

RAPID INVENTION, SLOW INDUSTRIALIZATION, AND THE ABSENT INNOVATIVE ENTREPRENEUR IN MEDIEVAL CHINA

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Introduction

The technological-progress paradox that has quite appropriately caught the attention of students of Chinese history has yet to be recognized as an invaluable lesson for economic policy today. The substance of the paradox is easy to summarize. China's record of invention from the fourth century BC through the thirteenth century, just before Marco Polo's much noted voyage, arguably went unmatched by any other country until the nineteenth century. However, Chinese society appears to have lacked any effective incentives for innovative entrepreneurship. In contrast, in recent decades few significant inventions seem to have come from China, but wealth-seeking entrepreneurship has become abundant. The curious consequence was that during the earlier period, overall productivity growth and the reduction of poverty were apparently not remarkable, while recent Chinese expansion in both of these arenas has been characterized by some observers as more rapid than that achieved in any other place or time. This curious performance relationship— and its implications for policy and promotion of the general welfare—will be considered here.

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Invention during the Long-Lasting Agrarian Economy and Its Limited Application to Industry

For some sixteen centuries, about eight times the length of the period since the onset of England's Industrial Revolution, China was the source of an astonishing outpouring of inventions that included a vast variety of prospectively valuable novelties as diverse as printing, the blast furnace, the spinning wheel, the wheelbarrow, and playing cards, in addition to the more widely recognized gunpowder and compass.³ As Joseph Needham (in Temple, 2007) has noted:

“One after another, extraordinary inventions and discoveries clearly appeared in Chinese literature, archeological evidence or pictorial witness, often, indeed generally, along preceding the parallel, or adopted, inventions and discoveries of Europe. Whether it was the array of binomial coefficients, or the standard method in interconversion of rotary and longitudinal motion, or the first of all clockwork escapements, or the plowshare of malleable cast iron, or the beginnings of geobotany and soil science, or cutaneous-visceral reflexes, or the finding of smallpox inoculation—wherever one looked there was ‘first’ after ‘first’”
(Needham in Temple, 2007, p. 9).

Even more striking, as Tang (1979) emphasizes, was the temporal length of China's lead over the rest of the world:

³ Needham (Vol. VII, Part 2) provides a marvelous table (p. 217 *et. seq.*) listing the 250 Chinese inventions that he has encountered in his researches. Although the list is surely incomplete, as he points out, there were “approximately 250 inventions over the last seventeen centuries; this means an average of nearly fifteen new inventions every hundred years” (pp 224-225). Does this, perhaps, make the accomplishment a bit less impressive?

“The emergence of the new institutions and agents took place in China when Europe was just settling into the Dark Age and insular Japan had yet to see the beginning of the long (about 300 years ending in 1868) Tokueawa feudal era that loomed far ahead” (p.4).

All of this gives rise to a great mystery, the apparent fact that none, or almost none, of these early Chinese inventions seems to have been put to effective use and employed to its full potential in the manner that characterizes the productive process in the world’s industrialized economies since they underwent their industrial revolutions. Some Chinese inventions were used in relatively primitive forms, undergoing little improvement from their earliest models. Others came to a sudden end, by imperial decree, like the destruction of the great ships that had composed the nation’s navy and had successfully explored China’s neighbors. Su Song’s⁴ magnificent and huge astronomical clock, for instance, was quickly forgotten after the original fell into the hands of an enemy, who destroyed it by mishandling. Thereafter, interest in European clocks focused on entertaining features such as the dancing figures driven by the mechanism, rather than on timekeeping. And while it is not true that gunpowder was employed exclusively for fireworks displays, Chinese gunpowder-using weapons were relatively crude and certainly fell far short of their potential power.” Certainly the cannon and other innovative weapons were insufficient to prevent the barbaric Mongols under Ghengis and Kubla Kahn from conquering the country. And if it is true, as has

⁴ Su Sung, a government official during Emperor Chen Tsung’s reign, built the most sophisticated and accurate clock of the era, circa 1080 (Pacey, 1996).

been claimed by Menzies (2002) that the Chinese discovered America in 1421, more than half a century before Columbus, it was not colonized or otherwise exploited, but was, rather, soon forgotten. As Fenby (2007) observes, “[o]ne of the great questions of history is why...most [Chinese] inventions were not developed or linked to the broader economy, as they were in Europe and North America. Inventors did not become entrepreneurs” (p.165). Needham (2007) offers a similar analysis:

“The strange thing is that China was able to absorb these earth-shaking discoveries and inventions while Europe was gravely affected by them....Gunpowder weapons made relatively little difference to the fighting in and around China, while in Europe they ruined the feudal castle and the armoured knight... The magnetic compass and the axial rudder permitted Europeans to discover the Americas, but Chinese sea-captains pursued their peaceful ways in the Indian Ocean and the Pacific as of old. .Printing helped to launch the Reformation and the revival of learning in the West; all it did in China (apart from preserving a host of books which would otherwise have perished) was to open civil service recruiting to a wider range of society.... [T]here certainly was some brake on technical developments in this society which was itself so intrinsically fertile in creating them. The gear-wheel, the crank, the piston-rod, the blast furnace, and the standard method of interconversion of rotary and longitudinal motion, all existing earlier, in some cases far earlier, in China than in Europe were doubtless utilized less than they might have been because they lacked application to the needs of that agrarian society which the bureaucracy was determined to

protect and stabilize. In other words Chinese society did not always succeed in moving from invention to innovation, Schumpeter's term for the wide application of an invention" (Vol. VII, Part 2, pp. 53-54, footnotes omitted).⁵

China had made a deliberate choice: instead of promoting the kind of entrepreneurship that might have fueled economic growth, China's rulers chose to protect and stabilize the country's agrarian economy. Thus, as Creel (1970) has observed, steadiness was a central feature of Chinese government: "[t]he Chinese pattern has governed more people, over a larger area, for a greater length of time, than any other.... No other system of government has maintained its sway over a state of anything approaching comparable size for two thousand years in almost uninterrupted succession. It has been the most viable government yet developed by man" (pp. 1-2).

But while these strategies promoted peace and stability, they did not encourage economic growth. In fact, such central controls discouraged productive entrepreneurship and pervasive business ownership by the petty bourgeoisie and, with it, an effective regime of free competition and free markets. Thus, in the Middle Ages, when Chinese technologies could have been transferred from agricultural to industrial applications, the opportunities were again and again bypassed.

⁵ Tang (1979) notes: "Underpinning the apparent puzzle is the economic-technological-institutional complex embodied in traditional China. In reflecting on the puzzle, a number of celebrated insights readily come to mind, although none dealt totalistically with the entire complex nor necessarily with China. To Joseph A. Schumpeter we owe the popularization of the notion that a system efficient in every aspect and at every point in time may not be the one that does well in dynamic growth terms. Schumpeter did not address himself to agriculture. His thesis had to do with innovations as the engine of growth and the role of big-business capitalism in his regard. Nonetheless, his notion of conflict between short-term efficiency in exploiting existing opportunities and growth dynamism is of general interest. An insight of particular import is obtained if one combines it with population dynamics" (p. 5).

This is one explanation that has been offered for the absence of a strong innovative entrepreneurial class in China. And this brings us to the essence of our story: the presence of an astonishing profusion of inventors, with the apparent absence of a cadre of innovative entrepreneurs who would have overseen a process of effective utilization and improvement of those innovations.

While China did indeed experience periods of prosperity, particularly during the Tang and Sung dynasties (from the seventh to the thirteenth centuries, AD), and while the country is estimated to have been wealthier than Western Europe until as late as the fourteenth century (Madisson, 2001, p. 42), it is surely plausible that during the long period of inventiveness, per capita income in China did not rise nearly as much and nor as quickly as it has in the last few decades since the demise of Chairman Mao. This seems to be connected with the other mystery that has been mentioned already: the apparent fact that none or almost none of the earlier great inventions seems to have been put to effective use and employed to its full potential in the manner that characterizes the productive process in the world's industrialized economies of today, post-industrial revolutions. In China, many of the inventions were apparently used in relatively primitive form, undergoing little improvement from their earliest models. Moreover, there seems to have been no period of spectacular economic growth parallel to that following Britain's Industrial Revolution and its sequels in Western Europe, the United States, Canada, and Japan.

From the point of view of prosperity and growth, something here was not quite right, and discovery of the source of the problem promises to be a matter of some importance—for it may be able to suggest how today's more successful economies can

avoid falling victim to similar underperformance and can learn to pursue their growth ambitions more effectively, even if they currently are performing reasonably well.

The Missing Innovative Entrepreneurial Class

It is unlikely that there is a single explanation for China's failure to put early inventions to productive use.⁶ However, as already noted, it will be argued here that an important part of the explanation is to be found in the scarcity of *innovative* entrepreneurs, whose primary economic mission is to see to it that promising inventions are put to effective use and that they or their products are effectively marketed.⁷

⁷ There is a growing literature that ascribes to other causes China's limited utilization of its inventions. They offer evidence that part of the problem was climate, geography (Pomeranz, 2000, Chapter 5), demographic patterns (Clark, 2007, Chapter 13), population growth patterns (Clark 2007, Chapters 12 and 13), political and economic obstacles (Elvin, 1973, Chapter 17) and other influences, while other writings deny the existence of such a problem at least until well into the 19th century. The complexity of the written language may also have taken its toll on the very early Chinese invention of printing. Before 1050, a commoner, Bi Sheng, is reported to have invented movable type, in which the individual word symbols were formed out of hardened clay, stored, and then assembled as needed to provide the text of a page that was to be printed. That, of course, is what Gutenberg was to do centuries later with the individually carved letters of the alphabet, thereby revolutionizing the recording of texts in the European languages and others. But in China, with its multitude of symbols, this did not work nearly so well, despite the invention of a clever method of storing the individual symbols. As a result, printers were driven to revert to labor-intensive block printing, which entails carving a page of writing on a single block of wood. This may have limited the use of printing in China and thereby inhibited the expansion of the supply of reading matter parallel to the explosion of printed materials that eventually occurred in Europe.

Two supplementary hypotheses also merit consideration. One is the sense among China's leaders of the superiority of Chinese achievement and knowledge, which led them to resist learning anything from elsewhere, as summed up in Emperor Quanlong's much quoted remark to Lord McCartney: "We possess all things....I have no use for your country's manufactures" (Winchester, 2008, p. 258). Another hypothesis is that the slowdown of technical progress began earlier than the date usually given—with the Mongol conquest by the Khans and the establishment of the Yuan dynasty, toward the end of the thirteenth century. The emperor Kublai Khan, and the Mongols perhaps showed excessive respect for Chinese accomplishment and tradition, thereby enforcing their preservation with little further change.

Here, we focus on entrepreneurship not in the belief that it is the only influence, but because it is the one that appears to be most readily amenable to the influence of policy. For example, the patent laws clearly can be changed more easily than the location of the Gobi Desert. To illustrate our basic contention, consider the claim that the Chinese discovered America in 1421, nearly three quarters of a century before Columbus (Menzies, 2002). The evidence here is certainly suggestive and even persuasive. But our argument focuses on the sequel—or rather, the lack of sequel. For, nothing followed for the Chinese economy from the discovery of America: no colonization, no importation of new products, no capture of gold and silver. The contrast with the history subsequent to the Spanish discovery of the New World is striking indeed. The hypothesis about China that is discussed here is a generalization of this example. The

The absence of such entrepreneurs, in turn, is plausibly attributable to the perverse incentives that they faced—many of these attributable to the political arrangements and prevailing social institutions—that led them to direct their talents elsewhere, thereby leaving the inventors and their products to fend, ineffectively, for themselves. We must emphasize that this is not meant to imply that entrepreneurship was absent or even scarce. Rather, our argument is that the incentive structure in Chinese society induced entrepreneurs to turn their efforts and abilities to other activities, generally avoiding the promotion of technological change and invention.

As usual in historical explanatory hypotheses, this suggestion eludes proof or disproof, because historical developments are subject to a multitude of influences, and the nature of the influence of each—moreover, the magnitude of that influence—generally eludes rigorous analytical explanation or even statistical approximation. History, in sum, offers few, if any, controlled experiments. Yet, it will be argued next, that the preceding hypothesis does seem to offer something like a controlled experiment, if we accept J.B. Say's observation about the three types of specialized effort required for success in a process of innovation and growth, as will be explained presently. We will note that China

Chinese may have been the first to discover printing, the compass, and other innovations, but it was left to the West, post-Industrial Revolution, to exploit these inventions with unprecedented effectiveness.

Gunpowder provides another telling illustration of this idea. The use of gunpowder by the Chinese clearly went well beyond the oft-cited fireworks: "...by the beginning of the 10th century [gunpowder] was applied in Chinese flamethrowers and by 969 it was used to fire arrows. By 1231 it was used in bombs, grenades, and rockets (which took the form of a mortar made in an iron tube)" (Hobson, 2004, p. 59). However, even with such sophisticated weapons, the Chinese were unable to defend themselves against conquest by comparatively primitive Mongol armies in 1279. (Perhaps this is because the Mongols engaged in effective Schumpeterian entrepreneurship in the form of transfer of military technology from China. According to Elvin (1973, Chapter 7), the Mongols succeeded in using effectively—and even improving—Chinese military inventions, including those based on gunpowder.)

Here, it is also important to note the reservations Easterly (2009) expresses about most of these proposed explanations, which, he argues, are based on too small a sample of observations to lend much confidence to the hypotheses proposed. Of course, this paper is particularly vulnerable to that criticism, since our focus is upon a sample of one—the story of Chinese development.

In all of this, our position follows that of Needham and Landes (1998, Chapter 6).

had an abundance of two of these three, but lacked the third—the innovative entrepreneur. It will be argued that this was so because Medieval China’s institutions and political arrangements did not encourage capable individuals to allocate themselves to this activity. In particular, we will discuss, as an example of such discouraging institutions, the widely misunderstood attributes of the much touted governmental examination system, a system which served as one of the primary paths to entry into the imperial government’s bureaucracy and which arguably served to distract individuals with entrepreneurial ability from promoting the practical utilization of novel products and processes.

Say’s Other Law: The Entrepreneur Is a Necessary Input for Successful Innovation

J. B. Say is surely one of the earliest, if not the first to take note of the important role of the entrepreneur in the growth process. He is quite appropriately regarded as the second significant contributor to the theory of entrepreneurship. Indeed, he has a solid claim to the position of first contributor to the theory of *innovative* entrepreneurship, since Cantillon, the earlier writer who touched on the general subject, focused on the risks to which the activity was subject and said nothing about innovation and the entrepreneur’s role in the process.

Say was precocious in many of his observations about innovative activity. Most relevant here, as already noted, he emphasized that successful invention required contributors of three types and generally could not be carried out effectively in the absence of any one of them. The first was the scientist or technician who has the idea and transforms it into a working entity. The third is the labor force that transforms the idea

into a concrete and replicable product. These two inputs and their roles are obvious enough, but Say's novel contribution was recognition of the vital intermediate contributor, the entrepreneur, who overlooks translation of the initial idea from mere curiosity into a practical entity that invites general attention and widespread use. In a passage, which already appears in the first edition (1803) of his most noted work, the *Traité d'Économie Politique*, and remains in its final edition of 1826, he spells out the consequences of absence of this individual:⁸

“Mere knowledge of the technological information that underlies innovation is insufficient. It may well survive only in the memory of a few individuals or in some books. It also requires the appearance of an entrepreneur with the means necessary to transform the knowledge into practice” (Say, 1803, p.11).

Here we will build on Say's argument, thereby transforming the Chinese experience, with its 'Needham mystery,' into a very rough approximation of a controlled experiment, as promised. We build on the observation that two of Say's three necessary ingredients for successful innovation were patently available to China in its period of great invention. The inventors clearly were present, for otherwise the profusion of

⁸ Our translation is deliberately more than a bit free, to bring out more clearly what we believe to be the intended meaning of the passage. In particular, we use the word “entrepreneur” where Say employs “manufacturier.” While Say does use the term “entrepreneur” elsewhere in the same chapter it should be remembered that in the first half of the nineteenth century, the terms and their meaning had not yet settled down; moreover, in English, the words that continued to be used for the purpose were “undertaker” or “adventurer.” Indeed, it is in error that Cantillon is credited with introducing the term “entrepreneur” into the English language. In the surviving portions of his original English work, the word “undertaker” is still used, while “entrepreneur” is found in the still extant French translation, which may or may not have been produced by Cantillon himself.

inventions could not have appeared.⁹ Moreover, China surely had the skilled labor force needed to produce magnificent decorated bronze vessels, great bells, other beautiful works that survive from well before the Han dynasty and preceded the birth of Christ by centuries, and later, the unforgettable Tang horses and lovely celadon vases. What was missing, apparently, was the third necessary contributor, the innovative entrepreneur.¹⁰

If we play the game of changing just one key variable, while holding the others constant, we may, in theory, examine the role of that single variable. But even if this procedure seems reasonably defensible, it is surely only a first step. We are driven to go on to ask what accounts for the paucity or virtual absence of such entrepreneurs, when in other societies they have been abundant and continue to be so today. Here, as we hope to show, Chinese practices, attitudes, and institutions, more generally, shed a great deal of light on the matter and contribute very plausible explanatory material.

To get at these insights we must first consider the goals of the entrepreneur and examine what the pertinent Chinese institutions could be expected to have induced the entrepreneur to do in pursuit of those objectives. More specifically, we will argue that the institutions in question exerted powerful pressures that sent enterprising individuals in directions far from the innovation process.

⁹ At least some historians take the inventors primarily to have been peasants and artisans with no special technical training, rather than persons with specialized education and scientific or educational knowledge. This conclusion is based on the low esteem in which contributions to technology and production were held in the Confucian tradition and the absence of any writings that can be deemed to be contributions to a systematic scientific literature.

¹⁰ Needham implies that there were impediments to entrepreneurship: "...if the entrepreneurial urge had been permitted in Chinese society, a true money economy must have arisen." (*loc. cit.* p.55) He goes on to argue that this absence bears a good deal of the responsibility for the lack of widespread and effective utilization of many of the country's great inventions (pp. 55-62). He also goes on to argue, as a good Marxist, that the absence of a bourgeoisie revolution in China was one of its primary handicaps. "[In Europe, in the wake of the introduction of printing,]...educated employers needed the help of artisans who could read and write. The gulf between artisans and scholars had at last been bridged. The fruit of this union was modern science and the industrial revolution. To explain why this did not happen in China one needs to explain why there was no bourgeoisie revolution. [One of the reasons was] deep rooted opposition to a mercantile ethos" (*op. cit.* p. 231).

Institutions as Providers of the Incentives that Guide Entrepreneurship

One of us has asserted elsewhere (Baumol, 1990) that entrepreneurs generally pursue three pertinent objectives: wealth, power, and prestige—though not always in that order. This underlies what Joel Mokyr has dubbed “the Willie Sutton model of entrepreneurship.”¹¹ In other words, in attempting to attain their goals, enterprising individuals depend on the institutions that determine the most promising avenues to success in the pertinent time and place. The activities and careers they select to pursue depend on the comparative promise of the available alternative courses. In some cases, activities that are likely to be effective in promoting one of the goals can impede or even totally prevent attainment of another—in which case, prospective entrepreneurs often can be expected to shun that activity. An excellent example of this comes from Ancient Rome, where productive effort outside of gentleman farming was considered a disgraceful occupation best left to former slaves and their ill regarded descendants. Despite the earnings it may have promised, the damage to prestige that accompanied productive entrepreneurship consequently appears to have been shunned by every enterprising Roman aristocrat, who instead could be expected to favor aggressive military activity.

The Chinese Analog: Attitudes Regarding Productive Labor, the Position of the Mandarin, and the Role of the Imperial Examinations

¹¹ It will be recalled that Willie Sutton was a much-publicized bank robber who when asked in an interview why he robbed banks, replied, “Because that’s where the money is.” Thus, the model under discussion here rests on the premise that entrepreneurial activity will be directed in the same way—toward those opportunities “where the money is.”

During the long period of great invention in China, it is also true that productive activity was considered demeaning. Prestige accrued to scholars, poets, and painters, though perhaps with a touch of suspicion of some of their personal peculiarities. More prestigious still were the mandarins, who served as bureaucrats in the service of the emperor or as court judges, as well as in the higher ranks of the military services. In contrast, productive labor was certainly no career for someone with higher status in society or for someone who aspired to such status. As a result, ambitious individuals with entrepreneurial propensities could be expected to avoid efforts directed to promotion and application of inventions. Instead, many of them would focus on preparation for the imperial examinations, which served as the main portal for entry into the prestigious civil service or the court system.¹² There, the individual was embroiled with struggle for advance in what has been described as the "...minutely calibrated layers of rank in which, it was said, every man regarded those above him as tigers to be feared and those below him as dogs to be kicked" (Fenby, 2007, p. 10).

The imperial examinations, moreover, were not open to all; former artisans, (and most notably for the discussion here), merchants, as well as others considered unfit to be scholars, such as Buddhist and Daoist monks.

Some devoted a good part of their lives preparing for the grueling exams, which went on for days.¹³ And it was for good reason that they did so. Once the candidate achieved success, he could nominate a relative or friend to a government post without the

¹² The examinations were not the only means of entry into the bureaucracy. For example, some entered by appointment by a senior government official.

¹³ There was also a good deal of cheating. There is a report that after the exam the floor could be littered with notes that had been smuggled into the premises. To prevent favoritism in grading, scribes were employed to recopy all of the answers before they were submitted to the examination graders, to prevent the latter from recognizing the handwriting of a favored examinee (Lee 1985, p.154 ff.). Lee concludes that "...corruption in the examination hall was very common" (p. 155).

nominee taking the examinations. Prestige, power, and often wealth were the successful nominees' reward. "The secret of Chinese bureaucracy...lay...in its awarding tremendous social rewards, including wealth, prestige and privilege..." (Lee 1985, p. 223).

The Chinese Examination System: Key Misunderstandings

The Imperial Examination System, as we will see, hardly was designed to encourage innovative entrepreneurship within or outside of the bureaucracy. Instead, the examinations played a critical role in providing an incentive for capable individuals to devote themselves to unproductive entrepreneurship. Of course, this was not the purpose of the system, which was used by rulers to strengthen their political power. In effect, however, the bureaucracy that was maintained with the help of the examinations guided educated people to seek power, prestige, and wealth via bureaucratic careers, rather than by pursuing economically productive goals. In order to understand this, we next examine the misconceptions that surround the examination system.

The role of the examination system seems sometimes to be interpreted as a means to inject something like an element of democracy into the imperial government and its bureaucracy. It is taken as an escape valve designed to contain the pressure of discontent in the lower ranks of society. It is also taken to be a historically early process for the selection of talent to ensure that governmental activities would be carried out by capable individuals who had received appropriate training and knew how to deal with the difficult issues that governments face. But historians tell us that all of this is a misunderstanding. In its origins, the examination was not intended to empower the lower ranks of society

but, rather, it is reported to have reflected a desire to curb the power of the aristocracy and to bring into the bureaucracy a wider variety of individuals. Moreover, the examinations were emphatically not open to all who might have wished to take them, and the contents of the examinations (or of the educational institutions that served as substitutes) were not to train future bureaucrats or test their knowledge in subjects such as public finance, the law, or effective military organization. Rather, the topics were (by then) ancient philosophy and, in particular, great classics, as well as poetry and calligraphy. The primary ability tested was not reasoning, but mnemonic skill. All of this evidently requires some explanation.

Origins of the Examinations. The influence of the examinations attained a peak during the Sung dynasties (960-1297). But it arose early, at the time of the European “dark ages,” during the Sui (581-618) and grew into an institution in the Tang (618-908). Its acceptance is explained by a problem that beset many monarchies: the power of the aristocrats. In English history, this sort of disturbance beset the king even earlier than the quarrels between the barons and king John that culminated in the Magna Carta; it recurred in the revolt of the magnates under the leadership of Simon de Montfort, in which Henry III and his successor (later, Edward I) found themselves prisoners, and it is the essence of the story of the Wars of the Roses. In Chinese history, such violent clashes also occur, and more than one emperor was deposed or even murdered and replaced by a powerful aristocrat. But even when no such overt clashes occurred, the bureaucracy that operated the government was dominated by aristocrats during the periods before the Tang. While the emperors may not have sought explicitly to free themselves from the resulting constraints upon exercise of their power, historians argue that a desire for

broadening the base from which governmental personnel were drawn underlay the adoption of the examination system. “In this way, the selected bureaucrats could come from a somewhat wider social base” (Lee, p. 142).

The Examinations as a Limited Opportunity for Social Advancement. Of course, aristocrats constituted only a small share of China’s already-huge population, which Maddison estimates reached about 59 million persons in 1000 AD (2001, p.241)—most of whom fell into the lower economic strata. The number of persons who passed the examinations was minuscule in comparison to the larger population. Indeed, the average number of graduates of the civil service examinations in existence at any time during the Sung dynasty has been estimated to have been about 8,000—of whom less than 5,000 “were of common background” (Lee, p. 25, n. 43). As such, the examinations were indeed an entree for people of ‘common background’ into the bureaucracy, where they constituted a significant portion of the whole. Still, compared to the millions of Chinese who lived in poverty, only a select few enjoyed the relative prosperity of the bureaucratic lifestyle. Thus, for most people, the bureaucracy was hardly an effective escape route from poverty.

However, as Tang (1979) notes, other benefits resulting from China’s system of examinations ultimately may have improved living standards for all stratas of Chinese society.

“While only a fraction of the aspirants succeeded in gaining an imperial examination degree, there can be little doubt that education-based mobility created a mass demand for schooling. This in turn led to widespread literacy and

mass circulation of printed works made possible by China's early (ninth century) printing technology. According to some, China was by the Sung-Yuan period the most literate and the most numerate nation in the world" (p. 1-2).

The Subject Matter of the Examinations. Noteworthy in the structure of the imperial examinations is the absence of questions on finance, accounting, market structure, productivity incentives, and the many other subjects that we would today consider an essential part of the training of government officials.¹⁴ Instead, the examinations were divided into two main categories:

"...the *chin-shih* (the subject of *belles lettres*) and the *chu-k'o* (various [other] subjects). The various subjects included the Nine Classics, the Five Classics, the Code of ...Rituals, the Three Standard Histories, the Three Classics on Rites, the *Three commentaries on the Ch'un-ch'iu*, specialization [in one or two classics] and law." (Lee, 1985, p. 143).¹⁵

Moreover, test content was heavily directed to memorization.¹⁶ The examination on the works dubbed "The Five Classics," for example, contained 80 memory questions and 50 written "elucidation questions."¹⁷ Other exams included verbatim

¹⁴ Apparently, in a few of the academies during the later Sung, both medicine and mathematics were offered in the curriculum, as reported by Mark Elvin, a colleague of Needham's (*Science and Civilization in China* Vol. VII Part II p. xxvii). However, even there, sheer memorization seems to have been stressed, and in the medical curriculum, astrological knowledge was tested—presumably to determine the prospective surgeon's knowledge of what would enable him to select auspicious timing for medical procedures.

¹⁵ The Chinese nomenclature has been omitted from most of this passage.

¹⁶ This memorization-based examination system was exactly the wrong way to train mathematicians, for instance, as Professor Chang Hsiu-Jung of National Taiwan University has asserted. Tang (1979) reports

“... recitations of the officially decreed classics and [subsequent officially approved] commentaries...[for example] ‘Confucius said of Tzu-ch’an that in him were to be found the four virtues that belong to the Way of the gentleman, what are those virtues?’...[One] form of the test questions was a simple memory test, called ‘filling out brackets....A passage from one of the classics was given with several words as clues, and then the candidates were required to complete the whole passage....students taking the examinations in the *chin-shih* subject had to demonstrate their ability, not only to memorize, but also to write poetry in various styles, plus composition of rhyme prose, policy essays and discussions [on topics such as ‘Compare the policies of Emperor Wen (r. 179-157 B.C.) and Emperor Hsüan (r. 73-49 B.C.) of the Han dynasty’” (Lee, 1985, pp.149-150).

It is clear that none of these subjects are anything like the questions we would expect to find in a civil service examination today. Moreover, they offer little information on the taker’s abilities as an innovator or an entrepreneur. Indeed, some commentators conclude that business activity, including the promotion and practical utilization of inventions, as already noted, generally was left to peasants and laborers, who had immediate use for inventions such as the wheelbarrow and the water mill. Thus, it can be argued persuasively that the tests were ill-designed for the purpose of selecting

Professor Chang’s observation, noting that, in China, “...the few noted mathematicians...tended to be rejects of the Imperial Examination System” (p. 10, fn. 30). Similarly, in the modern United States, rote learning apparently has not been the most effective way to educate entrepreneurs like Thomas Edison and Bill Gates, who succeeded after dropping out of the mainstream education system.

¹⁷ Although such examination matter is apt to seem strange today, the Medieval European equivalent may seem even more curious. See the Appendix for some questions and answers prepared by Alcuin, the noted British ecclesiastic who was friend and adviser to Charlemagne and a central figure in the Carolingian renaissance of the eighth century.

bureaucrats with the ability and inclination to contribute to the prosperity and growth of the economy.

Membership in the Bureaucracy as a Goal for Prospective Entrepreneurs in Medieval China

Securing a position in the bureaucracy was the supreme achievement for Medieval Chinese entrepreneurs, so it is not surprising that, according to Jin and Liu (1984) the ranks of this group swelled between 206 BC and 1911 AD.

“Generally speaking, when a new dynasty started, the bureaucracy was small, relatively clean, and the agencies were efficient. But as time went on, more and more agencies and officials crowded into the bureaucratic system. The bureaucratic machine gradually accumulated by redundant and abusing unqualified officials and staffs as waste, thicker and thicker. Finally, the bureaucratic machinery got rusty and spoiled” (p. 61).

This is clearly confirmed by the evidence shown in Table 1, which shows how the number of officials in the Chinese bureaucracy expanded substantially from one dynasty to the next. (However, it also must be noted that China’s population was also growing steadily during this period, as shown in Table 2, which may provide an alternative explanation for this phenomenon.)¹⁸

¹⁸ Here, it is important to note that much dispute surrounds historical Chinese population statistics. For more on this, see Deng (2003).

Table 1: Estimated Number of Bureaucratic Officials and Staffs in China, 206 BC - 1911 AD

Dynasty	Total Number of Officials: Start of Dynasty ⁺	Total Number of Officials: End of Dynasty (Estimated) ^{*+}	Total Number of Staffs: End of Dynasty (Estimated) ^{**+}	Total Number of Officials & Staffs: End of Dynasty (Estimated) ⁺
Eastern Han	7,567	22,701	227,010	249,711
Sui	12,676	38,028	380,280	418,308
Tang	(Gao Zong) 13,465	40,395	403,950	444,345
Song	(Tai Zu) 13,000	39,000	390,000	429,000
Yuan	16,425	49,275	492,750	542,025
Ming	(Tai Zu) 24,683	74,049	740,490	814,539
Qing	(Sheng Zu) 27,000	81,000	810,000	891,000

* Estimated number is calculated by multiplying the number of officials at the start of a dynasty by three.
** Estimated number is calculated by multiplying the number of officials at the end of a dynasty by 10.
+ Members of provincial and local governments are not included in these estimates.
Source: Jin & Liu (1984), footnote 3, page 62.

Table 2: Estimated Population of China, 221 BC - 1911 AD

Dynasty	Population (Estimated)
Qin (221-207 BC)	30-15 million
Western Han (206 BC – 9 AD)	15-60 million
Eastern Han (25-220 AD)	35-60 million
Sui (581-617 AD)	60-30 million
Tang (618-907 AD)	25-90 million
Song (960-1279 AD)	40-100 million
Yuan (1279-1368 AD)	70-85 million
Ming (1368-1644 AD)	60-100 million
Qing (1644-1911 AD)	120-430 million

Source: Jin & Liu (1984), footnote 3, page 62.

Arguably, this growth was partly ascribable to the efforts of prospective entrepreneurs, who sought activities that would provide them with both wealth and respect. An official and his family and relatives, for instance, were permanently exempted from taxation¹⁹ and corvée—just one of many incentives that may have led entrepreneurial individuals to

¹⁹ A result of such widespread unproductive activities was probably a decline of government power. Under the generous Tang Dynasty exemption system, for example, less than 40 percent of households and just 14 percent of the total population were required to pay taxes (Office of Information, the Statistical Bureau of China, 2002).

devote themselves to passage of the imperial examination in hope of joining the bureaucracy. Thus, rather than dedicating themselves to productive economic activities, which carried with them far lower social status, prospective entrepreneurs were drawn to positions in the bureaucracy.

Other Bureaucratic Disincentives for Exercise of Innovative Entrepreneurship

Even if government officials had been in a position to promote invention, the system discouraged this in several ways. The examinations were designed to select persons who were conservative in their Confucian orientation and were not attracted by change. In addition, the examinations were not constructed in a manner likely to find individuals with technical or scientific training. All of this plausibly can be taken to have discouraged productive entrepreneurship.

Moreover, anyone who did undertake such an activity was not in the presence of institutions that protected his interests in the ways that would be considered normal today. There was little rule of law that today would be recognized as such. For example, one could not turn to the courts for enforcement of a contract, there was no patent system, and property was subject to expropriation by Confucian government officials in the name of the emperor as, for example, is reported to have occurred to the printing facilities of the Buddhists who invented the process.²⁰

²⁰ See Balaz (1964, p. 18). Subsequent historians have questioned at least some of Balaz's conclusions. The story of printing in China is evidently more complicated than the remark in the text suggests, and much of it is apparently based on conjecture and limited evidence. Thus, compare Barrett (2008), though the reader should be warned that the title of Barrett's book, *The Woman Who Discovered Printing*, is rather misleading. In the book, the Empress Wu, the ruler in question, is not credited as the inventor of the process, but as a likely as a source of its use for facilitation of Buddhist activities.

The bottom line here is clear: the structure of incentives was not such as to attract the enterprising members of the Chinese society to a career of productive entrepreneurship. Rather, the earnings from corruption that were available to judges and government officials evidently provided powerful incentives for capable individuals to devote themselves to activities that contributed little to economic growth or to the general welfare. In other words, the availability of wealth derivable from corruption, along with the accompanying exalted social position, surely led would-be entrepreneurs to pursue a place in the bureaucracy, rather than turning to industry and the promotion of novel technology.²¹

Productive Entrepreneurship via Agriculture in Medieval China

Despite the overwhelming appeal of financially remunerative bureaucratic positions, there was, nevertheless, some entrepreneurial activity in Medieval China. This tended to focus on agriculture and is reported to have been an effective avenue for economic advancement—“from landless laborer to tenant and to full owner” (Tang, 1979, p. 3).²²

Agricultural entrepreneurs in Medieval China were aided, in part, by existing institutions, such as fee-simple ownership property rights that allowed land to be bought

²¹ Deng (2000) argues that entrepreneurship could not have been in short supply in China, as is evidenced by “the volume and range of Chinese inventions and innovations in premodern times” (p. 10) and by “the scale, scope, and profitability of Chinese commercial activities” (p. 10). However, the latter remark evidently pertains primarily to what we call “replicative” entrepreneurs, who have little or no association with innovation. Moreover, Deng’s remark about the profusion of innovation stands the issue under discussion here on its head. Although, the profusion of invention in Medieval China was astonishing, the issue we are concerned with here is why these inventions had such a limited effect on economic growth.

²² China’s agricultural sector always was robust, but efforts to expand the country’s industrial economy often struggled and failed. As already noted, China’s centrally controlled system of governance has been judged to have made it difficult for market-based competition and productive entrepreneurship, in the form of business ownership, to thrive. This may explain, in part, why China did not develop a strong innovative entrepreneurial class until the late twentieth century.

and sold freely (Tang, 1979, p. 2) and tenancy contracts, which were well understood by farmers and, as Tang (1979) notes, “tended to carry terms of tenure consistent with local conditions for efficient farming” (p. 3).²³

Farming innovations usually consisted of incremental, small-scale improvements that could be implemented by individual farmers without the intervention of large-scale research and development efforts (Tang, 1979, p. 5). However, dynastic governments did play an important role in spreading new techniques and technology among farmers:

“Officials opened and operated large polders, taught hydraulic techniques and introduced pumping equipment in areas unfamiliar with them. They encourage farmers to take up the new rice crops and provided tax relief and credit systems for its adoption” (Clydesdale, 2007, p. 65).

Aided by improving transportation systems and methods of communication, farmers eventually began trading their produce with farmers in other regions of China. Rather than merely growing food to feed their families, Chinese farmers became specialists—growing crops best suited to the climates and growing conditions where they lived and then selling their produce to farmers in other regions where that particular crop could not be grown.

“As farmers across the nation specialized in crops that made the most of local conditions, there was a quantum leap in productivity. The Chinese peasantry

²³ Another such institution was China’s “equal-field system,” which not only created an essential tax base, but also helped to maintain peace and stability via widespread economic security—each household was granted a piece of land to be used for agricultural production.

became adaptable, profit-oriented, petty entrepreneurs; and a wide range of new occupations and industries appeared” (Clydesdale, 2007, p. 66).

Does Only Entrepreneurship Matter?

Monistic explanations of complex phenomena are rarely defensible, and the failure of China to precede the West in its explosion of innovation and production that constituted the great industrialization is no exception. We do not claim that the absence of innovative entrepreneurs on which we have focused here is by itself the full explanation of this very important piece of history. Rather, it is a phenomenon rendered remarkable by China’s incredible record of invention—much of which was evidently well ahead of the performance of the West. Indeed, there is evidence suggesting strongly that much of the early innovation in Europe was borrowed from China and other Eastern civilizations. However, none of these societies seems ever to have achieved the explosion of living standards and production nor the changes in styles of living that accompanied the inventions introduced since the onset of the British Industrial Revolution. Search for the explanation evidently merits the effort entailed, and many such explanations, different from one another, have been offered—all of them with at least some degree of validity.

We do not contend that the absence of entrepreneurs is all there is to the story. Rather, we argue that it is an important component of the explanation.²⁴ Moreover, unlike climate and geography, it entails an influence that can be dealt with by appropriate policy that helps in the education of innovative entrepreneurs and provides incentives for their activity. Indeed the rapidity of the relatively recent ascent of the Chinese economy and

²⁴ An interesting example is provided by Deng (2000, p. 9), who describes nine rival explanatory hypotheses in the historical literature and then rejects them all.

that of other Asian countries indicates that policy has already provided the required contribution. However, there is still room here for further advances, and we take the position that achieving a better understanding the workings and the contribution of innovative entrepreneurship offers a promising avenue of exploration.

Concluding Comment: Eurocentrism, Democracy, and Speed of Economic Growth

As has been indicated above, the considerable literature dealing with our subject has led to a lively debate that recently seems to have reached a crescendo. In particular, a number of historians recently have taken issue with those in the field who are said, by the former, to suffer from a “Eurocentric” orientation. Here we will make no attempt to argue explicitly with any of the participants in this debate because it is our belief that there is validity to the observations contributed by each group, with error arising only to the degree that they take an either/or position.

Instead, we offer the following key observations:

- a. after the fall of Rome, Europe was indeed far slower than lands further to the east in contributing to an abundance of invention;
- b. many of the abundant inventions that underlay the British Industrial Revolution and its sequel rest on ideas and technological breakthroughs taken from the east;
- c. what seems unique about the British Industrial Revolution is the subsequent explosion in productivity growth and significantly increased living standards that are totally unparalleled in any other historical period or location; and

- d. democracy, or its absence, had little to do with the rapidity of productivity growth and the profusion of invention, but the attendant political arrangements were of critical importance—to the extent that they provided protection and other incentives for innovation and entrepreneurial activity.

As such, the explanation that rests on the availability and the allocation of entrepreneurial activity by no means takes into account all of the probably relevant influences.

The evidence supporting each of these contentions is clear. That Europe lagged technologically behind China at least well into the Ming dynasty is well known and widely documented—notably, in the work of Needham and, more recently, in writings by Clark, Hobson, and Menzies. Even those who are accused of being “Eurocentric” surely would not deny this. Neither would any historian deny that Europe obtained many of its most critical innovations via a process of technology transfer from the east. The compass and gunpowder have long been cited as examples, and there is reason to suspect the same of the windmill, the stirrup, the improved plough, and many other innovations had their origins in China or elsewhere in the east.

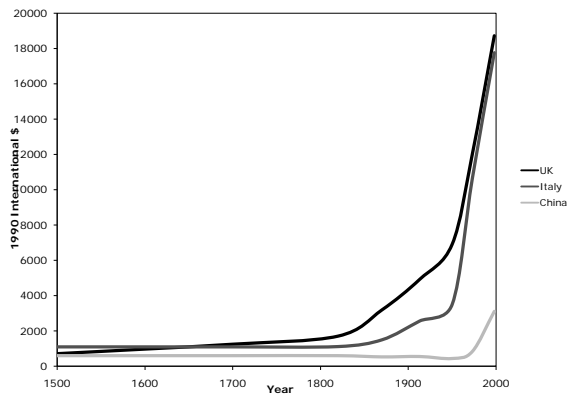
However, even during the periods of Tang or Sung prosperity, there was apparently no explosive increase in real per capita income, and poverty continued to be the norm for the general population. As a result, by the eighteenth century, Europe had pulled far ahead of China, in terms of living standards and productivity. This was true, even though the explosion of Western European growth and previously unimaginable inventions—such as the railroad, the telegraph, and the utilization of fossil fuels and electricity—did not occur until the nineteenth century.

Here, it is also important to emphasize that the casually asserted association of democracy with the Industrial Revolution's economic take-off is groundless. At the time of its take-off, Great Britain was far from democratic, with only a very small proportion of the population having the right to vote. The United States also was an extreme laggard, being one of the last of the prosperous economies to grant the right to vote to women and effectively extending this right to "inferior races" even later (Hobson, 2004, pp. 287-293). Evidently, in many industrialized countries, progress toward democracy lagged behind productivity growth.

Nevertheless, there is good reason to believe that political institutions did directly affect economic growth. The *Magna Charta*, which limited the king's ability to impose arbitrary exactions—notably on wealthy orphans and widows, was very much an economic document, at least in significant part. Moreover, it paved the way in the next century, for the granting of relevant powers to parliament, including movement toward a House of Commons and adoption of the principle of no taxation without representation under Edward I, as well as the introduction of the patent under Edward III. Most important, the final victory of the Tudors in the Wars of the Roses closed the opportunity for nobles to seek wealth through the businesslike military violence that had offered significant financial rewards to the victor. This forced entrepreneurs to seek other outlets for their ambitions. In contrast, there seems to have been no such upheaval in the Chinese economic incentive structure until the second half of the twentieth century—surely an important component of the story of its relatively low and static per capital GDP until

recent decades²⁵ (see Figure 1, with its comparison of GDP per Capita in China with those in Italy and the United Kingdom).²⁶

Figure 1: GDP per Capita from 1500 to 2006: China, Italy, and the United Kingdom (1990 International \$)



(Source: Maddison, A. (2001), *The World Economy: A Millennial Perspective*, Paris: OECD, p. 264.)

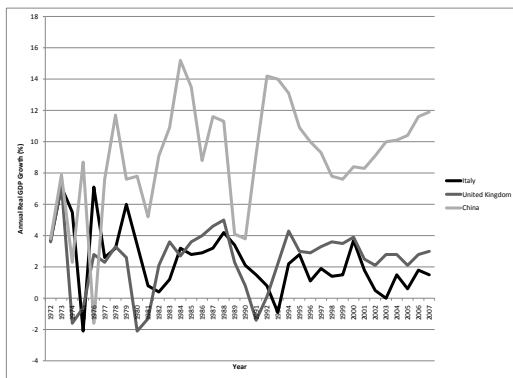
Finally, we must emphasize that a multitude of influences underlay the failure of an economic explosion in Medieval China—a curious state of affairs that stands in stark

²⁵ Unfortunately, we have not found any estimates of per capita income in China at any earlier date. We are aware, however, of the period of prosperity during the Tang and Sung dynasties (roughly 600-1300) that preceded the data presented here, which begins in 1500, by more than two centuries. Nevertheless, very rapid growth between the Tang-Sung period and the onset of the sixteenth century is hardly plausible, as that would have required that per capita income in China during the earlier period be much lower than the very low figure estimated here for 1500. That possibility hardly is consistent with the notion of Sung prosperity and is perhaps not even consistent with survival of much of China's population.

²⁶ Of course, it is important to bear in mind that the rise or decline of Chinese economic growth did not proceed at a steady and invariant pace. Rather, China has had its own protracted business cycle. Thus, when the economies of Western nations finally took off at the end of the nineteenth century, for instance, China was in a period of downturn that coincided with the end of the Qing Dynasty and, with it, the rule of the emperors. Similarly, Sung prosperity and its subsequent decline after the Mongol takeover illustrate that any simple characterization of the shape of China's time path must be a vast oversimplification.

contrast to China's spectacular growth performance in recent decades (as shown in Figure 2), when the respect and encouragement offered to entrepreneurs in China has grown sharply, even though the country has hardly re-attained anything like its former leadership in the invention process.

Figure 2: Annual Real GDP Growth from 1972 to 2007: China, Italy, and the United Kingdom



(Source: OECD (2009) OECD Factbook 2009: Economic, Environmental and Social Statistics, Paris: OECD.)

We suspect that all of this shows innovative entrepreneurship to be a necessary, but not a sufficient condition, for the creation of an explosive economic upsurge. That is, innovative entrepreneurs cannot achieve such spectacular growth acting alone, but without their participation, such development is, at the very least, improbable. For the moment, the rest of the world has supplied China with enough innovative products and

processes to keep Chinese entrepreneurs busy. It is arguable that those new ideas, put into practice by China's energetic entrepreneurs, are indeed sufficient to account for the bulk of China's recent growth explosion.

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Comment [S1]: Note to self: check to see that Vol/Part match pub year.

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Appendix

It is tempting to jump to the conclusion that the Chinese imperial examinations were badly designed as a stimulus to thought and education in some deeper sense. But they can also be interpreted as a product of their time in the chronology of human history. To make this point, we offer some more explicit material on Chinese examinations during the Sung dynasty (960-1279 AD), comparing this with the educational approaches in Medieval Europe. For the latter, we turn to the highly regarded “Carolingian Renaissance” of the eighth century and report some educational material prepared by Alcuin, that noted English ecclesiastic, friend of Charlemagne, and leader in the educational activities in the court.

Notes on the Chinese Examinations

We begin with some Chinese material:²⁷

“...[T]he emphasis, except for the tests in the *chin-shih* subject, was placed on memory—recitations of the officially decreed classics and their commentaries.”

“Question: ‘It is said that there were seven authors, who are they?’

Answer: ‘The seven authors are: so and so, answered respectfully.’

Question: ‘Confucius said of Tzu-ch’an that in him were to be found four virtues that belong to the Way of the gentleman, what are these virtues?’

Answer: ‘In his private conduct he was courteous, in serving his master he was punctilious, in providing for the needs of the people he gave them even more than their due; in

²⁷ Lee, Thomas H.C. (1985), *Government Education and Examinations in Sung China*, New York: St. Martin’s Press, pp.149-150 (portions of the discussion omitted).

exacting service from the people, he was just. I answer this question with respect.”

“Another form of test questions was a simple memory test, called “filling out brackets” (memory questions, *t'ieh-ching*). A passage from one of the classics was given with several words as clues, and then candidates were required to complete the whole passage, demonstrating their knowledge of the classic. There is no substantial difference between the two forms of tests mentioned above; they all placed emphasis on the ability of candidates to remember *verbatim* passages of the classics.

...[S]tudents taking the examinations in the *chin-shih* subject had to demonstrate their ability, not only to memorize, but also to write poetry in various styles, plus composition of rhyme prose, policy essays (*lun*) and discussions (*ts'e*) (see Table 8). The following is an example of a topic for a policy essay: “Compare the policies of Emperor Wen (r. 179-157 B.C.) and Emperor Hsüan (r. 73-49 B.C.) of the Han dynasty.” This topic was given by Emperor Chen-tsung in 1005.”

Some of Alcuin’s Materials for Charlemagne’s Eighth-Century Court

We turn next to a sample of Alcuin’s educational materials (note that these are not examination questions):²⁸

PEPIN	ALBINUS
“What is writing?	The guardian of history.
What is speech?	The revealer of the soul.
What produces speech?	The tongue.
What is the tongue?	The lash of the air.
What is air?	The guardian of life.
What is life?	The joy of the good, the sorrow of the wicked, the waiting for death.”

²⁸ Winston, Richard (1960), *Charlemagne from the Hammer to the Cross*, 2nd Ed., New York: Vintage Books, Random House, pp. 179-180.

PEPIN	ALBINUS
“What is the sun?	The splendor of the universe, the beauty of the sky, the glory of the day, the divider of the hours.
What is the moon?	The eye of night, the giver of dew, the foreteller of storms.
What are the stars?	Pictures on the roof of the heavens, guides of sailors, the ornament of night.”

The first section contains what apparently were considered key questions for the educational process, with answers provided by Alcuin. The second section covers topics in what may be considered natural science.