome. A Study of the Occupational Inscriptions, Norman, OK: University of Oklahoma Press, 1992.
- <sup>24</sup> Smits and Stromback, p. 5.
- <sup>25</sup> Joshel, Table 3.1 illustrates the asymmetry of men and women in the occupations inscriptions: in the categories of "Sales," "Banking," "Professional," and "Administration" she counts 538 men as against 38 women.
- <sup>26</sup> Private Domini in the Roman Brick Stamps of the Empire. Helsinki: Suomalainen Tiedeakatemia, 1977, p. 108.
- <sup>27</sup> Jan de Vries and An Van Der Woude, The First Modern Economy. Success, Failure, and Perseverance of the Dutch Economy 1500-1800, Cambridge University Press 1997, p. 170.
- <sup>28</sup> Sascha Becker and Ludger Woessman, "Was Weber wrong? A human capital theory of Protestant economic history," CESifo Working Paper no. 1987 (May 2007).
- <sup>29</sup> Richard Easterlin, "Why isn't the whole world developed," Journal of Economic History 41 (1981).
- <sup>30</sup> See Marc Kleigwegt, Ancient Youth, p. 81, who estimates illiteracy at 90%--that is, slightly lower than my rough estimate. My estimate could be doubled and still leave the Roman empire well below the early modern leaders. Beryl Rawson's recent Children and Childhood in Roman Italy (Oxford, 2003) assumes elite access to education when she refers to the importance of the paedagogus accompanying the student (p. 165).
- <sup>31</sup> See De Vries and Van Der Woude, p. 694, for the substantial early modern Dutch investment in basic education in human capital, even in orphans.
- <sup>32</sup> Pliny, Letters 4.13, on which see Rawson, p. 164.
- <sup>33</sup> "Urban Labour in Rome: Mercennarii and Tabernarii," in P. Garnsey (ed.) Non-Slave Labour in the Greco-Roman World, 1980.
- <sup>34</sup> Scheidel, "Germs for Rome," p. 175.
- <sup>35</sup> Meltzer, Mortality Decline, p. 10.