The Agricultural and Industrial Revolutions in England and China: A View through the Lens of Dynamic Property Rights Theory

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用一个动态产权理论对比英格兰和中国的农业和工业革命

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Abstract

This article presents a dynamic land property rights theory based on the law of the limit to land productivity, and then uses this theory and a large amount of data to compare the history of the agricultural and industrial revolutions in England and China. The article finds that, in England, the arable land—especially sown land—per capita of the agricultural population, trended downward before the Black Death, but after the Black Death, experienced a long-term upward trend. In China, however, over the same period, the sown area per capita of the rural population

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shrank. It is these opposing trends that account for the historical divergence between the economies of England and China. This article concludes that the agricultural and industrial revolutions in England, as well as England's capitalist market and private property rights regime, are the result of the expansion of the sown area per capita of the agricultural population. The article also concludes that the claim that England's capitalist system of markets and private property rights gave birth to its agricultural and industrial revolutions cannot be sustained.

Keywords

law of limited land productivity, dynamic land property rights theory, opposing trends of shrinking and expanding sown area per capita of the agricultural population, agricultural and industrial revolutions, the opposite path to industrialization and property rights changes between China and England

摘要

本文用土地生产率极限法则建立了一个动态土地产权理论，然后用这一理论和大量数据对比英格兰和中国的历史，发现英格兰的农业人口人均耕地，尤其是它的农业人口人均播种面积在黑死病后从缩小趋势变成了扩大的长期趋势，而中国的农村人口人均播种面积一直在缩小。正是这相反的趋势使它们的历史分岔。本文的结论是英格兰的农业和工业革命，资本主义的市场和私有产权制度都是它的农业人口人均播种面积扩大趋势的结果。那些宣称资本主义市场和私有产权制度是英格兰农业和工业革命的原因的人一直在自欺欺人。

关键词

土地生产率极限法则、动态土地产权理论、农业人口人均播种面积缩小和扩大的相反趋势、农业和工业革命、中国与英格兰相反的工业化道路和产权变化

The agricultural and industrial revolutions in England were important events in the history of the world, and deeply influenced the neoclassical theory of property rights. According to neoclassical theory, it was the capitalist market and private property rights regime that led to the agricultural and industrial revolutions in England (see, e.g., North and Thomas, 1973; Ruttan and Hayami, 1984; Feder and Feeny, 1991). This purported causality has led the World Bank to push for market-oriented land reforms to establish private property rights in many poor countries. Yet, such reforms have not reduced the poverty of these countries, but have had the opposite effect—namely, of reducing production and harming poor peasants (see, e.g., Ostrom, 2002; Borras, 2003; Lahiff, Borras, and Kay 2007; Jacoby and Minten, 2007). This calls into question the causality claimed by neoclassical property rights theory. To address this issue, this article uses the law of the limit to land productivity to establish a dynamic property rights theory, and then employs this theory to compare the economic history of England and China. It finds that the Black Death reduced England's population by half, causing its arable land—particularly its sown land—per capita of the agricultural population to shift from a downward trend to a long-term upward (or increasing) trend. It is this upward trend that gave birth to the twin phenomena of, first, the agricultural and industrial revolutions in England, and, second, England's capitalist private property rights and market regime. A trend of this sort will inevitably create three logical causal chains. (1) The expansion of the sown area per capita of the agricultural population $\rightarrow$ the expansion of the average scale of farms $\rightarrow$ labor inputs per unit of land veer away from the limit

to land productivity → increasing marginal returns to labor and declining labor costs per kilogram of food → growing labor productivity because the limit to land productivity does not restrict its growth → a potential for growth despite low land productivity because it is far from its limit → per capita income exceeds the survival level and its growth is not constrained by the limit to land productivity. (2) The expansion of the sown area per capita of the agricultural population → increasing space for establishing individual exclusive land rights → the exclusive right to land and market mechanisms exert a positive effect by increasing input and supply when returns exceed costs. (3) The expansion of the sown area per capita of the agricultural population → an expansion of the average area per farmer producing commercial grain for the urban population → the proportion of commercial grain in total food production rises → the proportion of the agricultural population drops and the proportion of the urban population increases → the division of labor, agricultural and industrial revolutions, and commodity exchange between the two proceed smoothly → a capitalist market system is formed.

The causality of neoclassical property rights theory has played a role in reducing production through the land reforms promoted by the World Bank because the sown area per capita of the rural population in most countries, especially China, the country with the largest population, has been shrinking. This trend has created the following three logical causal chains. (1) A reduction in the sown area per capita of the rural population → a reduction in the average size of farms → a constant increase in labor input per unit of land, approaching the limit to land productivity → diminishing marginal returns to labor and rising labor costs for food → stagnation of labor productivity because the limit to land productivity prevents its growth → high land productivity but no growth potential because it is too close to its own limit → per capita income is fixed at the level of survival by the limit to land productivity. (2) The sown area per capita of the rural

population shrinks → the space for establishing individual exclusive land rights disappears → the role of exclusive rights when costs exceed returns is not to increase but to reduce inputs and supply. At this time, it is not the market but sheer survival that forces peasants to increase inputs and endure diminishing returns. (3) The sown area per capita of the rural population shrinks → the average area per farmer producing commercial grain for the urban population shrinks → urbanization stagnates, and the proportion of the rural population in the total population tends not to decline or even increases → the development of a division of labor and commodity exchange between urban and rural areas and between industry and agriculture is stymied → the formation of a capitalist market system is impeded because it often plays a role in exacerbating famine in the population trap.

The limit to land productivity creates the above-mentioned opposite logical causal chains. This is because of the supply limit imposed by nature and has nothing to do with the market. The result is market failure. When the reduction in the sown area per capita of the rural population forces the labor input per unit of land to reach the limit to land productivity, no matter how high market prices and labor inputs may be, output will no longer increase. Historically, in England, with its trend of increasing sown area per capita of the rural population, the labor input per unit of land was far from the limit to land productivity, so that returns exceeded costs and production had the potential to increase. This gave the market and exclusive land rights an incentive to increase production—it does not mean that they could create production potential and make returns exceed costs. But if land productivity had no limit, the same amount of labor input on 1 hectare and 100 hectares of land would produce the same amount of output and return, and the above opposite logical causal chains would not appear. Thus it is the existence of the limit to land productivity that causes things to move in the opposite direction when they reach the limit.

This law changes the role of the market and exclusive land rights: they reduce production and per capita welfare when the trend of shrinking sown area per capita of the rural population causes costs to exceed returns, and thus their development is stymied; they increase production and per capita welfare when the trend of expanding sown area per capita of the rural population causes returns to exceed costs, thus enabling their development. To verify this dynamic land property rights theory, the first section of this article establishes a theoretical framework. The second section uses this framework to demonstrate that the agricultural and industrial revolutions in England, as well England's capitalist market and private property rights regime, were all the result of the transformation of the sown area per capita of the agricultural population from shrinking to expanding. The third section analyzes how the trend of shrinking sown area per capita of the rural population has shaped China's industrial revolution and land property rights model. The final section summarizes the article.

The Concept and Framework of the Dynamic Land Property Rights Theory

The Law of the Limit to Land Productivity

Soil fertility includes both natural and artificial fertility. The combination of the two creates economic fertility in the form of land productivity. Natural fertility, which is created not by humans but by nature, provides the soil characteristics and surface environment needed for plants to grow: soil depth, nutrients, moisture, air, light, heat, and so on. All these are a combination of the biological, physical, and chemical properties of the soil and the surface environment. One end of natural fertility is zero, such as in the case of desert or permafrost. The other end is the highest limit of natural fertility, such as the limits of annual sunlight and the accumulated temperature of a cultivated plot of land set by the nature. Hence natural fertility is a framework

where one end is at zero and the other is at the highest limit. Artificial fertility is created by the productive activities of land consolidation, construction of irrigation and drainage systems, farming, fertilization, crop rotation, multiple cropping, and so on. Because the inputs of labor and capital and the corresponding technology of these activities are applied within the framework of natural fertility, the formation of artificial fertility and land productivity is confined within this framework. Their formation in the short term depends on how labor and capital are invested and how natural fertility is manipulated. In the long run, the formation of artificial fertility and land productivity depends on the level of the technology that is used to exploit the potential of natural fertility. At a given stage, land productivity cannot be more than what is possible using the technology available at that stage, meaning there is a relative limit to land productivity. In the next stage, technological progress can raise the relative limit by tapping the potential of natural fertility but can never make it escape the framework of natural fertility. For example, the amount of sunshine required for photosynthesis on a plot of land is in constant supply each year. Technological progress can neither increase this supply nor override its maximum limit. Therefore, the highest limit of natural fertility is the absolute limit to land productivity. Under the technical level that can be achieved in a given development stage, the relative and absolute limits to land productivity can be regarded as a unified ceiling, meaning that the limits exist in all times and places and cannot be eliminated by technological progress.

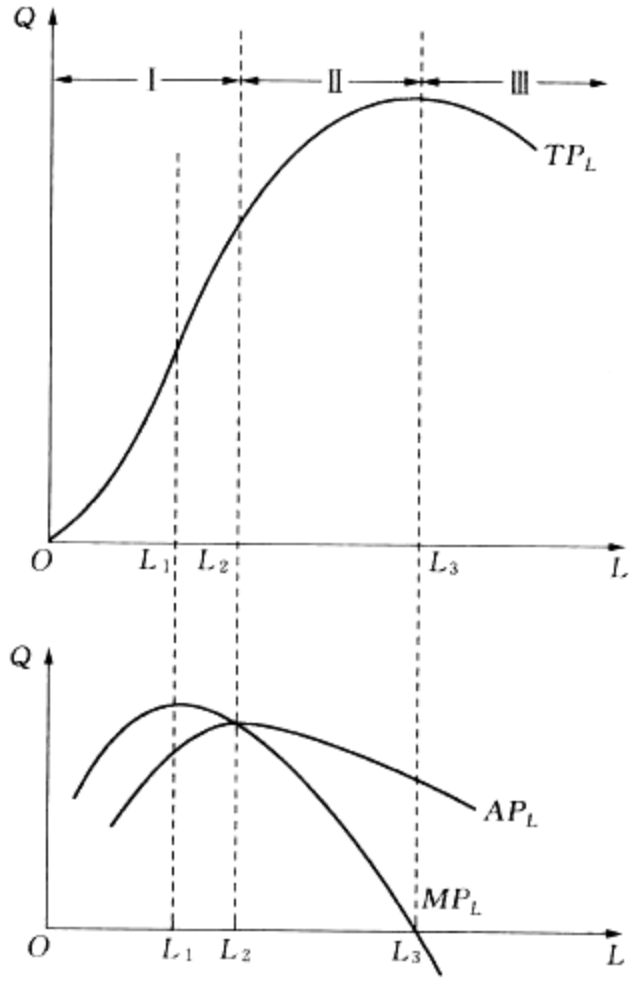

Figure 1. The relationship of the marginal product, average product, and total product of labor, and their relationship to the limit to land productivity (LTLP).

Source: MBAlib, http://wiki.mbalib.com/wiki/%E7%9F%AD%E6%9C%9F%E7%94%9F%E4%BA%A7%E5%87%BD%E6%95%B0

Figure 1 shows that the limit to land productivity (LTLP) is the cause of diminishing returns. The horizontal axis represents labor inputs and the vertical axis yield. TP_L is the total product curve of labor, MP_L is the marginal product curve of labor, and AP_L is the average

product curve of labor. The causality of the marginal and total product of labor is: TP_L increases when $MP_L > 0$, decreases when $MP_L < 0$, and is highest when $MP_L = 0$. The marginal returns to labor input pass through three stages: incremental, diminishing, and negative returns. When labor inputs increase from zero to L_1, they are less relative to natural fertility. It is the relatively greater natural fertility that increases the returns to each new labor input and the total product of labor the fastest. Labor inputs become more relative to natural fertility when they reach L_1 and available natural fertility used by each new labor input changes from increasing to decreasing. This in turn creates the peak of marginal returns to labor. When labor inputs increase from L_1 to L_2 and then to L_3, natural fertility gradually declines to zero, and thus the marginal return to labor falls to zero and the total output of labor reaches its peak. This apex is LTLP under a given level of technology (the relative LTLP as defined above). The farther labor input is from LTLP, the higher the marginal returns to labor, and conversely, the closer labor input is to LTLP, the lower the marginal returns. When labor inputs go beyond LTLP, marginal returns change from positive to negative and land productivity switches from rising to falling. For example, when crops are watered so much that they are flooded or if too much fertilizer is applied so that the crops are burned, the yield drops because genes have set the water and nutrient absorption limit of the crop. This is a law of nature—once inputs exceed LTLP, their role changes from positive to negative. But if there were no LTLP, marginal returns would not diminish, land productivity would grow in proportion to any increase in labor input, and TP_L would not be a parabola but would slant upward. If this were so, farm outputs would, like industrial outputs, not correlate to the area of land but instead to labor inputs, and the same amount of labor inputs in 1 ha and 100 ha would result in the same amount of outputs. In this case, there would be no need to struggle for land and to establish land rights.

Figure 1 also shows the causality of the marginal product and average product of labor. AP_L increases when $MP_L > AP_L$ and decreases when $MP_L < AP_L$, and is highest when $MP_L = AP_L$. These three relations tell us that changes in the average product of labor are the result of changes in the marginal product of labor. Changes in the latter in turn are the result of changes in the distance between the amount of labor input per hectare and LTLP, and thus changes in the average product of labor are also the result of changes in this distance. When labor inputs increase from zero to L_1 and the marginal product of labor increases, the average product of labor grows fastest and the AP_L curve is steepest. When labor inputs increase from L_1 to L_2 and the marginal product of labor diminishes, the AP_L curve becomes gentle but the average product of labor still grows because $MP_L > AP_L$. When labor input reaches L_2, the average product of labor reaches its apex. Since the average product of labor is labor productivity, labor productivity is highest when $MP_L = AP_L$. In a country with relatively ample land and few people, labor inputs do not exceed L_2 because more land and fewer people means more food per capita, a lower opportunity cost of land and a higher opportunity cost of labor, and the highest labor productivity. But in a country with little land and a large population, labor inputs tend to reach L_3 because less land and more people means less food per capita, a higher opportunity cost of land and a lower opportunity cost of labor, making the highest possible land productivity the only option. Hence pursuing the highest labor productivity is bound to sacrifice the highest land productivity, and pursuing the highest land productivity is bound to sacrifice the highest labor productivity. The two are contradictory and both sides cannot be satisfied at the same time. In fact, pursuing the highest land productivity in order to ensure people will have enough to eat is a process of approaching LTLP, and thus it is also a process whereby LTLP prevents labor productivity from growing. We can see from the declining AP_L curve that when labor inputs

increase from L_2 to L_3, LTLP prevents labor productivity from growing by reducing the average product of labor. This problem of overpopulated poor countries cannot easily be solved by advances in technology, because technology can only tap the potential of natural fertility but cannot cancel LTLP. As shown in Figure 2, new technology can only push up the TP_L curve, but it cannot change its parabolic shape. In other words, it cannot stop the MP_L curve from declining and change its relation to the TP_L curve and the AP_L curve. Under each new level of technology, it remains the case that TP_L increases when $MP_L > 0$, decreases when $MP_L < 0$, and is highest when $MP_L = 0$; similarly, AP_L increases when $MP_L > AP_L$, and decreases when $MP_L < AP_L$, and thus is highest when $MP_L = AP_L$. Moreover, the potential for technological progress to exploit natural fertility diminishes step by step, and thus there is less potential for overpopulated poor countries to improve labor productivity.

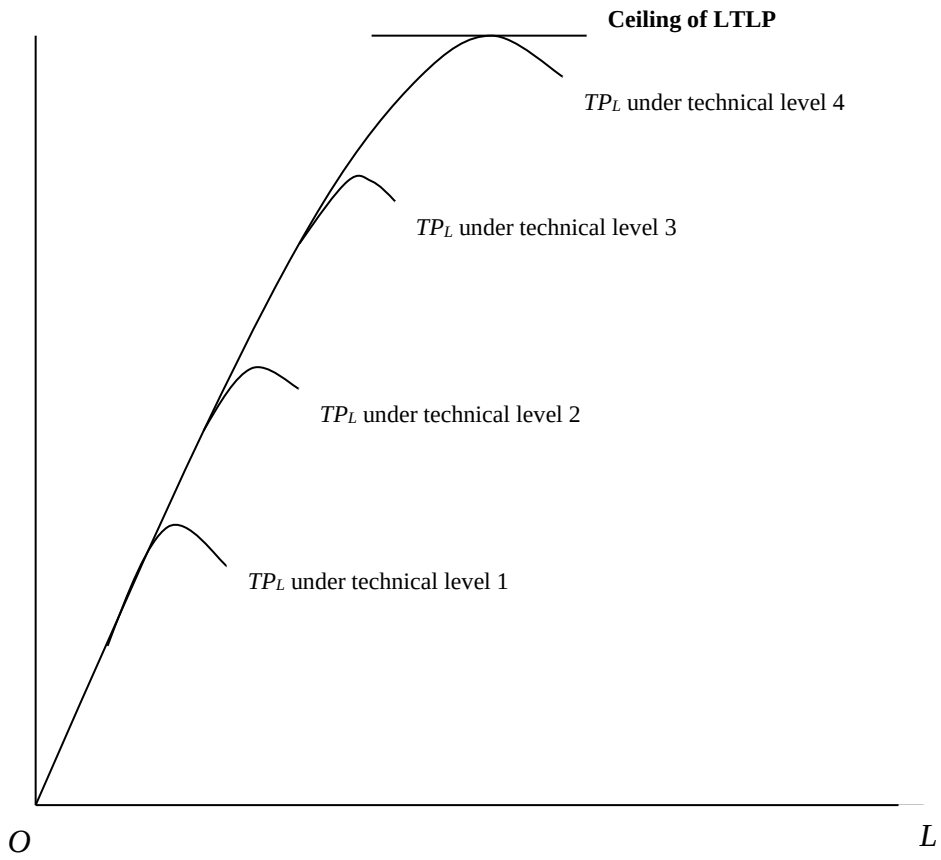

Figure 2. Technological progress cannot break the natural fertility framework and cancel LTLP.

Ester Boserup (1965) argued that population growth and a reduction in land per capita caused agriculture to go through five stages of development: forest fallow, bush fallow, short-term fallow, one cropping, and multiple cropping. In addition, appropriate farming techniques and tools were developed in each stage, from slash and burn cultivation to the use of the hoe, and then to the use of the plow. In short, the more densely a country is populated, the higher it will be on the five stages. Therefore, Boserup argued that population growth is not a dependent variable but an independent variable. By reversing Malthusian causality (Malthus, 1989), she made population growth the source of technological progress. Her argument is valid to a certain extent since humans are both the producer in her model and the consumer in the Malthusian model. But her argument cannot overturn the core of the Malthusian model: population grows geometrically but food production grows arithmetically. Her five stages of technological advancement have not changed this difference and have not made it possible for overpopulated poor countries to escape from the population trap. For example, China's demographic pressure led to the popularization of multiple cropping systems around 1000 CE, but the result was that China's natural fertility potential was exhausted and the country then fell deeper into the population trap. Obviously, there are loopholes in Boserup's theory. Douglass North (1981: 60) points out that she provides no theoretical bridge to account for the overcoming of diminishing returns to a fixed factor. This fixed factor is LTLP. First, population growth is certainly not the ultimate cause of technological progress. Otherwise, technology would advance whenever population grows, and there would be no population trap, and the most populous countries (such as China and India) would have the highest technology and per capita income. Second, technological advances occur only in a specific period, such as the transition from forest fallow to bush fallow. This must be because population growth encounters a formidable obstacle. That obstacle is the LTLP of forest fallow,

the relative LTLP defined above. Technological progress, however, can overcome this obstacle. Third, as shown in Figure 2, the five tillage systems cannot break out of the framework of natural fertility and increase the supply of sunlight energy. The only way they can evolve is by using land more intensively and capturing a fraction of that fixed supply. This in turn further reduces marginal returns to labor and increases labor costs per kilogram of output. Thus a new farming system can only push up the TP_L curve of the old system, but cannot change its parabolic shape and the causality underlying the marginal product, the average product, and the total product of labor. Under each farming system, the causality is repeated. What creates the cycle is that each system has its own LTLP. Otherwise there would be no next system. In sum, LTLP is both the origin of the difficulty of obtaining food in the Malthusian model, and the origin of technological innovation in Boserup's model. Thus LTLP remedies the defects of the two models, resolves their conflicts, and makes it possible to unify them into the same theoretical framework.

LTLP can be considered a law of nature, which is objective and refers to the inherent, natural, and repeated stable relations of the motion of matter. For example, each day the sun rises in the east and sets in the west. Humans cannot create, alter, or destroy the laws of nature, but they can make use of the material and energy flows that nature provides. The framework of natural fertility is an inherent objective thing of nature. Technological progress in agriculture involves a process of utilizing and developing natural fertility. This process can form relative limits to land productivity under various levels of technology, causing them to approach but not go beyond the absolute LTLP, because technology can only advance within the framework of natural fertility and the framework's maximum limit is the absolute LTLP. LTLP gives rise to four causal relations which are repeated under each level of technology. First, Malthus (1989) did not answer the question of what causes the population to grow geometrically but food

production to grow arithmetically. Hence his observation does not constitute a causal explanation but instead is a description of a phenomenon. In fact, by acting as a ceiling, LTLP checks population growth by causing food production to grow arithmetically. Second, Malthus also did not address the question of what causes diminishing returns; thus his point about diminishing returns is a description of a phenomenon as well. Figures 1 and 2 illustrate that LTLP causes returns to diminish and that this phenomenon is repeated under each level of technology; thus diminishing returns are not a law but are the result of the law of LTLP. Because diminishing returns mean rising labor costs per kilogram of output, this rise is also a result of the law of LTLP. Third, Figure 1 shows that it is LTLP that prevents labor productivity from growing by reducing the average product of labor, when labor inputs increase from L_2 to L_3 and the AP_L curve falls. This is why it is difficult for labor productivity and per capita income of overpopulated poor countries to grow. Fourth, LTLP is the critical point where MP_L changes from positive to negative and TP_L from increasing to decreasing—or the benchmark where things develop in the opposite direction when they become extreme. The four casual relations are component parts of the law of LTLP. They exist independently of property rights and markets and cannot be changed by the latter. On the contrary, they can change the role of the latter.

The Inverse Logics of the Stages of Development under the Law of the Limit to Land Productivity

Because farmland can be simultaneously a part of nature, the property of landowners, and a means of production used by tillers, its use takes place in a tri-world system: (1) the relation of population numbers to land resources and the physical laws of nature that govern crops' growth belong to the physical world; (2) the property relations among people belong to the institutional

world; and (3) tillers' actions in using land according to cost/return ratios and the outcomes, to the realm of the economic world. The institutional world's land rights pattern is the result of the physical world because human-to-human property relations arise from the physical relation of population to land resources. The economic world's pattern of action and its outcomes are the joint results of the physical and institutional worlds because the physical laws of nature and land-rights patterns jointly govern how land is used. Physical law here specifically refers to the law of LTLP, especially in the sense that things develop in the opposite direction when they become extreme.

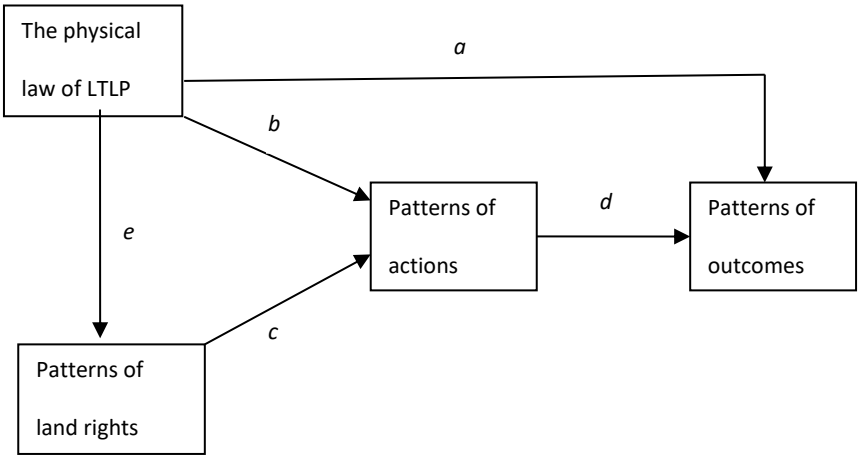

Figure 3. The system of the three worlds of land use.

Source: Pei, 2014: 49.

Figure 3 illustrates the inner links of the land use tri-world system. LTLP and patterns of land rights jointly affect patterns of action, which combine with LTLP to produce outcomes. The hard restraints of LTLP affect outcomes in two ways: one path leads via patterns of action (lines

b and *d*); the other path, line *a*, affects outcomes directly and independently of human choice. Patterns of land rights, however, only indirectly affect outcomes via lines *c* and *d* because they are soft restraints and work only via human choices and actions. Therefore, the three-worlds land-use model has four relations: (1) LTLP directly affects outcomes (line *a*) with diminishing returns as its result and evidence; (2) LTLP restricts actions (lines *b* and *d*) by fixing cost/return ratios; (3) private land rights can create both positive incentives to act if returns exceed costs and negative incentives if costs exceed returns (lines *b*, *c*, and *d*); (4) private land rights harm others and the general welfare if they do not match with LTLP (line *e*). For example, the exclusive right to land threatens the survival of new additions to a village's population and reduces the food supply by maintaining the inverse relation of farm size to yield per hectare: that is, low in big farms, which seek more marginal returns to labor, and high in small farms, because survival forces them to exploit their own labor (Chayanov, 1966 [1925]; Pei, 2004, 2008).

From the perspective of time, I use the Malthusian population model (Malthus, 1989) to depict the different stages of development before, in, and after the population trap. The model can be written as $AY > NS$ converges to $AY = NS$, or $AY/N > S$ converges to $AY/N = S$. The area of arable land (in hectares) is *A*, and *Y* is the yield of grain per hectare (kg/ha); *AY* is the grain supply; *N* is number of people; and *S* the subsistence level in terms of grain (kg/person). *NS* is the demand for grain. Malthus held that growth in *N* can lead any country from the stage of $AY/N > S$ (everyone has a farm surplus) to the stage of $AY/N = S$ (no one has a farm surplus), because *A* and *S* are constants, and *N* and *Y* are variables to growth over time, and what turns $AY/N > S$ to $AY/N = S$ is geometric growth in *N* (1, 2, 4, 8, 16 . . . every twenty-five years) versus arithmetic growth in *Y* (1, 2, 3, 4, 5 . . . every twenty-five years). Put another way, the denominator increases more rapidly than the numerator. But Malthus could not account for this

divergence and diminishing returns. We know that, acting as a ceiling, LTLP checks *N* from growing quickly by causing returns to diminish and *Y* to grow arithmetically. If we use Figure 3 and its four relations to sum up, what Malthus studied are only the *results* of the first relation: the end of line *a*. What he missed is LTLP: the outset of line *a*.

The Douglass North/Robert Thomas (1973: 8) model also misses LTLP, and uses the neoclassical assumption of self-interested man to claim that "given the described assumption about the way people behave, economic growth will occur if property rights make it worthwhile to undertake socially productive activity." This claim has lines *c* and *d* only of Figure 3: private property rights via line *c* create incentives to act; incentives to act via line *d* cause growth. This one-way model is unbalanced, like a car without brakes. It only takes into consideration the third relation shown in Figure 3, but at the same time denies that LTLP can affect outcomes via line *a* and check actions via line *b*. It implies that humans can control both their actions and the outcomes of their actions. However, in reality although humans can control their actions, they cannot control the outcomes of their actions. For example, diminishing returns to labor are the result of actions that humans cannot control but can only accept. Another of North's (1981: 17) one-sided claims is also unsupportable but has misled many reformers: "A theory of the state is essential because it is the state that specifies the property rights structure. Ultimately it is the state that is responsible for the efficiency of the property rights structure, which causes growth or stagnation or economic decline." The reason this theory is unsupportable is because, although the state can specify the property rights structure, it cannot control the effects that will flow from the structure it specifies. Table 1 shows that the same land rights specified by the state have inverse effects at different stages of development, which are not caused by the state but by the law that

things develop in the opposite direction when they become extreme. Therefore, in the final analysis the effects of the land rights structure are determined not by the state but by LTLP.

Table 1. Inverse Logics of the Stages of Development under the Law of LTLP

	AY/N > *S*	*AY/N* = *S*	*AY/N* > *S*
The Physical Word:			
A: area of arable land	Constant	Constant	Constant
N: population under the law of LTLP	Less	Most	Least
Land per rural capita	Large	Smallest	Largest
The Economic Word:			
Land size per family farm	Large	Smallest	Largest
Labor inputs per ha	Less	Most	Least
Labor inputs to LTLP	Far	Closest	Farthest
Marginal returns to labor	High	Lowest	Highest
The average labor cost per kg grain	Low	Highest	Lowest
Labor productivity	High	Lowest	Highest
Y: land productivity	Low	Highest	High
Returns to fixed capital investment	High	Lowest	Highest
To invest in farm machines?	Yes	No	Yes
Above ***S***: surplus grain	Have	No	Most
Aim of farming	Survival & profits	Survival	Mainly for profits
The Institutional World:			
Transfer of land use right	Work	Not work	Work
Land rental markets	Work	Fail	Work
Mortgaging land titles for bank loans?	Yes	No	Yes
Credit markets	Work	Fail	Work

Exclusive land rights	Not harm SNAP*	Harm SNAP	Not harm others
Patterns of land rights	More private	More communal	More private

* SNAP = survival of newly added population.

Source: Pei, 2014: 53, table 2.

Table 1 specifies the tri-world land-use system illustrated in Figure 3 and renders the system dynamic from the perspective of time. Columns 2, 3, and 4 represent three different stages of development: before, in, and after the population trap (or after industrialization). The horizontal items show the inverse logics of the three stages and extend the span of the Malthusian population model—which has a time factor and hence an analogue of columns 2–3 but not column 4 and an institutional world that is not its focus—to history after the Industrial Revolution. From the space perspective, the vertical items show that both the institutional and economic worlds are the results of the physical world's relation of population to land resources. The North/Thomas model has no physical world in a space perspective, because it sees the economic world as the result of the institutional world by denying the physical checks of LTLP on the institutional and the economic worlds. This static model lacks the time factor and thus breaks off in a time perspective and has an analogue of columns 2 and 4 but not column 3. If it had an analogue of column 3, it would contradict its own causality. In sum, the Malthusian model takes into consideration the information in columns 2–3 but ignores column 4 and the institutional world, while the North/Thomas model is fragmented and is not a valid theory since it considers the information in columns 2 and 4 but not column 3 and not the physical world.

Table 1 uses the law of LTLP that things develop in the opposite direction when they become extreme and a greater time-space framework to remedy the defects of the above two. It shows that England's path to industrialization began by retreating from the $AY/N = S$ population trap stage back to the $AY/N > S$ stage before the trap (from column 3 to column 2), and then to the $AY/N > S$ industrialized stage (column 4, with the same logic as column 2). What makes the logic of the two processes the same is the trend of expanding cultivated land and sown area per capita of the agricultural population. This trend created the following three logical causal chains.

(1) The expansion of the sown area per capita of the agricultural population → the expansion of the average scale of farms → labor input per unit of land veers away from the limit to land productivity → an increase in marginal returns of labor and declining labor costs per kg of food → a rise in labor productivity because the limit to land productivity does not restrict its growth → productivity remains low but has growth potential because it is far from its limit → per capita income exceeds the survival level and its growth is not constrained by the limit to land productivity. (2) Expansion of the sown area per capita of the agricultural population → increased space for establishing exclusive land rights → exclusive land rights and market mechanisms exert a positive effect on increasing input and supply when returns exceed costs. (3) Expansion of the sown area per capita of the agricultural population → expansion of the average area per farmer producing commercial grain for the urban population → a rise in the proportion of commercial grain in total food production → a drop in the proportion of the agricultural population and an increase in the proportion of the urban population → division of labor, agricultural and industrial revolutions and commodity exchange between the two proceed smoothly → the capitalist market system is formed.

In contrast, once China entered the AY/N = *S* population trap stage from the AY/N > *S* stage before the trap, it began to fall deeper and deeper into this trap, because its trend of shrinkage of the sown area per capita of the agricultural population created the following three logical causal chains. (1) A reduction in the sown area per capita of the rural population → the reduction in the average size of farms → labor input per unit of land increases and approaches the limit to land productivity → marginal returns to labor diminish and labor costs for food rise → labor productivity stagnates because the limit to land productivity prevents its growth → land

productivity increases but there is no growth potential because it is too close to its own limit → per capita income is fixed at the level of survival by the limit to land productivity. (2) The sown area per capita of the rural population shrinks → the space for establishing individual exclusive land rights disappears → the role of exclusive rights when costs exceed returns reduces input and supply. At this time, it is not the market but sheer survival that forces farmers to increase inputs and endure diminishing returns. (3) The sown area per capita of the rural population shrinks → the average area per farmer producing commercial grain for the urban population shrinks → urbanization stagnates, and the proportion of the rural population in the total population does not decline, but may even increase → the development of the division of labor and commodity exchange between urban and rural areas and industry and agriculture is stymied → the development of a capitalist market system is impeded because it often plays a role in exacerbating famine in the population trap.

The opposite logical causal chains outlined above are created by the law of LTLP that things develop in the opposite direction when they become extreme. This law is a law of nature and cannot be changed by property rights and markets. On the contrary, it can change the latter's role. In the English causal chain, it was the expanding sown area per farmer that made per hectare labor inputs veer away from LTLP. This increased the contribution share of natural fertility to each kilogram of grain and reduced the share of labor cost. It was the increasing share of the unpaid contribution of nature that made it possible, through the market exchange of agricultural and industrial products, to accumulate capital for the Industrial Revolution, rather than the market system per se that increased the unpaid contribution of nature to capital accumulation. In the Chinese causal chain, the falling sown area per farmer caused per hectare labor inputs to approach LTLP. This made the share of nature's contribution fall to the bottom

and the share of manpower to rise to the top. A market system in China in fact developed earlier than in England, but it was unable to reverse this logical causal chain made by the law of LTLP. On the contrary, this law led the market system to raise food prices and wages, reduce the average social profit to zero, deplete investment resources, and cause the economy to stagnate. Therefore, China could only use non-market forced accumulation to launch an artificial industrial revolution, and then use this revolution to reduce the share of the rural population, so as to reverse the several-thousand-year-old decline in the arable land and sown area per capita of the rural population.

The Origin of the Capitalist Market and Private Property Rights System in England

The Black Death in England in 1348–1349 reduced the total population by 48 percent, from 4.25 million in 1300 to 2.22 million in 1500; the agricultural population fell by 50 percent, from 3.34 million in 1300 to 1.67 million in 1500, and has never exceeded the 1300 level since then (see Table 2). This reversed the 1250–1300 trend of shrinking arable land and sown area per capita of the agricultural population to a trend of expansion. Thus England retreated from the $AY/N = S$ population trap stage back to the pre-population trap stage of $AY/N > S$. Moreover, this trend of expansion was long-lasting, so that England could continue to shift to the $AY/N > S$ industrialization stage. As shown in Figure 4, although there were fluctuations in arable land and sown area per capita of the agricultural population in the period 1300–1871, the general trend of expansion continued. In particular, the sown area per capita of the agricultural population was always higher than in 1300, and expanded most rapidly in 1600–1871, when the fallow system was replaced by the Norfolk rotation system. The two trends of expanding arable land and sown area per capita of the agricultural population made changes in property rights in England

opposite those in China. Figure 4 shows how changes in the two trends in each period led to changes in property rights: the decline of the two trends in 1250–1300 led to land being evenly divided between the growing population and the serfs, who accounted for the vast majority of the population, and had only land use rights; the sharp rise of the two trends in 1300–1380 caused the feudal manor system to collapse, the serfs to abandon their status, and the lords to enclose and merge the past small family farms into a large capitalist spreads; the decline of the two trends in 1380–1420 caused England's royal family, Parliament, and the judiciary to stop the enclosure movement, so that the erstwhile serfs gained exclusive rights to land and became land-holding yeomen; the decline of the two trends in 1420–1600 drove the arable land per capita of the agricultural population below the level before the Black Death and labor inputs per acre approached LTLP of the fallow system. Therefore, this relative limit (defined above) erased the role of exclusive land rights in increasing production and made the growth of labor productivity negative in 1550–1650. This triggered a shift from the fallow system to the Norfolk rotation system, because the latter could both expand the sown area per farmer and contribute to a higher relative limit to land productivity than the former. Around the year 1650, the lords began recovering the land property rights of yeoman because their land ownership promoted this technological progress. The yeomen lost their landholding rights because such exclusive rights hindered the advancement of farming technology.

Table 2. Changes in Arable Land, Population, and Arable Land Per Capita of the Agricultural Population in England, 1250–1871

Years	Arable land use (millions of acres)				Population (millions)			Per agricultural head (acres)	
	Total arable	Fallow arable	Sown arable	Fallow rate (%)	Total	Agriculture	Share A/T (%)	Arable area	Sown area
1250	10.30	3.68	6.62	35.70	3.80	3.05	80.26	3.38	2.17
1300	10.53	3.77	6.76	35.80	4.25	3.34	78.59	3.15	2.02
1348					3.83	3.01	78.59		
1380	7.98	3.22	4.76	40.40	2.34	1.77	75.64	4.51	2.69
1420	7.09	2.97	4.13	41.90	2.28	1.72	75.44	4.12	2.40
1500					2.22	1.67	75.23		
1550					3.02	2.03	67.22		
1600	8.23	2.00	6.23	24.30	4.11	2.87	69.83	2.87	2.17

1650					5.31	3.25	61.21		
1700	9.00	1.80	7.20	20.00	5.20	2.78	53.46	3.24	2.59
1750	9.90	1.50	8.40	15.20	5.89	2.60	44.14	3.81	3.23
1800	10.69	1.20	9.49	11.20	8.62	3.14	36.43	3.40	3.02
1830	14.19	1.33	12.86	9.40					
1871	13.83	0.48	13.35	3.50	16.51	3.30	19.99	4.19	4.05

Source: Apostolides et al., 2008: tables 2A and 17.

Figures 4 and 5 also illustrate the third logical causal chain in England: The expansion of arable land and sown area per capita of the agricultural population → the expansion of the average area per farmer producing commercial grain for the urban population → a rise in the proportion of commercial grain in total food production → a decrease in the proportion of the agricultural population and a proportional increase in the urban population → the development of a division of labor, an agricultural and an industrial revolution, and commodity exchange between the two → the formation of a capitalist market system. As Figure 5 shows, the share of the agricultural population in the total population went through two stages: a slow decline from 1348 to 1600, and an accelerated decline from 1600 to 1871. The slow decline in the first phase was because the Black Death reduced N by half, which shifted $AY/N = S$ to $AY/N > S$. Concomitantly, arable land per capita of the agricultural population quickly increased by 43 percent in the years 1300–1380. This reversed the trend of the shrinking of arable land per capita of the agricultural population in the years 1250–1300, creating a downward trend of the share of the agricultural population by turning the area per farmer producing commercial grain for the urban population from decreasing to increasing. However, when N increased faster than A and Y in years 1500–1600, $AY/N > S$ converged to $AY/N = S$ and the arable land per capita of the agricultural population became even less than that of 1300. This increased the share of the agricultural population from 67.22 percent in 1550 to 69.83 percent in 1600, showing that the decline in this share caused by the Black Death was reversing. This reversal was clearly the result of the arable land per capita of the agricultural population changing from expanding to shrinking. Therefore, in the second stage, the Norfolk rotation system expanded A (sown area per capita of the agricultural population) and increased Y to overcome this reversal, causing $AY/N = S$ to turn to $AY/N > S$ again and the share of the agricultural population to fall from 69.83 percent in

1600 to 20 percent in 1871. This fall is attributable to the introduction of the Norfolk rotation system, whereby one farmer could produce enough grain to feed four urban residents. Compare this with the fallow system it replaced, which required the labor of seven farmers to feed three urban residents. With the shift to the Norfolk system, the share of commercial grain in total grain output increased from 30 percent to 80 percent. Therefore, the accelerated decline in the share of the agricultural population and the accelerated rise in the share of the non-agricultural population between 1600 and 1871, illustrated in Figure 5, indicate that the division of labor, the agricultural and industrial revolutions, and commodity exchange between the two developed rapidly, which gave birth to a capitalist market system. Because England's path to industrialization was to retreat from the $AY/N = S$ population trap stage back to the $AY/N > S$ stage before the trap and then to the $AY/N > S$ industrialized stage, this section will analyze the two processes separately and then end with a summary.

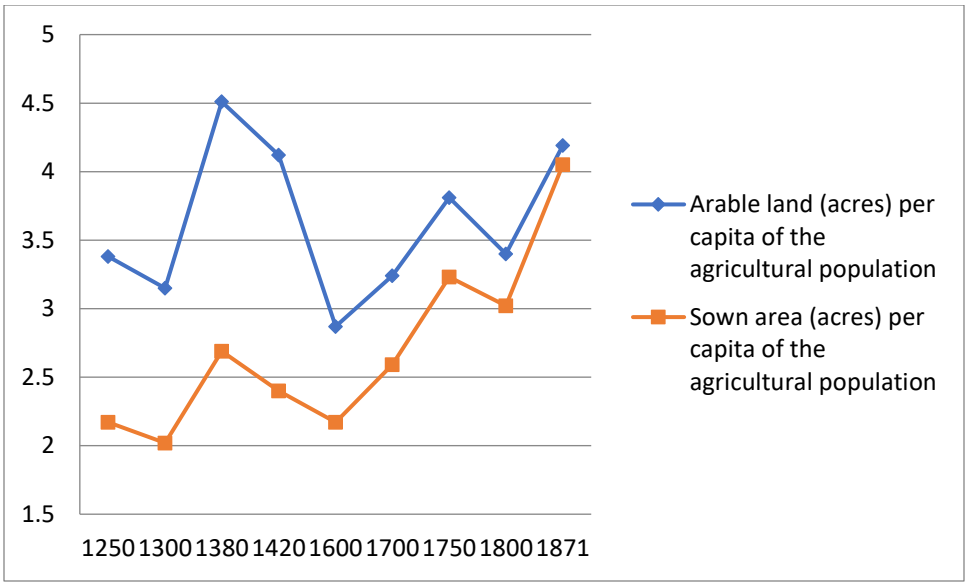

Figure 4. The trend of the expansion of arable land and sown area per capita of the agricultural population in England, 1250–1871.

Source: Table 2.

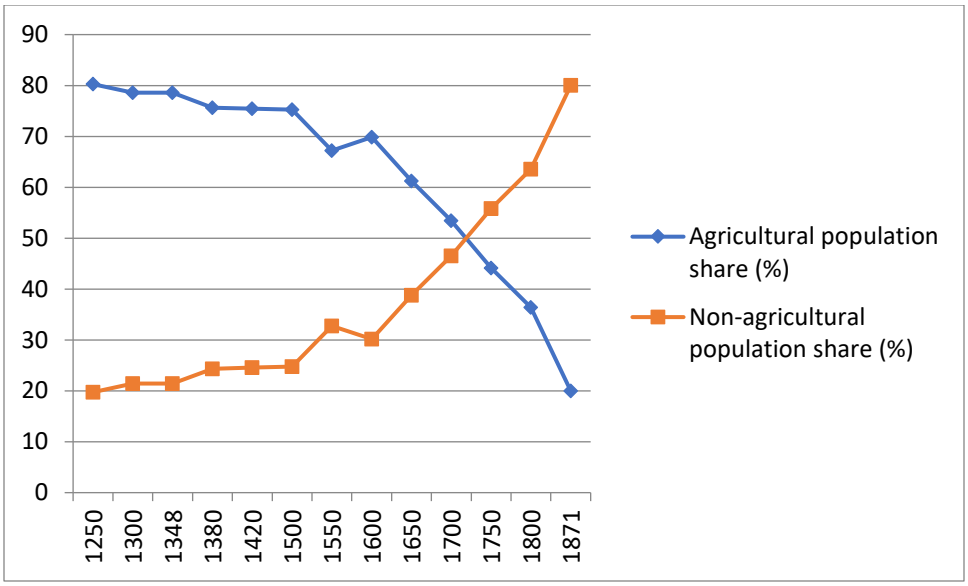

Figure 5. Structural changes in the share (%) of the agricultural and non-agricultural population in England, 1250–1871.

Source: Table 2

The Transfer of Land Property Rights from Manor Lords to Serfs

The Black Death in England in 1348–1349 led to a reversal from $AY/N = S$ to $AY/N > S$ (see Figure 6). This resulted in a reduction of N by half and a sudden increase in the arable land per capita of the agricultural population of 43 percent, even when the total area of arable land was reduced by 3.44 million acres by virtue of the enclosure movement. This reversed the trend of population growth reducing arable land per capita in the years 1250–1300 and directly changed per capita welfare from the survival type of $AY/N = S$ to the residual type of $AY/N > S$ via line *a*. The reversal of per capita land from shrinking to expanding also increased the space for establishing exclusive land rights (through line *e*), so that the establishment of such rights did not decrease but rather increased per capita welfare. Human law cannot increase land per capita, but an increase in land per capita can lead to changes in the law. This is evident in the fact that concomitant with an increase in land per capita in England, peasants were transformed from serfs—land users with only use rights—into landholders with exclusive land rights. The reversal from $AY/N = S$ to $AY/N > S$ changed the mode of action via line *b*, because land per capita, which had been decreasing, moved in the opposite direction, changing labor inputs per acre from approaching to moving away from the limit of Y, thus changing the marginal return to labor from decreasing to increasing. Through line *d*, the change in the welfare model of per capita income from the survival type of $AY/N = S$ to the residual type of $AY/N > S$ can also change the mode of action from labor at all costs for survival to labor at the cost/benefit rate. At such a time, exclusive land rights can protect profits from increasing labor returns through line *c*, and on the other hand can prevent the labor input per acre and Y from steeply decreasing, thereby uniting the protection of personal interests and the improvement of per capita welfare.

The source of the transfer of land property rights from the manor lord to the serf lay in the fact that after England moved from $AY/N = S$ to $AY/N > S$, there was a trend of returning to $AY/N = S$. As shown in Table 3, with the population growth in years 1250–1300, which increased the number of agricultural families from 680,000 to 740,000, arable land per family decreased from 15.21 to 14.18 acres. This led to an increase in the days worked per family (from 315 to 381), but wheat produced per family dropped (from 132.48 to 116.8 bushels). Agricultural labor productivity also grew negatively, −0.27 percent on average annually in the years 1265–1300 and −0.32 percent on average annually in years 1300–1348. Wheat yield per working day also dropped, from 0.42 to 0.31 bushels, indicating diminishing returns to labor and a rise in labor costs per bushel. This situation was reversed when the Black Death massively reduced the number of farm households—from 740,000 in 1300 to 400,000 in 1380. With this cataclysmic fall in population, arable land per family increased from 14.18 to 20.3 acres. This led to a reduction in the days worked per family per year from 381 to 331, but the wheat produced per family substantially increased—from 116.8 bushels to 151.4 bushels—and labor productivity grew positively, reaching 0.61 percent in the years 1348–1400. Wheat yield per working day in particular rose rapidly, from 0.31 bushels in 1300 to 0.46 bushels in 1380, the result of increasing returns to labor and a significant fall in labor costs per bushel. Clearly, the increasing returns to labor, the fall in labor costs of grain, and the growth in labor productivity were all the result of the fact that labor inputs per acre changed from approaching to moving away from the limit of Y. It was this reversal from $AY/N = S$ to $AY/N > S$ that changed the mode of action from labor at all costs for survival to labor at the cost/benefit rate, and thus the days worked and the wheat produced per family per year fell respectively to 266 days and 109.2 bushels around 1450.

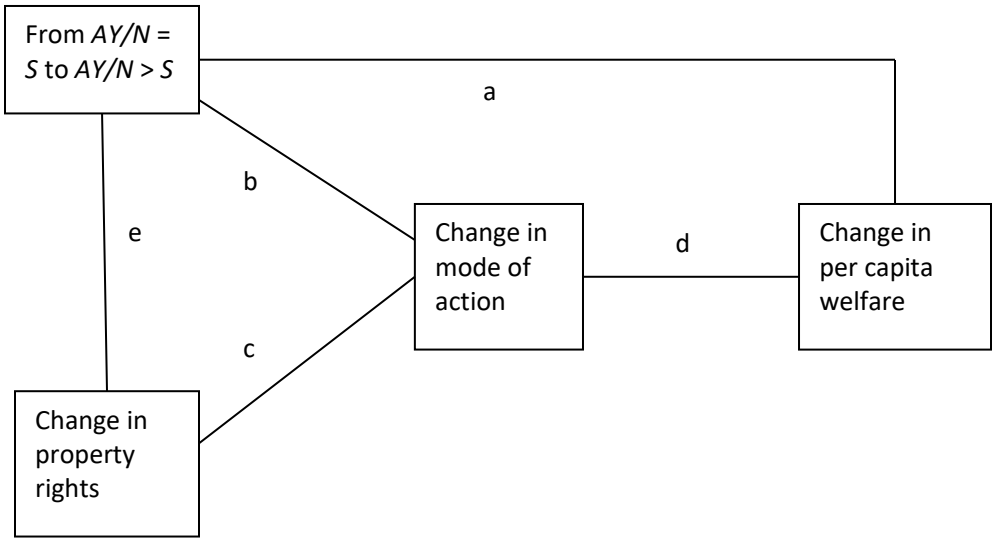

Figure 6. The reversal from *AY/N = S* to *AY/N > S* and welfare, property rights, and mode of action in England.

The wheat output per family farm increased significantly from 116.8 bushels in 1300 to 151.4 bushels in 1380 and then dropped to 109.2 bushels in 1420, indicating that after England moved from *AY/N = S* to *AY/N > S*, it might return to *AY/N = S*. The consumption data in Table 4 show the same trend: the calorie intake per person per day from wheat, rye, barley, and oats jumped from 2,241 kcal in 1300 to 3,192 kcal in 1380, but then dropped to 2,356 kcal in 1450, close to the level of 1300. Thus the question arises, was the return of *AY/N > S* to *AY/N = S* mainly caused by the reduction of *A* by the enclosure movement, or was it mainly caused by the change of labor input per acre from approaching the limit of *Y* to departing from the limit of *Y*? The enclosure movement reduced the area of arable land by 33 percent—from 10.53 million to 7.09 million acres—between 1300 and 1450. The yield per sown acre (*Y*) of wheat, rye, barley, oats, and pulses dropped respectively by 32 percent, 14 percent, 18 percent, 18 percent, and 27

percent from 1250–1299 to 1450–1499. By 1500, the total population and agricultural population had fallen to its lowest point in the entire period from 1250 to 1871, with a decline rate of 50 percent. Because *A* fell more than *Y* and the change in labor inputs per acre from approaching to moving away from the limit of *Y* did not make the per capita ration lower than *S*, we can see that it was mainly the enclosure movement that further reduced *N* after the Black Death and caused $AY/N > S$ to return to $AY/N = S$. The effect of the transfer of land property rights from the lord to the serf was to end this crisis. First, this transfer changed *A* from falling to rising. Second, serfs could increase *Y* immediately after obtaining exclusive rights to land, because the labor inputs per acre had changed from approaching to moving away from the limit of *Y*, so that there was ample potential to increase *Y*. Third, labor productivity had changed from declining to rising, and marginal returns to labor changed from declining to increasing, and the labor cost of food changed from rising to declining. All these changes not only created space for farmers to make profits, but also gave exclusive land rights a role in protecting profits and stimulating production. Fourth, when *A* and *Y* changed from falling to rising, *N* not only changed from falling to rising, but it rose faster than *A* and *Y*. Therefore, the transfer of land property rights from the lord to the serf not only changed $AY/N = S$ to $AY/N > S$ but also maintained this trend so that *N* could increase smoothly. This required that the property rights acquired by serfs were not only exclusive but also were enduring.

Table 3. Impact of LTLP on Labor Costs of Grain and the Average Annual Growth Rate of Agricultural Labor Productivity (%) in England, 1250–1871

Years	Agricultural families (millions)	Arable land per family (acres)	Wheat yield per acre (bushels)	Wheat yield per family (bushels)	Days worked per family	Wheat yield per day (bushels)	Years	Labor productivity (%)
							1265–1300	−0.27
							1300–1348	−0.32
1250	0.68	15.21	8.71	132.48	315	0.42	1348–1400	0.61
1300	0.74	14.18	8.24	116.80	381	0.31	1400–1450	0.08
1380	0.40	20.30	7.46	151.40	331	0.46	1450–1475	0.48
1420	0.38	18.54	5.89	109.20	266	0.41	1475–1555	−0.05
1600	0.64	12.92	10.45	134.96	404	0.33	1555–1600	−0.16
1700	0.62	14.58	11.36	165.63	405	0.41	1600–1650	−0.11
1750		17.15	13.79	236.43			1650–1700	0.64
1800	0.69	15.30	17.26	264.08	473	0.56	1700–1750	0.70

1830	0.73		23.16		539	1750–1800	0.37
1871		18.86	26.69	503.24		1800–1850	0.63

Source: Apostolides et al., 2008: tables 2A, 4C, 18, and 19A. Apostolides et al. assume that the average family consisted of 2 adults and 2.5 children. To simplify the analysis, I assume that all arable land was used to grow wheat.

Before the Black Death, England's agriculture was dominated by the manor system. In theory the crown was the ultimate owner of all land, but in fact property rights to land were devolved on the nobles. The lord's manor was the basic unit of ownership. It had three kinds of land: demesne, free land, and serf land. The lord directly managed the demesne, and used the surplus labor of serfs to cultivate it. Free tenants cultivated free land, and serfs cultivated serf land. According to Robert C. Allen's 1279 data (1992: 62–63: table 4-1, table 4-2), 14 acres of arable land were needed to support a medium-sized family, and thus the average size of serf farms was 13.56 acres. The average size of free tenants' farms was 14.84 acres. Table 3 shows that the average size of an English family farm was 14.2 acres in 1300. These data indicate that the lords basically distributed land equally according to the number of family members, ensuring their rations (*S*). The average size of demesnes was 165 acres. Cultivating farms of this size required a great deal of forced labor by serfs. Serfs could provide this (surplus) labor because their small-scale family farms did not exhaust their labor.

Table 4. Yield Per Acre Net of Seed (Bushels) and Per Capita Daily Kilocalorie Consumption of Wheat, Rye, Barley, Oats, and Potatoes in England, 1250–1899

Years	Wheat	Rye	Barley	Oats	Pulses		Years	Kcal. Net of seed
1250–1299	8.71	10.71	10.25	7.24	6.03		1300	2,241
1300–1349	8.24	10.36	9.46	6.60	6.14		1380	3,192
1350–1399	7.46	9.21	9.74	7.49	5.86		1450	2,356
1400–1449	5.89	10.46	8.44	6.55	5.42		1600	2,236
1450–1499	6.48	13.96	8.56	5.95	4.49		1700	*2,526
							1800	*3,361
1550–1599	7.88	9.21	8.40	7.87	7.62		1830	*3,365
1600–1649	10.45	16.28	11.16	10.97	8.62		1850	*3,474
1650–1699	11.36	14.19	12.48	10.82	8.39			
1700–1749	13.79	14.82	15.08	12.27	10.23			
1750–1799	17.26	17.87	21.88	20.9	14.19			
1800–1849	23.16	19.52	25.90	28.37	17.85			
1850–1899	26.69	26.18	23.82	31.36	16.30			

Source: Apostolides et al., 2008: table 4C and table 20.

*Includes net grain imports and potatoes.

Although the difference in size between the family farms of free tenants and of serfs was not large, there were great differences in the property rights to arable land. Before the Black Death, free tenants already enjoyed the right to use, lease, and leave land to future generations, this because the royal courts took precedence over manorial courts to enforce the landholding rights of free tenants. The royal courts, in short, protected landholding rights of free tenants. Serfs were a different matter. Their land and labor belonged to the lord, and the lord could even sell his serfs. Legally, serfs' land rights were stipulated by the court of the manor, obliging serfs to use the land as the lord wished. As long as serfs acquiesced, their use rights would not be disturbed. Serfs also had no right to rent out and inherit their farms. These matters were decided by the lord. The serf would be punished if he transferred land without the permission of the lord. If the lord expelled a serf, the royal courts would not take action to protect the serf's property rights.

But serfs and free tenants enjoyed the same grazing rights on the grasslands and wastelands of manors. This was a way of guaranteeing the survival of serfs and ensuring that their surplus labor could be exploited. Animal husbandry was a very important part of manor agriculture. Allen (2005: Table 1) shows that the area of grasslands (meadows of rivers and lakes), pastures, and commons in England was twice the area of its arable land. Hay was raised on grasslands, which, like arable land, were evenly distributed to families. After the hay was harvested, the grasslands were opened as a public pasture. The commons were completely public places. All members of the estate could graze livestock or cut brush for fuel. They could also graze livestock on arable land after the harvest and on fallow fields. The equal grazing right ensured that all members of the estate could survive under the condition of $AY/N = S$. Aside from the lord, the vast majority of the members of the manor lacked surplus products to exchange. They could only obtain a (very limited) monetary income by selling

livestock or fur. Therefore, the manor was not only the basic unit for maintaining land and agricultural production, but also the basic unit for ensuring self-sufficiency in food and clothing.

Table 5. The Effect of the Reversal from *AY*/*N* = *S* to *AY*/*N* > *S* on the Property Rights Structure and Per Capita Welfare in England

	Landowner 土地所有者	Landholder 土地持有者	Use-right lessor 使用权出租者	Yeoman 自耕农	Land-user 土地使用者
Land use rights	Rations/ Employment	Rations/ Employment	Rations/ Employment	Rations/ Employment	Rations/ Employment
Residual income right	Residual income	Residual income	Residual income	Residual income	
Right to transfer use rights	Rental income	Rental income	Rental income		
Exclusive land rights	Stable possession	Stable possession			
Alienation (e.g., sale)	Private property				
Ensure others' rations（*S*）?	No	Yes	Yes	Yes	Yes
Is it fair to others?	No	Yes	Yes	Yes	Yes
Effect on per capita welfare	Harm	No harm	No harm	No harm	No harm

To sum up, serfs were only land users. The lords granted them use rights to ensure their rations (*S*) and then used their surplus labor to cultivate the demesne and provide other services (see Table 5). Since serfs made up the majority of the manor's population and their social status was the lowest, their use rights would not reduce the rations of others and harm per capita welfare. This was also true within serfdom, because serf land was evenly distributed according to family size. This was again because in the $AY/N = S$ population trap only the constant division of land ensured rations for all. Yeomen enjoyed use right plus the right to residual income since their labor belonged to themselves and their use rights and labor input were tied to the same piece of land. Thus labor inputs, the income stream from the land, and surplus income all belonged to the yeoman. In contrast, the labor of serfs belonged to the lord, and thus the lord could use their surplus labor to cultivate the demesne and take the income therefrom. Use-right lessors enjoyed the rights of yeomen plus the right to transfer land use rights. But the $AY/N = S$ population trap would obviate this right, because the use-right lessor would not rent out land when the equally distributed land could only ensure the survival of the family. We can view free tenants as landholders because, even before the Black Death, they enjoyed long-term rights to use, lease, and leave land for future generations. Their exclusive land rights made their tenure securer than that of use-right lessors. But this would hurt the newly increased population, because the different family population growth rates in the $AY/N = S$ population trap inevitably created three kinds of family farms—$AY/N > S$, $AY/N = S$, and $AY/N < S$—and exclusive land rights prevented the redistribution of land and threatened the survival of $AY/N < S$ families. Fortunately, the small number of free tenants reduced the scope and degree of injury. This was also why the lords had to redistribute land among the serfs who made up the majority of the population. Therefore, the lords were not the source of serfs having no right to rent out and inherit land. In sum, the property rights structure with the lord as the actual landowner and a small number of free tenants as landholders and a large number of serfs as land

users guaranteed the survival of everyone in the *AY/N = S* type manor. But when the Black Death shifted England from the *AY/N = S* population trap to the *AY/N > S* stage before the trap, the effect of this property rights structure on per capita welfare was also reversed: ownership allowed the lord to enclose and reduce *A*, thus harming per capita welfare. The shift of per capita land from decreasing to increasing changed the effect of landholders' exclusive rights on per capita welfare from being harmful to beneficial. Thus it was the change of per capita land from decreasing to increasing that, first, changed the effect of the property rights structure on per capita welfare, and then caused the transfer of land property rights from the lord to the serf.

The Black Death not only reduced the population of England by half, but also destroyed the manor system. Table 2 shows that the halving of the population and labor force first led to the large-scale enclosures from 1380 to 1450, because converting arable land that required a great deal of labor into sheep farms that needed little labor could counter the rise in wages during a time of labor shortages and maintain the lease value of the land. The lord merged small family farms into huge pastures and leased them to agricultural capitalists who hired labor. This represented a direct transition from the feudal manor system to the capitalist system. This great leap forward transformation encountered relatively little resistance in barren areas where large numbers of people could not survive and farmers voluntarily gave up poor soil. It shows that if the population of England had not decreased by half but continued to grow, the degradation of arable land to grassland and cropping to animal husbandry, and the institutional transformation of feudal society to capitalist society, would not have occurred. Indeed, in areas with relatively few deaths and fertile land, enclosures encountered great resistance from farmers, as well as the crown and its judicial system, and so by 1500, 55 percent of England had no enclosures (Overton, 1996: 148). In these areas, when land per capita began to increase, the serf's status and property rights were transformed. The reduction in population and labor

inevitably caused idle land to increase, wages to rise, and rents to fall as lords eagerly leased land to anyone willing to pay. These changes were the conditions for the transformation of serfs' identity, because the serf's status was such that he belonged only to his own lord, but in front of other lords he was no different from a freeman. Since each manor had idle land that could be rented out, serfs abandoned their serf status and fled to other lords' manors. By 1485, the status of serf had almost completely disappeared (Allen, 1992: 65). But if the population had not been reduced by half and if large expanses of land had not fallen idle, this change would not have occurred. When the lords competed with each other to lease their idle land, not only did land rent fall, but slave labor and various taxes and miscellaneous levies on serfs were eliminated. When lords could no longer exploit serfs' surplus labor by directly operating demesnes, they also began to rent out their demesnes. These changes enabled erstwhile serfs to acquire generous land rights and interests, allowing them to move directly from being land users to landholders.

By around 1500, three major tenures had emerged in unenclosed areas: copyholds of inheritance (which could be passed onto heirs), copyholds for lives, and beneficial leases. With copyholds of inheritance, the tenant paid a small annual rent and a more substantial fine when the property was sold or when it was passed to an heir. Sometime the fine was fixed by custom and sometimes it was at the will of the lord. But by the seventeenth century the law courts had limited fines, rendering the lords no longer free to levy fines as they wished. Copyholds for lives were often granted to three lives: the farmer, his wife, and his son. When the son grew up and established his own family, he gave up his copyhold and readmitted a new copy specifying himself, his wife, and son as the three tenants. He paid an arbitrary fine for extending the agreement. Since he had no automatic right to renew his lease, his copyhold land rights were less secure than the rights in heritable copyholds. The lord could also refuse to renew copyholds for lives, but from the fifteenth century (Allen, 1992: 68), the Chancery forced the

lords to renew contracts according to the customs of the manor; that is, before the Black Death the lord usually allowed a serf to transfer his land to his descendants. The common law courts also began to protect the security of tenure of copyholds for lives. This was different from the situation in the thirteenth century, when common law courts regarded serf tenancy as a tenancy at the lord's will. If serfs were expelled by the lords in violation of the customs of the manor, they could not obtain legal protection from these courts. However, by 1600, copyholders could recover their landholdings in this situation. But even when the chancellor and the common law courts enforced the manor's customs to protect them, their property rights still lacked security. Therefore, the second stage of protecting copyholders was to reject "unreasonable" customs. For a common law court to hear a lawsuit for the recovery of real property, the copyholder had to be able to produce a lease, but granting a lease violated the customs of most manors. Therefore, the courts decided that this custom was "unreasonable" and declared that the right to grant a lease was a custom in all manors in the kingdom. The more important decision was to cap entry fines for copyholds.

Because the land of beneficial leases came mainly from what had been demesnes, this kind of lease appeared soon after the Black Death. But the lease period at that time was relatively short. By the sixteenth century, the beneficial lease was also divided into three specific lives. Therefore, the property rights of the beneficial lessees were almost the same as those of copyholders for lives, with a low annual rent and a high fine at the beginning. By the seventeenth century, the term of beneficial leases was extended by several years. A shortcoming of the lessees' property rights relative to copyholders for lives was that the fewer the number of years left on the lease the harder it was for the lessee to sublease his land. Multi-year (such as ninety-nine year) leases did not create a freehold estate. If a leaseholder was expelled by the lord, he could not recover possession of the land. The lord only compensated the leaseholder for the loss of crops and the remainder of the fine. However, a 1499

decision allowed tenants to use land-recovery lawsuits to restore possession of the land during the term of the lease. The protection of the property rights of beneficial lessees was established at the same time that the chancellor intervened to protect the rights of copyholders (Allen, 1992: 71). These steps to protect copyholders and beneficial lessees were directed at the lords' depopulating enclosures. Enclosures significantly exacerbated the social crisis caused by the Black Death, further reducing the number of villages, the population, and the production of food. These crises led the legal profession, the crown, and Parliament to protect tillers. Before 1500, the crown and Parliament issued several decrees banning the depopulating enclosures, but did not immediately check the first wave of enclosures. In 1515 Parliament passed another act prohibiting the conversion of arable to pastures and the merger of small farms into large pastures; in 1517, a committee was established to investigate the population decline nationwide. Information from the investigation was used in prosecutions in the Chancery and the King's Bench for the next twenty years. In short, the development of property law and the democratization of land property rights in the sixteenth century not only transformed erstwhile serfs from land users to landholders, but also ensured them long-term exclusive land rights in the years 1500–1700. For example, in the seventeenth century, the term "yeoman" was applied indiscriminately to freeholders, copyholders, and beneficial lessees. On the land tax assessment form in the eighteenth century, it was not the lord of the manor, but the copyholder and the beneficial lessee who were listed as "proprietors."

Allen (1992: 72) has described the seventeenth century as the golden age of the English yeomen, but in fact they encountered the LTLP ceiling around 1650, and thus their numbers stopped rising and began declining. Table 2 shows that the arable land area (*A*) increased by 16 percent from 1450 to 1600, and by 9 percent between 1600 and 1700. This shows that the transfer of land property rights to serfs prevented the lords from enclosing and increased *A* for yeoman-cultivation, but this effect was

greater in the period 1450–1600. Table 4 shows that the yield per acre (*Y*) of wheat, rye, barley, oats, and pulses grew, respectively, by 77 percent, 56 percent, 32 percent, 67 percent, and 59 percent from 1449 to 1649, and by 8.7 percent, −13 percent, 12 percent, −1.5 percent and −3 percent between 1650 and 1699. Because the increase in *Y* far exceeded the increase in *A* in the period 1450–1650, the exclusive land rights of yeoman played a major role in increasing total grain output. But the ultimate reason *Y* grew substantially was its substantial fall during 1349–1450 when *Y* moved away from its limit. This created the potential to increase *Y*. Exclusive land rights could not create this potential but they made it possible to take advantage of it. Hence, the effect of exclusive land rights on increasing *Y* diminished as the potential diminished. This was confirmed by the sharp decline in the *Y* growth rate of wheat and barley during 1650–1699 and the negative growth in the *Y* of rye, oats, and pulses. Table 2 shows that the total population and the agricultural population increased by 139 percent and 95 percent, respectively, from 1500 to 1650, but decreased by 2.1 percent and 14.5 percent, respectively, between 1650 and 1700 (the agricultural population decreased faster because urbanization reduced its share in the total population). In short, these data show that the transfer of land property rights from lords to serfs indeed reversed the crisis after the Black Death, making *A*, *Y*, and *N* all change from falling to rising, and *Y* and *N* exceed the pre-Black Death level. But precisely because they exceeded the level before the Black Death and *N* grew faster than *Y*, the total population experienced negative growth again around 1650. This shows that the growth of *Y* and *N* both met the ceiling before the Black Death: the limit to land productivity of the fallow system. Thus the vicious circle in years 1250–1348 before the Black Death reappeared.

Table 3 shows that when the rapid recovery of the agricultural population between 1450 and 1600 increased the number of family farms from 380,000 to 640,000, arable land per family fell from 18.54 to 12.92 acres. The combined effect of this reduction and exclusive land rights increased the working

days per family per year from 266 to 404, surpassing the 381 days in 1300. This demonstrates that the labor input per acre was increasing and approaching the limit of *Y*. Therefore, labor productivity begun to grow progressively more negative, –0.05 percent, –0.16 percent, and –0.11 percent in years 1475–1555, 1555–1600, and 1600–1650, respectively. Wheat yield per working day also decreased, from 0.41 to 0.33 bushels, indicating that returns to labor were diminishing and the labor cost per bushel of wheat was rising again. Obviously, diminishing returns, rising labor costs of food, increased negative growth of labor productivity, and the decline in the influence of exclusive land rights on production incentives all originated from the limit of *Y*. The story of the change in per capita welfare (see Table 4) was the same: calories per person per day from wheat, rye, barley, and oats increased rapidly (by 42 percent) in the years 1300–1380 because reducing *N* by half directly changed the per capita welfare from $AY/N = S$ to $AY/N > S$; during 1380–1450 it dropped (by 26 percent) because the decline of *A* and *Y* caused $AY/N > S$ to return to $AY/N = S$; in the period of 1450–1600 it fell (by 5 percent) and returned to the level of 1300 because *A*, *Y*, and *N* all increased, but *N* increased faster than *A* and *Y*. The different sources, directions, and rates of change in these three stages show that the transfer of land property rights from lords to serfs during 1450–1600 certainly played a role in changing per capita welfare from $AY/N = S$ to $AY/N > S$, otherwise the total population could not have grown from 2.22 million in 1500 to 4.11 million in 1600. But under the check of the limit of *Y*, it is precisely this faster growth of *N* that finally propelled per capita welfare (*S*) back to the survival level again. Since all of the above vicious cycles originated from the limit of *Y* of the fallow system, the only way to break free was to shift agriculture from fallow farming to annual farming.

The Norfolk System and the Emergence of an Agricultural Revolution and Capitalist Markets

Allen (1992: 78–104) shows that the yeoman farms, which were common in unenclosed areas in the seventeenth century, were replaced by large capitalist farms in the eighteenth century. This process began from the restoration of Charles II in 1660, and thus the demise of yeoman farms cannot be blamed on the parliamentary enclosure during 1750–1830. Indeed, the area of arable land and total population during the parliamentary enclosure period not only did not decrease but increased substantially (see Table 2). Moreover, the expansion of farms in unenclosed areas also began before the parliamentary enclosure. In these areas the average size of farms was 34 acres around 1500,[1] 59 acres around 1600, and 65 acres around 1700, but it expanded to 145 acres around 1800, almost the same as the average size of the 147-acre farm in the enclosed areas. A 10 percent increase in the average size of farms in unenclosed areas in years 1600–1700 indicates that they were still yeoman family farms. It also suggests that these farmers wanted to switch from fallow to annual farming as in the Norfolk rotation system, but their small scale made this impossible. The 223 percent expansion of the average size of farms in the unenclosed area during 1700–1800 confirms that only large farms could switch from fallow to the Norfolk annual farming system. It shows as well that farms in unenclosed areas also became entities characterized by the three-tier production relations of farms in enclosed areas: the lord leased land to the agricultural capitalist, who then hired landless labor.[2] In

[1] This was larger than the average size of a serf farm before the Black Death (14 acres). It was also larger than the average size of the family farm in Table 3 in 1500 because it included uncultivated land, such as grasslands.

[2] Therefore, the family farm data in Table 3 are presented only for the purpose of comparing changes and trends in various stages from 1250 to 1871. These farms were not necessarily still family farms after 1700.

short, the increasing scale of farms in unenclosed areas, and their convergence with farms in enclosed areas in both scale and production relations, confirm that there was only one way forward, as mentioned above: since the crop yields in unenclosed areas and in enclosed areas already approached the limit of *Y* under the fallow system, the solution was to turn to annual farming as in the Norfolk rotation system.

But Allen and other economic historians have not discussed the inevitability behind this scale expansion; instead, they have focused on and discussed the expansion of the scale of farms itself, because they did not have the concept and theory of the limit to land productivity. Allen has proposed his own set of explanations in the process of arguing with other historians. First, he used the pre-Black Death demesne farm to argue that large farms replaced small farms because they were more efficient and could maximize the manor lord's land rent. This explanation is obviously related to Allen's failure to recognize the inevitability behind the expansion of farms. Under the same farming system, the reason large farms could pay high land rent is not that they were more efficient, but that the share of wages per acre of output distribution was low because their inputs of labor per acre were less, and the share of land rent high. It is precisely because the labor input per acre of large farms was small and far from the limit to land productivity that their labor productivity was higher than that of small farms, but the land productivity (*Y*) had to be lower than that of small farms. Larger farms also feed fewer people per acre than small farms. Otherwise land before the Black Death would not have been divided into large-scale demesnes and small-scale free land and serf land. Only when large farms could switch from fallow to annual farming represented by the Norfolk rotation system, but small farms could not, was it possible for the labor productivity, land productivity, and land rent of the big farms to exceed that of small farms using the fallow system.

Second, Allen went on to discuss how large farms were formed in England, a question long debated by historians: large farms could be formed either by rich farmers or capable small farmers by renting neighbors' land, or by lords taking back the land of the manor. But history shows that the first method failed. Why? Allen's answer is that when a small farmer rented neighbors' land, he fertilized his own land only and despoiled the land of others. Thus not only did small farmers lack the wherewithal to rent in large amounts of land, but neighbors were unwilling to rent their land to anyone who would not protect its fertility. Using a great deal of data, Allen demonstrated that the land market only aggravated the inequality of land property rights, so that land transferred solely in one direction: from small owners to large owners. Therefore, it was the expansion of the original manor lord's property rather than the diligent efforts of small farmers to expand their land that created the structures of farms and rural society in nineteenth-century England. With the restoration of the monarchy in 1660, manor lords began to recover their manor land. They did so by buying back the land of small freeholders and heritable copyholders. This required mutual consent. In fact, small freeholders and heritable copyholders were willing to sell because, in the years 1600–1700, the economic situation had deteriorated and the land tax had been increased (see Table 6). It was also the case that powerful lords could outbid others. Recovering the land of copyholds for lives and beneficial leases, on the other hand, could be accomplished even against the will of these farmers. Leases could simply not be renewed, such as when the copyholders for lives died. But Allen did not tackle of question of why the English judicial system stopped protecting the exclusive land rights of yeomen. The answer, in fact, is clear: the English judicial system perceived that the exclusive land rights of yeoman were hindering, and the ownership of the lord was conducive to, the transformation of agriculture from fallow to annual farming. *Therefore, it was the transition from fallow to annual farming that changed the effect*

of ownership of the lords on per capita welfare (see Table 5) from harm to non-harm and the effect of the landholder's exclusive land rights on per capita welfare from beneficial to harmful.

Third, Allen pointed out that the evolution of modern mortgages was the main factor in the elimination of yeoman farming. The turning point of this development was the Restoration following the seventeenth-century civil war. When Parliament sold confiscated royalist estates, the most important buyers were the dispossessed owners. They relied on redemption rights and mortgage financing to buy back their land. To counter Parliament's 1654 decree that limited the right to redeem to one year, the crown supported the Chancery in elaborating its doctrine of equity of redemption. But the relevant laws remained confused at least into the 1670s. It was not until around 1700 that mortgages became automatically and indefinitely extendable so long as the mortgagor regularly paid interest. Long-term loans allowed lords to repurchase the land of freeholders and heritable copyholders. When the lords leased their land to agricultural capitalists and the market rent they received was much higher than the traditional rent, they enjoyed a rise in income. Therefore, the lords were able to pay the interest on loans on time but were also in a position to no longer renew copyholds for lives and beneficial leases. This made it easier for them to repay the principal of their loans. The above three points constitute the core of Allen's interpretation. Because the basis of his interpretation is that market rents paid by agricultural capitalists to lords were much higher than the traditional rents paid by the small yeomen, Allen emphasized that it was the greater scale efficiency of large farms that made it possible for them to pay higher rent.

I do not deny that higher rents prompted the manor lords to reclaim their land. My disagreement with Allen is that he has contended that the scale of large farms was the source of increased rents, whereas, I contend, the change from fallow to annual farming was the actual source. Mark Overton (1996), unlike Allen, has not established his own system of interpretation, but he has synthesized

almost all the studies on the English agricultural revolution. Overton correctly points out that the replacement of fallow by crops in the Norfolk annual farming system was the cornerstone of the English agricultural revolution, although he does not point out that this was also the source of the increase in rents. He assumes that the arable land area and land fertility are fixed, and the fixed land fertility determines that land productivity is also fixed, so the purpose of the fallow year is merely to restore fixed land fertility and maintain fixed land productivity. If the annual planting area is increased by reducing the fallow area, land fertility and grain output per acre will be reduced accordingly. In other words, the grain yield per acre planted in the annual tillage system is equal to half the grain yield per acre planted in the fallow system. Overton calls this an unbreakable closed circle. Although Overton does not avail himself of the concept and theory of the limit to land productivity, his fixed land fertility, fixed land productivity, and closed circle are close to what I call the relative limit to land productivity under the fallow system. England broke this relative limit through the cultivation of four crops in the Norfolk rotation system: on the same field, the first year wheat was sown, followed by turnips in the second year, barley or oats in the third year, and nitrogen-fixing clover in the fourth. Overton believes that the Norfolk rotation had broken the closed circle in four ways. First, the cultivation of turnips and clover replaced unproductive fallow and increased the supply of food crops. Second, turnips not only countered perennial weeds, made the soil more friable and easier to cultivate, but also provided, though its leaves and rhizomes, fodder. Third, clover not only provided feed but, since it is nitrogen fixing, it improved land fertility. Fourth, because turnips and clover increased the supply of feed, livestock manure, and land fertility, they more than compensated for any losses incurred by no longer allowing fields to lie fallow. In short, the Norfolk rotation system could produce more in the way of farming and animal husbandry products on the same land area than the fallow system.

All this makes clear that the source of increased rents was the change from the fallow system to annual farming. First, as Table 2 shows, the sown area in England in 1871 was twice that in 1600–1700. It was the shift from fallow to annual cultivation itself that doubled the source of land rent each year. Second, as Table 6 shows, the rent per acre did not change under the fallow system during 1250–1450, but increased by 167 percent in years 1700–1850. Therefore, the source of the increase in rent was not the expansion of farms but the change from fallow to annual farming, which greatly increased *Y*, because the increase in rent per acre was highly correlated with the increase in *Y*, and not correlated with the size of the farm. As Table 4 confirms, the change in rent per acre is highly correlated with the change in *Y*. Under the relative LTLP of the fallow system the yield per acre of wheat, rye, barley, oats, and pulses increased respectively by only 20 percent, 52 percent, 9 percent, 52 percent, and 43 percent in the four hundred years from 1250 to 1650. However, under the relative LTLP of the Norfolk annual farming system they increased, respectively, by 135 percent, 85 percent, 108 percent, 190 percent, and 94 percent in the two hundred years from 1650 to 1850. In this period the increase in yield of the five crops was generally lower than the increase of rent. As Table 6 shows, this was caused by the increase in the share of rent in the agricultural total income distribution. In the long run, the share of rent fell sharply during the Black Death but then began to rise, reaching its peak by 1850. The share of wages rose sharply during the Black Death but then began to decline, reaching the bottom by 1850. The tax share also experienced a long-term trend of decline. The share of profits remained virtually unchanged until 1600, indicating that there was no change in the investment of yeoman farming under the fallow system. Its significant increase after 1600 (especially between 1700–1850), reveals that agricultural capitalists on large farms indeed increased investment and reduced wage costs, as Allen pointed out, in order to increase the share of profits in income distribution. But I have demonstrated elsewhere that the increase in the number of farm animals used by agricultural capitalists, like the

increase in agricultural machinery per 100 acres today, was not because of the expansion of farms but because the Norfolk rotation system expanded the feed-sown area (Pei, 2017: 350–51). This increased the share of the feed-sown area to the total sown area from the previous 14 percent to 54 percent, making it possible for the number of farm animals in England to grow by 120 percent from 1700 to 1850. The fact that the annual area doubled once again confirms my argument: agricultural capitalists relied on the Norfolk rotation to increase the amount of feed first, and then increased the number of farm animals and investment, so they could use animal power to replace manpower and reduce wage costs.

The share of rent going to the lord from the gross profit of agricultural capitalists was determined after the distribution of profits and wages within the farm. This determination was influenced not only by the contest between the lords and the capitalist farmers, but also by the different contributions of land, capital, and labor to total agricultural output. From 1600 to 1850, the share of rent in total agricultural income increased by 42 percent, and the share of profits by 23 percent. This may be a reflection of the fact that the value and use efficiency of land rose sharply during the transition from the fallow system to the Norfolk rotation system, contributing more to the increase in total agricultural output than capital. For example, the source of increased investment by capitalist farmers was land. From 1700 to 1850, the share of rent increased by 9.1 percent, while the share of profits increased by 58 percent. This may reflect that the number of bargaining chips in the hands of capitalist farmers rose sharply once the Norfolk rotation system was perfected, indicating that their investment strategies and management had perfected the system and greatly increased its gross profits. No matter how the rents and profits were distributed, their shares appreciably increased, so that both lords and capitalists greatly benefited from the transition from the fallow system to the Norfolk rotation system. In contrast, the share of wages in total agricultural income declined by 32.3 percent in the period 1600–1850,

showing that the transition from the fallow system to the Norfolk rotation system directly hurt the erstwhile yeomen, making them proletarians, fleeing to cities and even emigrating overseas to find another way to survive. Although some of them became workers on large farms, their wages in real terms were lower than in the period after the Black Death, although their labor productivity was much higher (see Apostolides et al., 2008: figures 16 and 17). The large deviation between wages and labor productivity meant that the former yeomen had to endure exploitation after they lost land as a bargaining chip.

Table 6. English Agricultural Income (5-year Averages) and Distribution Structure (%)

Year	Rent per acre (s.)	Total rent (£ m.)	Wage bill (£ m.)	Capital costs (£ m.)	Taxes (£ m.)	Income distribution structure (%)			
						Rent	Wages	Profits	Taxes
1250	0.945	0.58	1.00	0.22	0.32	27.23	46.95	10.33	15.02
1300	0.941	0.59	1.48	0.30	0.45	20.92	52.48	10.64	15.96
1380	0.931	0.50	1.61	0.30	0.30	18.45	59.41	11.07	11.07
1450	0.922	0.51	1.44	0.27	0.20	21.07	59.50	11.16	8.26
1600	6.588	5.01	6.68	2.17	1.05	33.60	44.80	14.55	7.04
1700	11.731	11.13	9.29	2.88	2.13	43.77	36.53	11.33	8.38
1800	22.579	31.76	21.89	10.46	5.44	45.67	31.48	15.04	7.82
1850	31.292	46.99	29.83	17.62	3.97	47.75	30.31	17.90	4.03

Source: Apostolides et al., 2008: table 19.

But on the other hand, the extinction of yeomen sprang from the fact that their exclusive land rights prevented them from abandoning the fallow system in favor of the Norfolk rotation system. The open field and fallow system, which lasted for hundreds of years in England, not only fragmented the land, but also made it possible for the farming of the whole village to be carried out in a unified manner. If you did not fallow your strip field, your crops could be trampled by the livestock on neighboring fallow fields. Small plots of land could not be transformed into the Norfolk rotation system. Only by concentrating plots into a large farm could the paths between plots as well as the ditches be removed, creating the space needed for the Norfolk rotation field system, which replaced manpower with animal power. This could break the relative LTLP of the fallow system and expand the sown area, and thereby increase *Y* and per capita welfare. But these achievements required reshaping the topography of the material world. The exclusive rights of small yeomen prevented changes in topography and landforms, and so the role of exclusive rights in production and per capita welfare changed from favorable to harmful. The ownership of the lord, on the other hand, was conducive to changing the topography and landforms, and thus its role in production and per capita welfare changed from harmful in the past to beneficial. But if there had been no limit to land productivity, these differences and changes would not have occurred.

It is precisely because *Y* had a new growth limit that the previous vicious circle was broken. We have seen that whenever population decline caused the average size of farms to expand and labor inputs per acre to leave LTLP of the fallow system, labor productivity rose, marginal returns increased, and the labor costs of food decreased, such as during 1348–1475. On the contrary, whenever population growth caused the average size of farms to shrink and the labor input per acre to approach the LTLP of the fallow system, labor productivity fell, marginal

returns diminished, and the labor costs of food rose, even though *Y* rose, such as during 1265–1348 and 1475–1650. It was only during 1650–1850 that the rapid growth in labor productivity coincided with the sharp increase in *Y* (yield) of wheat, rye, barley, oats, and pulses (see Tables 3 and 4). The annual growth rate of labor productivity reached 0.64 percent, 0.70 percent, 0.37 percent, and 0.63 percent during 1650–1700, 1700–1750, 1750–1800 and 1800–1850, respectively. This in turn increased the wheat produced per day of labor from 0.41 bushels in 1700 to 0.56 bushels in 1800, indicating that the increasing marginal return reduced the labor cost per bushel. These data show that it was only after the fallow system was replaced by the Norfolk annual farming system that an increase in land productivity, labor productivity, and marginal returns, and a decline in labor costs of food occurred simultaneously. This confirms my argument vis-à-vis Allen: only when small farms cannot but large farms can switch from the fallow to the annual farming system, can labor productivity, land productivity, and the rent of large farms all be higher than that of small farms.

The calories obtained from wheat, rye, barley, and oats per person per day in England increased rapidly by 42 percent during 1300–1380, but fell by 26 percent between 1380 and 1450 (see Table 4). It fell further by 5 percent during 1450–1600 and returned to the level of 1300. From this we see that the LTLP of the fallow system from 1300 to 1600 prevented per capita welfare in England from escaping the closed circle of $AY/N = S$. Following the high point in calorie consumption (in the year 1380), calories per capita did not increase until 1700–1850. In the latter period, calories per capita not only greatly surpassed the average between 1300 and 1600, but also, between 1800 and 1850, surpassed the previous highest historical level, attained in the year 1380 (and attributable to the Black Death). It was the Norfolk annual farming system that made this possible. That is, thanks to the Norfolk system, per capita welfare in England

changed from the survival type of $AY/N = S$ to the residual type of $AY/N > S$. But it must be pointed out that calories per capita in the years 1700–1850 included the contribution of imported grain. After the Norfolk rotation system doubled the grain yield, the labor input per acre approached the new limit of *Y*. This led to an acceleration of diminishing returns, an increase in the price of food and wages in the industrial sector, and a corresponding decrease in industrial profits and investment. To reverse this trend, which hindered industrialization, in 1846, based on Ricardo's (1973) comparative cost theory, England abolished the previous laws restricting cereal imports and allowed the import of low-cost surplus grain from the United States, Canada, Australia, and Argentina. The low cost of food in these countries was due to their abundant per capita arable land, with the labor input per acre much less than in England. But the import of low-priced food was mainly to counter the rise in food prices caused by rapid population growth. It was not the basis for the huge population growth in England, from 5.2 million in 1700 to 16.51 million in 1850 (see Table 2). Restricted by the LTLP of the fallow system, whenever the population of England approached or exceeded about 5 million, there was both a rise in food prices and the cessation, or decline, of population growth, such as in the early fourteenth century and during 1650–1700 (Overton, 1996: 8). Only when the Norfolk annual farming system caused the grain yield to exceed the limit of *Y* under the fallow system, did the total population of England exceed the upper limit of about five million.

To review this section, and referring to Figures 4 and 5 in particular, we begin with the Black Death, which led to an expansion of arable land per capita of the agricultural population by 43 percent during 1300–1380. This expansion was, of course, entirely attributable to the precipitous fall in the population. The result was that labor per acre departed from LTLP, and the number of labor days per household and wheat yield per acre fell (by 13 percent and 10 percent,

respectively), but wheat output per labor day and per household increased (by 48 percent and 30 percent, respectively). The increased wheat output per household (from 116.8 to 151.4 bushels) turned grain into a commodity, making possible the increase in the urban population and the reduction in the share of the agricultural population (from 78.59 percent to 75.64 percent) (see Tables 2 and 3). But during 1380–1600, *N* increased faster than *A* and *Y*. This reduced the arable land per capita of the agricultural population by 36 percent. When the average size of family farms (12.92 acres) became smaller than in 1300,[3] labor input per acre approached LTLP again. The annual number of working days per household and the wheat yield per acre increased (by 22 percent and 40 percent, respectively), but the wheat produced per labor day and per household decreased (by 28 percent and 11 percent, respectively). The reduction of wheat produced per household (from 154.1 to 134.96 bushels) reduced the commercial grain available for the urban population, and the share of the agricultural population rose (from 67.22 percent in 1550 to 69.83 percent in 1600). This rise indicated that the downtrend of the share of the agricultural population caused by the Black Death was reversing. This was the result of arable land per capita of the agricultural population changing from expanding to shrinking. Therefore, the Norfolk system overcame this reversal by expanding *A* (sown area per capita of the agricultural population) and increasing *Y*, speeding up the decline of the share of the agricultural population. Figure 4 show that when the Black Death expanded the arable land per capita of the agricultural population between 1300 and 1380 (from 3.15 acres to 4.51 acres), the fallow system only slightly expanded the sown area per capita of the agricultural population (from 2.02 to 2.69

[3] Because the total area of arable land in 1600 was less than that in 1300 (see Table 2).

acres). This reserved room for an expansion of the sown area, which increased by 114 percent from 1600 to 1871, while the arable area increased only by 68 percent. Therefore, the sown area per capita of the agricultural population in 1871 expanded to 1.5 times its highest level in 1380 under the fallow system, while the area of arable land per capita of the agricultural population could not exceed the level in 1380. The large increase in the sown area per capita of the agricultural population caused each agricultural family (although their farms were not yet family farms) to increase their working days per year to 539, far exceeding the upper limit of about 400 days under the fallow system. At the same time, the higher LTLP of annual farming compared to the fallow system increased the wheat output per working day and per acre (by 33 percent and 155 percent, respectively). These combined increases in turn increased the wheat produced by each agricultural family (from 134.96 bushels to 503.24 bushels). This greatly boosted the availability of commercial grain, paving the way for the huge expansion of the urban population, and the concomitantly huge and rapid drop in the share of the agricultural population, from 69.83 percent in 1600 to 20 percent in 1871. To reiterate a point made earlier, the fallow system required seven farmers to feed three urban people, while the Norfolk annual farming system made it possible for one farmer to feed four urban people. In the long run, it was the expansion of the sown area of per capita of the agricultural population that led to the decline in the share of the agricultural population. However, the rising curve of the sown area per capita of the agricultural population between 1600 and 1871 shows that the accelerated decline in the share of the agricultural population in turn expanded the sown area per capita of the agricultural population. The two formed a mutually beneficial virtuous cycle when the Norfolk annual farming system took root.

This virtuous cycle, as shown in the revolutionary changes in the agricultural and non-agricultural population share structure from 1600 to 1871 (see Figure 5), also included the division of labor, the agricultural and industrial revolutions, and the mutually reinforcing exchange of market commodities between the two. The rapid fall in the share of the agricultural population and the rapid rise in the share of the non-agricultural population themselves demonstrate that the division of labor and the agricultural and industrial revolutions were progressing simultaneously. The sharp decline in the share of the agricultural population in turn led to an increase in the sown area per capita of the agricultural population, less labor input per unit of land, lower labor costs per kilogram of grain, higher labor productivity, and more commodity grain produced per farmer. Because the share of the non-agricultural population in the total population was equal to the share of commercial grain in the total grain output, its sharp increase in share means that the share of the population depending on the market for food was increasing. Thus the division of labor, the mutual promotion of the agricultural and industrial revolutions, and the exchange of commodities between the two were also the result of the upward trend in the sown area per capita of the agricultural population. On the other hand, the trend of declining sown area per capita of the agricultural population inevitably reduced the area share of commodity grain and the share of commodity grain in total grain output, thus preventing the division of labor and the development of market commodity exchange between agriculture and industry. In any society, as the sown area per capita of the agricultural population decreases, labor inputs per unit of land must be increased to ensure survival. If labor is shifted from agriculture to industry at this time, labor inputs and crop yield (Y) must fall and cause famine, and thus a trend of declining sown area per capita of the agricultural population prevents population and labor from shifting from agriculture to industry, and even leads to de-

urbanization and de-industrialization. For example, during the Great Famine in China around the year 1960, the Chinese state found itself obliged to return thirty million workers, who had entered the cities from the countryside during the Great Leap Forward in 1958, to the countryside in order to increase labor input per unit of land (see Figure 9). The rise in the share of the agricultural population in England from 67.22 percent in 1550 to 69.83 percent in 1600 also confirms that the reduction in the arable land per capita of the agricultural population inevitably led to de-urbanization and prevented the development of the division of labor and market commodity exchange.

Overton (1996: 133–47) specifically compared how the reduction in the sown area per capita of the agricultural population prevented and how the increase in the sown area per capita of the agricultural population promoted the development of market exchange in England from the sixteenth century to the middle of the nineteenth century. From the perspectives of the scope, period, quantity, and system of exchange, the market of England went through three stages of development: the growth of local markets, the linking of local markets, and the formation of a national market. Around 1500, there were about eight hundred independent bazaars scattered throughout England's market towns. The local authorities regarded bazaars as places to directly distribute the surplus grain of local producers to local consumers, and hence they formulated a system to restrict middlemen. For example, the market was held once a week and food could not be bought or sold at other times. Grain sellers had to agree to the local price before the opening bell sounded at 9 a.m. After the market opened, buyers could only make purchases for their own consumption and could only buy up to two bushels. Those who already had enough food were not allowed to make purchases. Indirect sellers, such as bakers and beer brewers, had to be licensed and could not purchase before 11 a.m. In some areas, the exclusion of middlemen

continued until the end of the eighteenth century, because they were considered profiteers who constrained the distribution of producers' products, prevented consumers from getting food, drove up prices, and exacerbated famine. For example, in July 1597, rye sold for 96 shillings per quart at ports in northeast England, but the average price between 1590 and 1600 was only 10 shillings. Therefore, all levels of government attempted to regulate middlemen. In 1552 and 1563, Parliament issued special regulations restricting intermediaries, and strengthened these regulations in 1650. Overton has pointed out that these controls were the toughest in times of famine in England during 1550–1630. Our Table 4 also shows that the calories consumed per person per day in England in 1600 were even less than in 1300. The share of the agricultural population in England also changed from falling to rising during 1550–1600. In short, it was the decline in the sown area per capita of the agricultural population and in the share of commercial grain in total grain output that led to policies and systems of regulating middlemen and markets. When these two became rising trends, policies and institutions naturally changed.

The state began to allow middlemen to trade in food between regions after 1663. This was not only because there were still regional differences in food surpluses, shortages, and prices after famines had abated, but also because urbanization was accelerating. Intermediaries had information about those differences. Their long-distance trafficking and trading could both smooth the differences between regions and link rural producers and urban consumers. In time, middlemen became an indispensable link between various regions and urban and rural markets. The small food transactions between producers and consumers of the past were transformed into large transactions between producers and intermediaries. This unleashed a flow of information, material, and funds. Mobility also increased with the growth of the total population and the urban population. For example, London's population was 55,000, 200,000, 575,000, and 960,000 in

1500, 1600, 1700, and 1801, respectively. This increase and the demand for commodity grain that accompanied it made London a center for linking markets in various regions, because London's grain merchants had to go to markets throughout the country to locate commodity grain before the autumn harvest and order from farmers in advance. Later, farmers everywhere brought samples to London's grain exchange or trade fair to negotiate and sign contracts with middlemen. This in turn enabled the rapid development of a complete market system encompassing information, futures, wholesale and retail, capital lending, and transportation. For example, in order to reduce freight costs, England began to dig inland canals after 1770. Thanks to these waterways, after 1830, in addition to perishable food, most other agricultural products formed a national market. A sign of this market was the disappearance of regional differences in food prices. The role of middlemen, in short, changed from negative to positive. And the conviction that prices should be freely determined by the interaction between supply and demand took hold. For instance, the Assize of Bread, which regulated prices and protected the poor, was abolished in 1836. In sum, the causality here is obviously that the change in the sown area per capita of the agricultural population from a decreasing to an increasing trend first caused the share of commercial grain in total grain output to increase (from 30 percent to 80 percent), which in turn led to the formation of a capitalist market system in England in the mid-nineteenth century.

China's Industrial Revolution and Land Property Rights Model

The reportedly large increase in the total area of arable land in China between 1995 and 1996 can be attributed to the use of different data sources and calculation methods. China completed its first national land survey in 1996, using remote sensing surveying and other methods, and found

that the actual area of arable land was larger than had previously been reported by grassroots village cadres to the National Statistics Compilation Department. This “increased” arable land was basically in mountainous areas, with poor quality soil and low yields. People tended to consider a few mu (1 mu = 1/6 acre) of hillside land as equivalent to one mu of flat land. Of course, under-reporting the area of arable land could also mean paying less taxes such as public grain, redounding to the benefit of local villagers. In short, the arable land area data for 1996 are more accurate than before—but arable land itself did not increase. In fact, as Table 7 shows, China’s industrialization and urban expansion resulted in a year-on-year decrease and long-term decline in the country’s total arable area, but at the same time China’s total population increased. As a result, arable land per capita of the total population decreased from 0.18 hectares in 1949 to 0.09 hectares in 2008. The declining curve of arable land per capita of the total population shown in Figure 7 was actually a five-thousand-year historical trend in China. In fact, there was no sudden rise in arable land per capita between 1995 and 1996. Moreover, there could be no change in its downward trend unless the absolute size of China’s total population changed from increasing to decreasing.

Table 7. China's Population, Arable Land Use, and Per Capita Arable (p-c-a) and Sown Area (p-c-s-a) of the Total Population (T-p) and Rural Population (R-p), 1949–2008

	Population			Arable land use			T-p	R-p	
Years	Total (10,000)	Rural (10,000)	Share (R/T, %)	Total arable (1,000 ha.)	Sown area (1,000 ha.)	Multiple rate (%)	P-c-a (ha.)	P-c-a (ha.)	P-c-s-a (ha.)
1949	54,167	48,402	89.4	97,881.3	124,286.0	126.98	0.181	0.202	0.257
1952	57,482	50,319	87.5	107,918.7	141,256.0	130.89	0.188	0.214	0.281
1957	64,653	54,704	84.6	111,830.0	157,244.0	140.61	0.173	0.204	0.287
1962	67,295	55,636	82.7	102,903.3	140,228.7	136.27	0.153	0.185	0.252
1965	72,538	59,493	82.0	103,594.0	143,290.7	138.32	0.143	0.174	0.241
1970	82,992	68,568	82.6	101,134.7	143,487.3	141.88	0.122	0.147	0.209
1975	92,420	76,390	82.7	99,708.0	149,545.3	149.98	0.108	0.131	0.196
1980	98,705	79,565	80.6	99,305.3	146,379.5	147.40	0.101	0.125	0.184
1985	105,851	80,757	76.3	96,846.0	143,625.9	148.30	0.091	0.120	0.178
1990	114,333	84,138	73.6	95,672.7	148,362.3	155.07	0.084	0.114	0.176

1995	121,121	85,947	71.0	94,970.9	149,879.3	157.82	0.078	0.110	0.174
1996	122,389	85,085	69.5	130,039.2	152,380.6	117.18	0.106	0.153	0.179
2000	126,743	80,837	63.8	130,039.2	156,299.8	120.19	0.103	0.161	0.193
2005	130,756	74,544	57.0	130,039.2	155,487.7	119.57	0.099	0.174	0.209
2006	131,448	73,742	56.1	121,735.6	152,149.5	124.98	0.093	0.165	0.206
2007	132,129	72,750	55.1	121,735.2	153,463.9	126.06	0.092	0.167	0.211
2008	132,802	72,135	54.3	121,715.9	156,265.7	128.39	0.092	0.169	0.217

Source: National Statistics Compilation Department, 2010: tables 0103 and 0131.

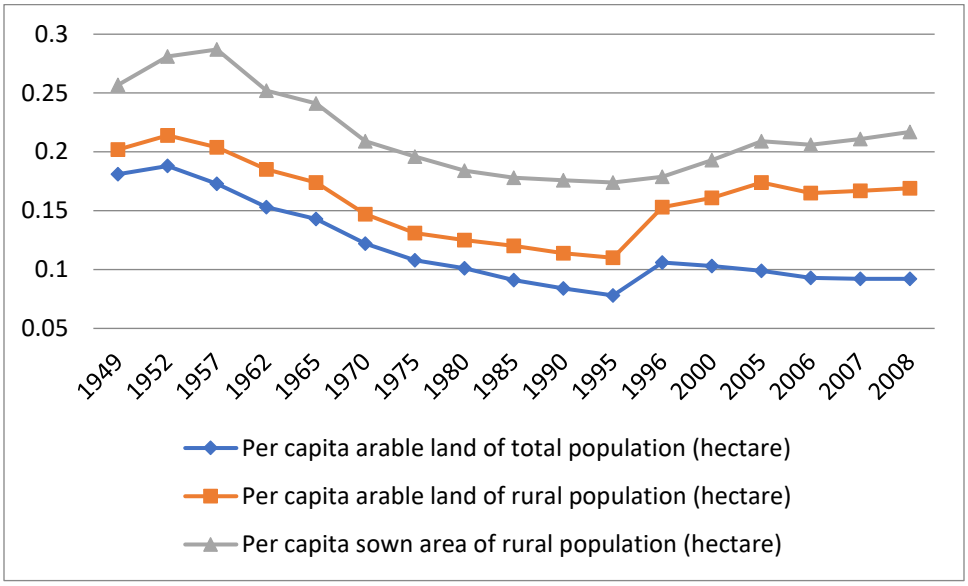

Figure 7. Trends in China's arable land per capita of the total population, arable land per capita of the rural population, and sown area per capita, 1949–2008.

Source: Table 7.

But the absolute size of China's rural population did in fact reach a peak in 1995 and thereafter began to decrease year by year. This unprecedentedly turned the downward curve of the arable land per capita of the rural population into an upward curve. However, the falsely reported increase in arable land area between 1995 and 1996 also exaggerated its rise. The curve of the sown area per capita of the rural population changing from falling to rising is very flat, because there was no such false increase in sown area. Although the agricultural population in England experienced a recovery after being halved by the Black Death, its absolute numbers during 1380–1871 were consistently lower than the level of 1300. The Black Death was, then, a watershed in which the absolute size of England's agricultural population changed from increasing to decreasing. This watershed in China only appeared between 1995 and 1996, more

than six hundred years later than in England. Moreover, three crucial turning points in England—the absolute size of England's agricultural moving from increasing to decreasing, the arable land per capita of the agricultural population changed from shrinking to expanding, and the formation of a downward trend in the share of the agricultural population—all occurred at the same time after the Black Death. In China, however, the absolute size of the rural population changed from increasing to decreasing when the share of the rural population fell from 89.4 percent in 1949 to 69.5 percent in 1995. This half-century lag indicates that the decline in the absolute size of China's rural population was the result of a decline in the share of the rural population. This in turn was the result of China's industrial revolution. When China introduced its first five-year plan and launched an industrial revolution in 1953, the share of the rural population was 87 percent, which was higher than that of England in 1250. When China had successfully established an industrial system dominated by heavy industry in 1978 and therefore began to shift from a planned economy to a market economy, the share of the rural population fell only slightly (to 82 percent, still higher than that of England in 1250). This suggests it was far more difficult and took far longer to reverse China's five-thousand-year trend of declining sown area per capita of the rural population than to establish a modern industrial system. Moreover, it shows that the expansion of the sown area per capita of the rural population constituted the basis of the English industrial revolution, whereas it could only be the result of the Chinese industrial revolution.

The agricultural and industrial revolutions in England were the result of the following causal chain: the sown area per capita of the agricultural population expands → labor input per hectare is reduced and remains far from LTLP, thus returns increase and food costs fall → the share of commodity grain in total grain output increases → the share of the agricultural

population decreases and the share of the urban population increases → division of labor, agricultural and industrial revolutions, and exchange of commodities between the two develop rapidly → capitalist market institutions emerge. The causal chain in China, with its *AY/N* = *S* population trap, was the opposite: The sown area per capita of the rural population shrinks → labor input per hectare increases and approaches LTLP, thus returns diminish and food costs rise → the share of commodity grain in total grain output and the share of urban population in total population cannot be easily increased → the division of labor, the agricultural and industrial revolutions, and the exchange of commodities between them are difficult to develop. This is because, as Ricardo (1973) pointed out, the diminishing returns of the population trap will inevitably cause food prices and wages to rise, the average social profit to fall to zero, the exhaustion of investment sources, and economic stagnation. I have further demonstrated (Pei, 2008: 232–38) that the diminishing returns in the Ricardo model are a product of the limit to land productivity, and hence the opposite logical causal chain between England and China is also a product of this limit. In the logical causal chain in England, labor inputs per hectare far from LTLP increased the share of nature's unpaid contribution to agriculture, and thus marginal returns increased and the labor cost of food decreased. In China's logical causal chain, the labor input per hectare approaching LTLP reduced the share of nature's unpaid contribution to agriculture, and thus marginal returns diminished and the labor cost of food increased. This shows that natural fertility enjoyed by each farmer is positively related to the area of land he/she works. It was the expansion of the sown area of each farmer in England that increased the share of nature's unpaid contribution to his production. Through the market exchange of industrial and agricultural products, this enabled the accumulation of capital for the industrial revolution, rather

than the capitalist market system itself, which can increase the free contribution of natural forces and accumulate capital for the industrial revolution.

It is precisely because the market system could not change China's logical causal chain that China used the planned system to change it from 1953 to 1978. I have shown (Pei, 2005, 2015) that when the sown area per farmer was reduced and the share of nature's contribution to agricultural production was falling and the share of labor cost was rising, the planned system fixed the price of farm products to prevent them from rising. This transformed the farmer's surplus labor value into investment in heavy industry via the following causal chain: low-priced agricultural products → low-priced food for the urban population and low-priced raw materials for state-owned industry and commerce → low wages and low raw material costs in the non-agricultural sector caused the high profits in that sector → the profits were fully captured as state revenue → a high level of state investment in heavy industry. This accumulated capital for China's industrial revolution and rapidly transformed heavy industry from the weakest sector to the most powerful sector. On that basis, the output structure of agriculture, light industry, and heavy industry changed from 70:22:8 in 1949 to 25:32:43 in 1978. From the perspective of the change in the output value structure of the three major industries, as shown in Figure 8, the industrial revolution that changed China from a typical poor agrarian country to a country with a strong investment productive capacity only occurred in the planned economy period of 1949–1978. This structure has not undergone another revolution in the reform period, this because the establishment of heavy industry has changed China's logical causal chain. It has not only reversed China's extremely low investment rate in the past to an extremely high rate, but has also caused the investment rate to remain high for a long time—about 33 percent from 1953 to 1990, and as high as 40 percent from 1991 to 1995. Therefore, compared with other developing

countries, China's most distinctive feature over the past seventy years as a whole has been a very high and stable investment rate. This is because once heavy industry has been established, the future investment rate is determined by its investment productive capacity rather than the subjective accumulation tendency of the state plan. It was this assurance that led the planned economy to withdraw from the historical stage after completing the mission of establishing heavy industry. It is precisely because the objective production capacity of heavy industry has ensured long-term stable high investment and sustained high growth that China shifted from a planned economy to a market economy and achieved an economic takeoff. This in turn is because China's unbalanced economic structure before the reform determined the conditions and character of its economic transition and takeoff.

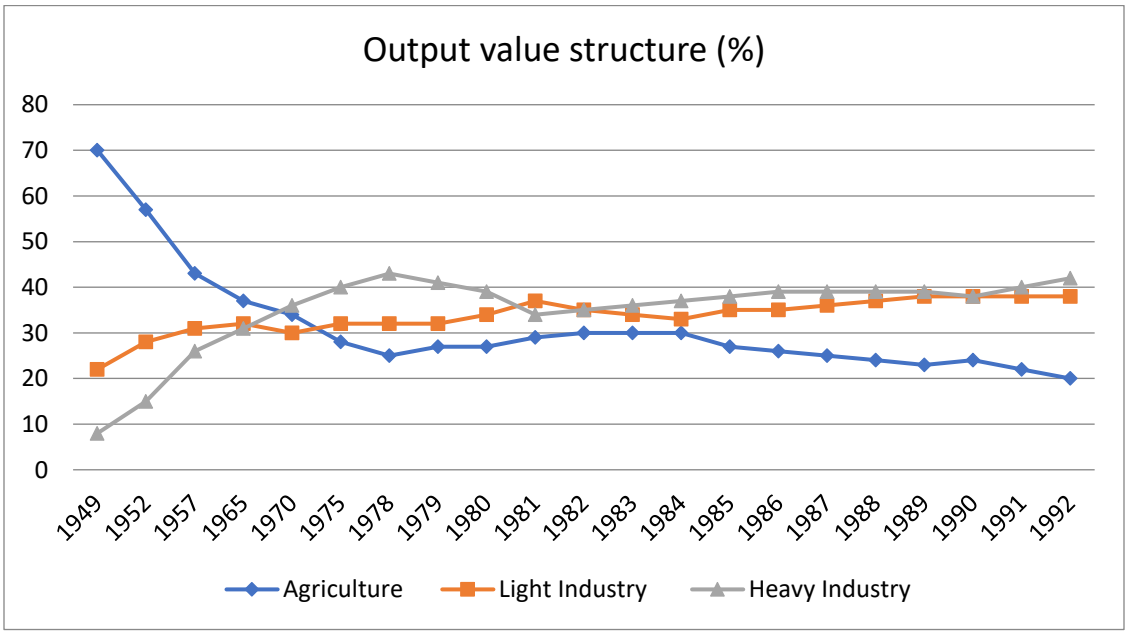

Figure 8. How China's industrial revolution (1949–1978) changed the share structure (percent) of the output value of agriculture, light industry, and heavy industry.

Source: Pei, 2015: table 1.

The forced accumulation from 1953 to 1978 created a dual economy with investment concentrated in heavy industry on one side, and agriculture with its huge surplus labor on the other, and in between a vacuum of undeveloped light industry. If the tension in this unbalanced structure could be released, it could make both investment goods from heavy industry and the surplus labor from agricultural flow to the vacuum of light industry to automatically balance the economy and propel a takeoff. This was realized in 1979 when the state started to raise the purchase price of farm products. This was possible because the logical causal chain of the past was replaced by a new one: a rise in prices of farm products → food price subsidies for the urban population and rising costs of the state sector → a heavy financial burden and huge deficits in the national budget → getting governments at all levels to share the burden and decentralization of the fiscal system → a fall of the share of fiscal revenue in GDP → a fall of the state share in total investment. Raising the purchase price of farm products also created another logical causal chain: a rise in prices of farm products → an unprecedented tripling of rural per capita income in the period 1978–1985, which caused rural savings to rise → a change of previous fiscal funds into bank funds → the emergence of a new investment-financing system and rural private and collective capital. Capital was invested in labor-intensive and light industries. Thus, a vacuum of light industry, a dire shortage of consumer goods, a huge rural surplus labor force, a strong heavy industry, and a rise in the prices of farm goods naturally induced China's transition model. Moreover, the tension in this unbalanced structure inherently sustained high investment, because the vast surplus labor per se demanded investment in light industry, which created off-farm jobs. To reduce overproduction, heavy industry automatically supplied investment goods for the expansion of light industry. From the demand side, the dire shortage of consumer goods also

drove the expansion of light industry and absorbed its goods. Thus, when labor-intensive rural industry rapidly expanded to fill the gap in both light industry and consumer goods, it not only led to a higher investment rate than before the reform, but also triggered China's economic takeoff.

Since the farm surplus connected China's vast surplus labor and heavy industry, it was its reverse flow that launched China's economic transition and takeoff. From 1979 to 1983, the continued rise in state purchasing prices of farm goods caused the share of state revenues in GDP to drop sharply from 31.2 percent to 22.9 percent, shifting about 13 percent and 22 percent of state investments to rural collective and private investors, respectively. This macro redistribution of the savings part of China's GDP was accomplished by neither the market nor privatization, but by the same mechanism of the pre-reform era for transferring farm surpluses. It not only quickly ended the centralized investment system, but also created and regularized the pluralistic structure of state, rural collective, and private investments at 65:13:22 from 1984 to 1991. This is why the reverse flow of the farm surplus could support the transfer 110 million rural surplus laborers to township-village enterprises (TVEs) from 1978 to 1996, at a time when China had no factor market for land, capital, and labor. This type of resource allocation, which relied on planned economic channels and collective landownership to transfer a huge number of laborers from agriculture to industry in such a short time, was unique in world history. Within just five years (from 1983 to 1988), this kind of resource reallocation moved 63.1 million rural surplus laborers from agriculture to rural industry. Therefore, the growth rates of both employment and industrial output value of the TVE sector far exceeded that of the state and urban collective sectors in these five years. It is the expansion of investment, employment, and output value of rural industry that filled the gaps in the pre-reform investment structure, labor structure, and

output value structure, shifting these structures from being imbalanced to being balanced (Pei, 1996, 1998, 2002, 2005, 2015, 2018).

As I have pointed out in an earlier publication (Pei, 1994), when the former Soviet Union and the Eastern European countries began to reform their economies, they could not imitate China's transition model because different population structures produced different economic transition models. Most of their population was already urbanized and industrialized when they began to reform, and so their economic transition started with privatization. When China launched its economic reform at the end of 1978, its urban-rural population structure was 18:82, and so its pre-reform dual economy produced non-state-designed rural industrialization. This rural industrialization, which Deng Xiaoping did not anticipate, immediately triggered China's economic takeoff, and pushed China's privatization to the next stage of reform: the mid-1990s' large-scale privatization of state-owned small and medium-sized enterprises and rural collective industrial enterprises. It is not accidental that the creation of capital, labor, and land markets by privatization appeared around 1995, because the sown area per capita of China's rural population experienced an epoch-making transition from decreasing to increasing in that year. The epoch-making turning point in England was caused by the Black Death reducing its population by half. This not only led to the transfer of land property rights from lords to serfs, but also reduced the share of the agricultural population in the total population from 79 percent in 1300 to 53 percent in 1700. This 47:53 urban-rural demographic structure was the prerequisite for the English Industrial Revolution, and enabled its agricultural and industrial revolutions of 1750–1871 to reinforce each other. As a result, the share of the agricultural population further decreased from 44 percent to 20 percent, and the arable land and sown area per capita of the agricultural population expanded from 3.81 and 3.23 to 4.19 acres and 4.05 acres, respectively. This virtuous

cycle kept the changes in population and labor structure in sync with the changes in the output value structure. In China, the urban-rural population ratio was 12:88 in 1952 (see Figure 9). When it became 46:54 in 2008, it was close to the ratio of 47:53 in England in 1700. Therefore, Figure 9 confirms that the expansion of the sown area per capita of the rural population is the cause of the English agricultural and industrial revolutions but the result of the Chinese industrial revolution. It can also explain why changes in China's labor and population structure were neither synchronized nor balanced with changes in its output value structure.

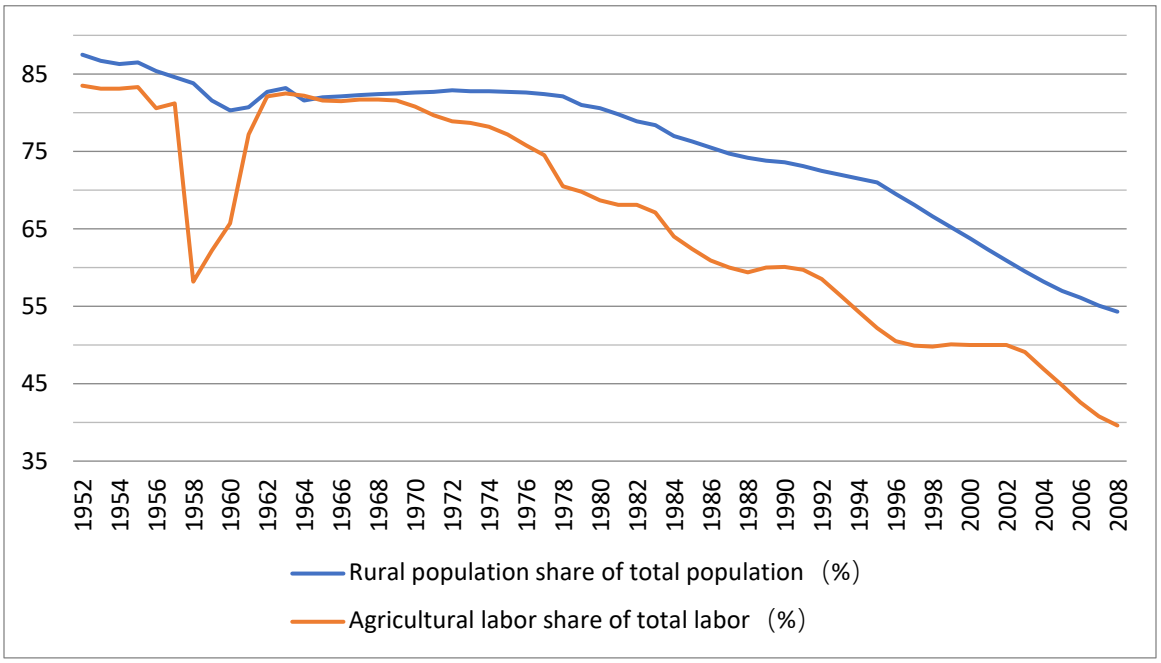

Figure 9. Changes in the share of the rural population in total population and the share of agricultural labor in total labor in China, 1952–2008.

Source: National Statistics Compilation Department, 2010: table 0103 and 0104.

First, China's industrial revolution of 1949–1978 led to a fall of agriculture's share in the output structure of agriculture, light industry, and heavy industry from 70 percent to 25 percent.

However, the share of agricultural labor in total labor and the share of the rural population in the total population fell only slightly, from 84 percent and 88 percent in 1952 to 71 percent and 82 percent in 1978, respectively. Changes in the two structures lagged far behind changes in the structure of output value. Although this was related to the fact that capital-intensive heavy industry did not absorb surplus rural labor, the ultimate reason was that the decline in the sown area per capita of the rural population prevented a change in the share of commercial grain in total grain output. This in turn restricted any change in the shares of agricultural labor in total labor and rural population in total population. It was this restriction that turned the sudden decline in the share of agricultural labor and rural population during the Great Leap Forward in 1958 back to 83 percent in 1963. Second, from the perspective of different stages of development, it was precisely the unsynchronization and imbalance of the structural change that triggered the rural industrialization of 1978–1995, which industrialized the labor structure. The reduction in the agricultural labor share and the absolute number of agricultural workers peaked in 1991, and thus the trend of a reduction in the sown area per laborer caused by the increase of China's farm labor force for thousands of years turned into an increasing trend. But this reversal did not involve the share of the rural population declining at the same rate as the share of agricultural workers, because the TVE workers did not leave the countryside. The sown area per capita of the rural population continued to decrease, which inevitably restricted the change in the share of commercial grain in total grain output. Third, the share of the rural population began to fall rapidly (from 71 percent in 1995 to 59.5 percent in 2003), but the share of agricultural laborers did not decline in this period, this because after the absolute size of the rural population peaked in 1995, China experienced a virtuous cycle similar to that of England: the increase in the sown area per capita of the rural population inevitably led to an increase in the share of

commercial grain and the share of the urban population. This in turn expanded the area sown per farm laborer. In short, China has gone through three stages in changing the sown area per capita of the rural population from shrinking to expanding. (1) The forced accumulation and industrial revolution from 1953 to 1978 first industrialized the output value structure. As a result, the investment productive capacity of heavy industry reversed China's past depletion of investment sources and economic stagnation, ensuring high future growth. (2) The reverse flow of farm surplus value from 1978 to 1995 released the structural tension in the dual economy, which led to the automatic flow of investment goods from heavy industry and 110 million surplus laborers from agriculture to light industry. This self-balancing of the dual economy accelerated the industrialization of the labor structure, with the result that the absolute number of farm laborers changed from increasing to decreasing in 1991, and the sown area per farm laborer changed from shrinking to expanding. (3) The expanded farming area of each farmer caused the number of people the farmer supported to change from less to more, promoting the industrialization and urbanization of the population structure. This changed the sown area per capita of China's rural population from a shrinking to an unprecedentedly expanding trend in 1995.

China's logical causal chain was changed by forced accumulation. And forced accumulation was the result of collective landownership. This ownership system, which was unlike that of England, was ultimately the result of a downward trend in the sown area per capita of the rural population. This downward trend, as shown in Figure 10, inevitably pushed labor input per hectare to LTLP. In this sense, the $AY/N = S$ model is dynamic. It shows that LTLP was independent of human choice to fix per capita welfare on S (subsistence level) directly via line *a*, which requires the equal distribution of land according to the different growth rates of family population, so as to make all family farms the $AY/N = S$ type. This causes the labor input of each

farm to approach LTLP through lines *d* and *b*, maximizing the total grain output. *AY/N = S* also indicates that the space for establishing exclusive land rights has disappeared. If we ignore this disappearance and establish those rights, the combined effects of different growth rates of family population and exclusive land rights create *AY/N > S*, *AY/N = S*, and *AY/N < S* farms. *AY/N < S* families have the least land per capita. They had been unable to increase land productivity and faced starvation. *AY/N > S* families have the most land per capita. Their falling population pressure and exclusive land rights changed their labor input per hectare from approaching to leaving LTLP through line *c*, so as to change labor productivity and marginal returns from falling to rising. This reduces total grain output and per capita welfare through line *d*. The undesirable outcome was the result of China's policy makers applying the English property rights model, built on a trend toward the expansion of the sown area per capita of the agricultural population, to the Chinese environment, where the sown area per capita of the rural population was shrinking. The increase in the average size of farms in England lengthened the distance between labor input per hectare and LTLP. It is this that allowed returns to exceed costs and exclusive land rights to increase labor inputs. The trend of shrinking sown area per capita of China's rural population caused the distance between labor input per hectare and LTLP to disappear. This in turn caused costs to exceed returns and changed the role of exclusive rights from increasing to reducing labor input. At this time, it was not exclusive land rights but rather survival that forced farmers to increase the input of labor. Therefore, line *e* in Figure 10 indicates that the land property rights model must obey the laws of LTLP.

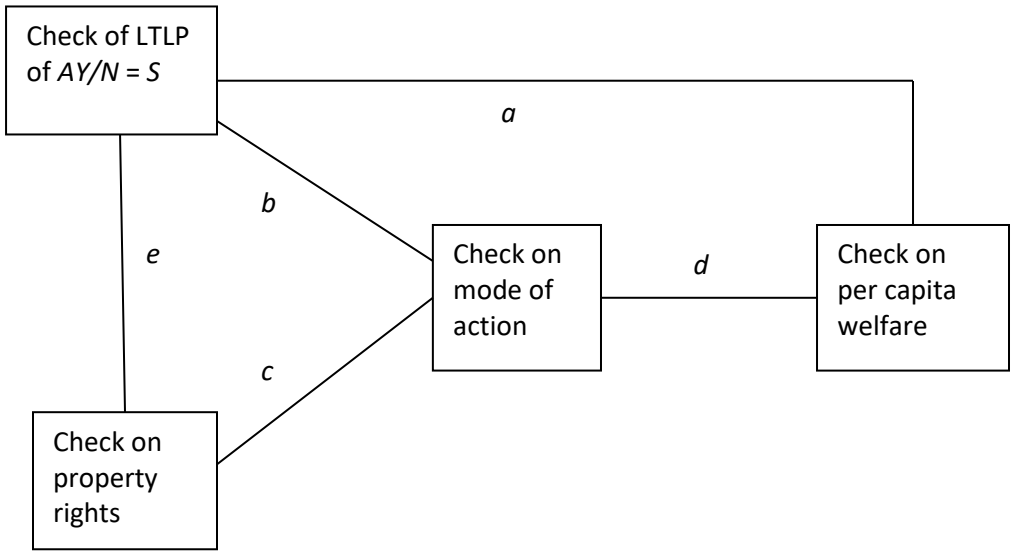

Figure 10. Check of LTLP of the *AY/N = S* population trap on the welfare, property rights, and mode of action in rural China.

In 1949, 70 percent of China's total industrial and agricultural output value came from agriculture. This determined that forced accumulation could only be carried out by transferring the surplus labor value of peasants, who accounted for 90 percent of the total population. Therefore, after land reform was completed in 1953, the state closed the grain market and began to use a "unified purchase and supply of grain" (UPSG) policy to purchase grain directly from China's 110 million rural households. Many grassroots cadres, when they started implementing this policy, had a difficult time distinguishing the boundary between the surplus grain of peasant households and the grain that was essential for subsistence. They often purchased not only the surplus grain but also part of the peasants' rations. In some areas peasants refused to sell grain to the state. As a result, homes were searched, land certificates were confiscated, and some peasants were even tied up and hung. Acts like these made it very hard to implement the UPSG policy,

which led Mao to vigorously promote the collectivization of agriculture. In response, the number of “advanced agricultural cooperatives” soared from 500 in 1955 to 540,000 in 1956, and 90 percent of rural households were organized into cooperatives. These, however, were co-ops in name only. In reality, they were collectives, since all the means of production, such as land, draft animals, and farm implements, were collectivized. Production, labor, and income distribution were in the hands of collective management as well. After agriculture was collectivized, state purchasing accounts were reduced from 110 million households to 540,000 collectives. This not only made the collective a medium for avoiding direct conflict between the state and peasants, but also reduced the operational cost of transferring the agricultural surplus. From a demographic perspective, what was involved was an institutional transformation: when the sown area per capita of the rural population was shrinking, the state first used land reform to distribute the land of landlords evenly to the peasants, turning 110 million rural households into $AY/N = S$-type individual economic units, and then organized them into 540,000 $AY/N = S$-type collectives.

The UPSG and collectivization were a response to the difficulty in implementing the “First Five-Year Plan” because of the shortage of commodity grain. The grain subject to unified purchase and sale was not really commodity grain, because the state directly purchased all the surplus grain of peasants, who accounted for 90 percent of the total population, and then rationed it to the urban population, who accounted for 10 percent of the total population. The equal distribution of food for all confirms that the reduction in the per capita sown area had brought labor input per hectare to LTLP and this limit had fixed per capita food at the S level through line a. Compulsory low-priced purchases amounted to the exploitation of the surplus labor of peasants and the violation of the private property rights of 110 million $AY/N = S$ family farms. But in fact, China’s farms, to reiterate, were differentiated into three types: $AY/N >$ S, $AY/N = S$,

and *AY/N* < *S*. Due to natural and other disasters, some families had been forced to sell the land they had just obtained through the land reform, transforming them into *AY/N* < *S*-type poor households. *AY/N* > *S*-type households were new rich peasants who had purchased the land of *AY/N* < *S*-type peasants. Mao Zedong therefore considered the distribution of landlords' land to peasants as merely the "first step in revolution." The "second step" was collectivization. If there had been no such second step, history would have gone backward. Indeed, private landownership and market transactions that were not eliminated by the land reform soon polarized the rich and the poor. China's history of more than two thousand years of a landlord economy also demonstrates that under the trend of shrinking arable land per capita of the rural population, private landownership and a land-trading market inevitably lead to a system of class divisions and class exploitation between *AY/N* > *S* (landowners with extensive holdings) and *AY/N* < *S* (poor peasants).The only way to prevent the sale of land and division of rural society into *AY/N* > *S* and *AY/N* < *S* households was to use agricultural collectivization to eliminate private landownership. Including all peasants in the *AY/N* = *S* collectives ensured the smooth transfer of the agricultural surplus. But more than that, the trend of shrinking arable land per capita of the rural population eliminated the space for exclusive land rights. The transformation of China's family farms into *AY/N* = *S* collectives was not equivalent to the expansion of the average size of English farms after the Black Death, because in China arable land per capita of the rural population continued to shrink. It was this trend of shrinking that caused the collective, after it completed the mission of accumulating capital for China's industrial revolution, to be replaced by the household contract system.

Table 8. How the *AY/N = S* Population Trap Shaped China's Land Property Rights Structure and Restricted Change

	Landowner 土地所有者	Landholder 土地持有者	Use-right lessor 使用权出租者	Yeoman 自耕农	Land-user 土地使用者
Land use rights	Employment	Employment	Employment	Employment	Employment
Residual income right	Efficiency	Efficiency	Efficiency	Efficiency	
Right to transfer use rights	Rental income	Rental income	Rental income		
Exclusive land rights	Stable possession	Stable possession			
Alienation (e.g., sale)	Private property				
Ensure others' rations（*S*）?	No	No	Yes	Yes	Yes
Fair to others?	No	No	Yes	Yes	Yes
Effect on per capita welfare	Harm	Harm	Not harm	Not harm	Not harm

To summarize, Mao promoted collectivization to transform rural households from landowners to members and land users of collective economic organizations, because he believed that private landownership and exclusive land rights led to polarization between the rich and the poor and undercut subsistence of $AY/N < S$ households, and, as well, hindered China's industrial revolution and long-term development (see Table 8). Time has shown that these views were justified. For example, the collective economy withdrew from the historical stage after China's industrial revolution. Today most households in the contract system also oppose the establishment of private landownership and exclusive rights. Of course, in promoting collectivization, Mao also made mistakes, such as insisting on quick results and rejecting any form of agricultural production that was not "large and collective." The most serious mistake was the merger of many advanced agricultural cooperatives into large people's communes in 1958. This clashed with the trend of shrinking arable land per capita of the rural population and the average farm size. Mao personally presided over the formulation of the Regulations on the Work of Rural People's Communes in 1961 (referred to as Sixty Regulations on Rural Work).[4] This document decentralized the basic unit of independent accounting and self-financing from the commune to the production team, making the latter both the unit of collective landownership and the operating unit for organizing production and distributing income. Production teams comprised twenty to thirty households. They worked collectively on the team's land. Remuneration was according to a work-based system and was paid to the individual, but in fact, income was distributed in such a way as to ensure the survival of all members. First, each task

[4] My father, Pei Run 裴润, and Mao Zedong's secretary Tian Jiaying 田家英 participated in the drafting of this document and several rural investigations related to the drafting.

was assigned a certain number of workpoints. This was not a piece-rate system but a timing system. Workpoints were calculated not on the basis of the actual contributions of the members of the production team, but were estimated based on the possible contributions of various tasks. Tasks were divided into male labor, female labor, whole labor, half labor, and so on, according to physical strength, skill, age, and gender, and were used as benchmarks for setting the number of workpoints for each task for one day. If the workpoints of families with little manpower but many members were insufficient to ensure their subsistence, then the distribution of the team's income had to be adjusted to meet their needs. This kind of distribution made various households slightly different in terms of the survival line (S). For example, the rations of small families with ample manpower were more than adequate, but the same could not be said of large families with little manpower. Second, because the land was collectively owned, all members of the production team, including existing members and people who were born in the village after collectivization, as well as women who married into the village from outside, enjoyed equal land use rights and the right to an income.

This system of equal distribution to ensure the employment and rations of all members did not harm the team's per capita welfare (see Table 8). Obviously, each production team before the reform was a Malthusian equilibrium $AY/N = S$ unit. First, the arable land area (A) of each production team was invariable, because the purchase and sale of collective land was not allowed. Second, the constant A had to bear the pressure of the increasing population (N). From the collectivization of agriculture in 1956 to the introduction of the "household responsibility system"—wherein the land of all production teams was contracted to households—in 1983, China's rural population increased from 536.43 million to 807.34 million, and the country's total population grew from more than 628 million to over 1 billion. Therefore, the fixed A of each

production team not only had to deal with the increased demand for food caused by the 51 percent increase in its own population, but also bore the pressure of the demand for food brought by the 64 percent increase in the total population. This split China's immensely heavy population pressure and made every piece of collective land bear its share evenly. Thus the People's Republic has been spared unremitting continuous social conflicts like those before 1949. China's history shows that under private landownership, a population increase of 64 percent in twenty-seven years would inevitably have led to violent class conflict and even civil war. Conversely, collective landownership was also the reason for the rapid population expansion and the ten-year-long Cultural Revolution. If there had been a famine like the one after the Great Leap Forward, the Cultural Revolution would certainly not have been possible. Third, the increase in population pressure pushed the labor input and *Y* of each production team's land to the limit of *Y*. Therefore, the final reason for the above-mentioned equal distribution in kind was not collective landownership, but the trend of shrinking arable land and sown area per capita, which made labor input approach the limit of *Y* and this limit directly fixed the per capita grain on *S* through line *a*.

After reviewing a great deal of research and debate on the English agricultural revolution, Overton (1996: 1–9) summarized several recognized signs of that revolution: (1) Changes in agricultural technology, especially the transition from the fallow system to the Norfolk annual farming system. (2) Institutional changes, including the replacement of feudal leases with market-based leasing, the establishment of capitalist production relations, the expansion of the scale of farms, and so on. (3) The simultaneous increase in labor productivity and land productivity (*Y*), because *Y* in England hardly increased under the hundreds of years of the fallow system, yet, between 1750 and 1871, the heyday of the Norfolk annual cultivation system, it

fully doubled. (4) The most important thing was whether agriculture could support more people. The total population of England could not exceed the upper limit of about 5 million during the hundreds of years of the fallow system. Its growth from 5.89 million to 16.51 million only occurred when the Norfolk annual cultivation system was implemented. I have shown that from 1700 to 1871 the arable land and sown area per capita of the English agricultural population increased by 29.3 percent and 56.4 percent, respectively. This led to the results pointed out in the first, second, and third points above, because the simultaneous increase of these two inevitably increased the space for adopting new technologies and establishing exclusive land rights, leading to the expansion of the average farm size and the simultaneous growth of land productivity and labor productivity. The increase in population in England was also the result of the simultaneous increase in *Y* and the sown area per capita of the agricultural population. But from the perspective of *Y*, it took more than one hundred years for the English agricultural revolution to double the grain output per acre, while China's collective agriculture only took twenty-two years (1957–1979) to make the grain yield per sown area increase by 93 percent (National Bureau of Statistics, 1990: 370). Because the latter was far more efficient than the former in increasing *Y*, the latter increased the population by 64 percent in only twenty-seven years, while the former increased the population by 180 percent in a hundred and twenty-one years. Moreover, the increase in the sown area per capita of the agricultural population in England far exceeded the increase in the arable area, indicating that when English agriculture shifted from the fallow system to the Norfolk annual cultivation system, its potential to increase *Y* was greater than that of China's collective agriculture without the next cultivation system. Nonetheless, the former was far behind the latter in improving *Y*. From 1956 to 1979 the arable land and sown area per capita of China's rural population decreased by 41 percent and 37 percent, respectively. The

reduction in the sown area was less than the decrease in the area of arable land, demonstrating that the multiple planting rates were increasing and the annual labor input per hectare was closer to the limit of *Y* than before. For example, during the Mao period, three crops of rice were planted in southern China each year, making its collective agriculture more efficient than the English agricultural revolution under private ownership in raising *Y* and supporting more people. But the trend of shrinking arable land and sown area per capita of the rural population also closed the space for adopting new technologies and establishing exclusive rights, and the forced establishment of exclusive rights harmed per capita welfare. Therefore, it was the reduction of the above two that included all peasants in the $AY/N = S$ collective, allowing them to use their own population growth pressure to increase *Y* and ensure their survival. This role of collective land is something that cannot be easily changed by China's economic reforms, and consequently, land is still collectively owned today.

There have been several stages in the history of collective landownership in China. The rural collective constituted both the unit of ownership and operation of land from 1956 to 1982. The household contract system established in 1983 turned households into operating units and collectives into owning units. This separation was achieved by allocating the production team's land to each household according to the number of people in the family and their manpower. This was in line with the trend of the shrinking of both arable land per capita and the average size of farms, and led to the following changes. First, from a population perspective, the Malthusian micro-equilibrium unit of $AY/N = S$ shrank from the production team to the household. Second, when the production team was both the land-owning and operating unit, the state could direct its production decisions, such as what and how much to plant. The state could also intervene in the production team's distribution of the harvest, and transfer the agricultural

surplus through a set of systems such as planned quotas, unified purchase, and planned prices.

When households became land management units, the command principles of the planned economy were replaced by market contract principles. Peasants described this as “after paying the state and the collective, the rest is your own.” They decided what and how much to plant and how to handle what they grew. This change, like the UPSG policy in 1953 which led to the agricultural collectivization in 1956, was the result of the increase in the purchase price of farm products and the end of the forced accumulation policy in 1979. Third, just as everything has both positive and negative effects, egalitarianism in the production team also led to the “free rider” problem. But collectivization made possible the accumulation of capital for the industrial revolution precisely because egalitarianism ensured the survival of all members. Thus when forced accumulation ended, the $AY/N = S$ Malthusian micro-equilibrium unit shrank from the production teams to households, causing the free rider problem to disappear. Free riding had been possible in the collectives because each member’s use rights were dispersed on collective land. There was no direct link between individual labor input and land output. When the land of the production team was evenly distributed to each household, land use rights became concentrated within a clearly defined range. As shown in Table 8, this turned erstwhile land users into yeomen (or “owner-cultivators”), making their labor inputs closely related to land output, and allowing them to use their residual income rights to improve efficiency. However, yeomen and land users have a common feature: both allow people who were born locally after collectivization and women who married into the village from outside to enter the $AY/N = S$ collective and enjoy equal land use rights. Therefore, the property rights of both users and yeomen ensure the employment and rations of the new population, without harming the per capita welfare of the collective. This is why after establishing the household contract system, the

village collective periodically adjusts or even redistributes land according to changes in the family population. However, this does not change the characteristics of yeomen, because after equal redistribution of land, use rights are still confined within a clearly defined range, and the free-rider problem does not reappear. In short, the reason the Chinese yeoman, unlike the English yeoman after the Black Death, cannot obtain exclusive land rights is that the trend of shrinking sown area per capita of the rural population has eliminated space for establishing exclusive rights while egalitarianism continues. The trend of expansion in England inevitably increased the space for establishing exclusive rights. It is different trends that make property rights different rather than vice versa. However, in line with the neoclassical theory of property rights, Zhou Qiren and Liu Shouying (1997) argued that all members' equal property rights to collective land was the reason for land adjustments in rural China. In fact, both equal property rights and land adjustments are the result of a decline in rural per capita arable land.

The use-right lessors mentioned in Table 8 enjoy the property rights of yeomen plus the right to transfer land use rights. In fact, the Chinese state and its laws have encouraged peasants to transfer their land use rights. But whether such transfers work does not depend on the state and the law, but on the availability of good paying off-farm employment opportunities. If there is, the yeoman can become the use-right lessor. If not, he will remain a yeoman because the right to transfer land use rights has no effect. The first case can reduce the population relying on land for survival, or industrialization can create off-farm employment opportunities to reduce N, so that the trend of the reduction of arable land per capita reverses. Therefore, the use-right lessor does not harm the per capita welfare but ensures the employment and food of others, especially when he transfers land use rights to the newly increased population. In the second case, if an $AY/N = S$ type household leases part of its land to others, it will become $AY/N < S$ type and suffer hunger or

even death. Thus it is the law of survival that invalidates the right to transfer land use rights. But if *Y* had no limit, leasing a part of the land would not make *AY/N* = *S* type households become *AY/N* < *S* type. Thus in the end, LTLP nullifies the right to transfer.

When the right to lease land is null, the use-right lessor has no effect on others, or he is still a yeoman. Table 9 provides the land lease rate data obtained by Brandt et al. (2002) in village and farm household sample surveys in 215 villages. These villages are distributed in eight provinces, including four relatively affluent coastal provinces (Liaoning, Hebei, Shandong, and Zhejiang), three medium-level provinces (Hubei, Sichuan, and Shaanxi), and one comparative poor province (Yunnan). Since these data are from various regions of China, they can be considered representative of the extent and changes of peasants' lease or transfer of land use rights throughout the country. Rural industrialization in Zhejiang not only started earlier than in the other seven provinces, but also reached a relatively high level among the provinces surveyed. This created more off-farm jobs and led to households in Zhejiang leasing 1.6 percent of their arable land in 1988, which was 1.23–16 times that of the other provinces. In 1995, they leased 6.9 percent of their arable land, which was 1.9–7.7 times that of other provinces. In terms of growth rate, the arable land leased by peasants in Liaoning increased the fastest, from 0.1 percent in 1988 to 3.6 percent in 1995, a thirty-six-fold increase, because Liaoning has more per capita arable land than the other seven provinces. In Yunnan, however, rented farmland in fact decreased, from 1.3 percent in 1988 to 0.9 percent in 1995. This confirms my analysis of the second situation. If Yunnan's peasants did not have off-farm job opportunities but their population did not grow, the land leased should not have declined. If their number of non-agricultural jobs had been equal to the number of the newly added population, there should have been no reduction in the amount of land leased. Therefore, it was the growth in their population

that reduced arable land per capita and rendered the right to lease land increasingly ineffective. The farmland rented by households in these eight provinces as a whole increased from 0.6 percent in 1988 to 2.9 percent in 1995, an increase of 4.83 times. This rate should have accelerated after 1995, because in that year the arable land per capita of China's rural population stopped decreasing and began an unprecedented increase. According to the theory presented in this article, this reversal will inevitably change the right to lease land from null to effective.

Table 9. Percentage of Land Rented in China's Villages between 1988 and 1995

	Liaoning	Hebei	Shandong	Zhejiang	Hubei	Sichuan	Shaanxi	Yunnan	Total
1988	0.1%	0.3%	n.a.	1.6%	0.3%	0.2%	0.8%	1.3%	0.6%
1995	3.6%	2.1%	1.1%	6.9%	3.6%	2.1%	2.2%	0.9%	2.9%
1995/1988	36	7		4.31	12	10.5	2.75	0.69	4.83

Data source: Brandt et al., 2002: table 3; total number of villages surveyed: 215.

The landholder mentioned in Table 8 enjoys the property rights of the use-right lessor plus the exclusive right to refuse the newly added population land use rights, and thus the landholder's exclusive rights harm the per capita welfare of the collective, especially the employment and rations of newly added members. This is caused by the law of LTLP: things develop in the opposite direction when they become extreme. In the $AY/N = S$ collective, population growth reduces per capita arable land. If all households have the same population growth rate, they do not adjust land and naturally become $AY/N = S$ type landholders. Although the limit of Y at this time makes costs greater than returns and exclusive rights do not create profits to be protected, the survival pressure will cause their labor inputs to increase and approach the limit of Y. But in the real world, the population growth rate must be different and

create *AY/N* > *S*, *AY/N* = *S*, and *AY/N* < *S* farms. For example, the death of a family's grandparents or the marriage of two daughters out to other villages can create *AY/N* > *S* family farms. That two sons of another family have married daughters-in-law from outside and have had children can make *AY/N* < *S* farms. I have repeatedly demonstrated that as long as a family farm changes from the *AY/N* = *S* type to the *AY/N* > *S* surplus type, it will pursue profit maximization. This causes its labor input to decrease and veer away from LTLP, making returns greater than costs and exclusive rights protect its profits. But if *Y* had no limit, there would be no such reversal after the survival pressure disappears. It is precisely because the limit of *Y* has created this reversal that the village collective has seen that exclusive rights protect *AY/N* > *S* farms from reducing the total grain output and harming the survival of *AY/N* < *S* farms. The collective adjusts land between *AY/N* > *S* and *AY/N* < *S* farms in order to make all farms return to the *AY/N* = *S* Malthusian dynamic model under the trend of per capita land reduction, so that the total grain output and per capita welfare are maximized. I have pointed out elsewhere (Pei, 2004) that in a country like China, with many people and little land, maximizing total grain output is the main goal of agriculture. This is achieved by maximizing *Y*. Since many people and little land also makes the opportunity costs of land high and the opportunity costs of labor low, whether China can maximize total factor productivity depends on the following ratio: total grain output/land and labor opportunity cost. As long as cheap labor and the scarce land are fully combined, total grain output is maximized and the opportunity cost is minimized. This is why agriculture in China's collectivization period was more efficient in raising *Y* and supporting more people than the English agricultural revolution under private ownership. From evidence of developing countries in Asia, Africa, and Latin America, Berry and Cline (1979: 18) also find that the most productive agrarian structure is that composed of the smallest farms possible, consistent with full allocation

of the available land and labor force, i.e., total area divided by the total number of farm families. The purpose of land adjustments in rural China is to maintain this most productive agrarian structure and make it dynamic, because the emergence of $AY/N > S$, $AY/N = S$, and $AY/N < S$ farms destroys it.

Table 10. Peasants' Opinions on the Chinese State's Policy of Prohibiting Land Adjustments (%)

	No	Unsure	Yes
Is it reasonable not to adjust land within the 30-year-term of household contracts?	62.79%	5.20%	32.01%
Is it reasonable not to increase land when the number of family members increases?	61.98%	9.04%	28.98%
Is it reasonable not to reduce family land when daughters marry outside?	59.95%	9.67%	30.38%
Is it reasonable not to reduce family land when grandparents die?	61.03%	9.31%	29.06%

Source: Tao Ran et al., 2009: table 5; total number of households surveyed: 2,212.

To collect data on land adjustments in rural China, Tao Ran et al. (2009) surveyed 120 villages and 2,212 rural households (about nineteen households in each village). These 120 villages are located in Jilin province in the northeast, Hebei province in North China, Shaanxi province in the northwest, Sichuan province in the southwest, Jiangsu province in the east, and Fujian province in the southeast (twenty villages per province). This sample survey not only covers all regions in China, but also includes two stages. The first stage was 1983–1997, because when the household contract system was fully established in China in 1983, all village collectives signed fifteen-year contracts with households. It was state policy at this stage to generally stabilize contracts, but allow "small land adjustments" in response to population changes. At the beginning of the second round of rural household contracts in 1998, the new Land Management Law stipulated that the duration of the rural household contracts should be thirty years. The Rural Land Contract Law promulgated in 2002 further prohibits land adjustments during the thirty-year contract period. As shown in Table 10, as many as 63 percent of the households surveyed opposed the state policy of prohibiting land adjustments, only 32 percent of households agreed, and 5 percent expressed no opinion. Regarding the three specific propositions of "increasing population without increasing land and decreasing population without reducing land," the proportion of peasants who objected, agreed, and did not express an opinion is basically consistent with proportion of responses to the general policy question (i.e., the first question in Table 10). Those who oppose the state's policy of prohibiting land adjustments are mainly families who will likely marry wives from the outside, or will have babies—for these people, the prohibition of land adjustments inevitably will reduce their per capita arable land and per capita welfare. Those who agree with the state's policy of prohibiting land adjustments are mainly families with old people nearing the end of their lives or families

with daughters, who are going to marry elsewhere, and the ban on land adjustments will turn their farms into the *AY/N* > *S* type. Those who did not express an opinion may include many village cadres, because it is they who are responsible for adjusting collective-owned land. If they openly oppose the state's policies, they will lose power. In short, the fact that 60 to 70 percent of the peasants opposed the establishment of exclusive rights demonstrates that these rights harm the welfare of most people and reduce per capita welfare. When China's policy makers copied the model of exclusive rights created by the trend of expanding arable land per capita of the English rural population and applied it to rural China under the trend of shrinking arable land per capita, this undermined the welfare of most peasants.

Table 11 lists specific data on land adjustments in rural China in 1983–1997 and 1998–2008. In fact, the original data of Tao Ran et al. (2009) specifically distinguished between "large adjustments" to redistribute land evenly according to the population changes in each household, and small-scale adjustments only between families with *AY/N* > *S* farms and *AY/N* < *S* farms. To simplify the analysis, Table 11 does not distinguish between large adjustments and small adjustments. During 1983–1997, 81 percent of the surveyed villages in Jilin adjusted their land, with an average of 3.66 adjustments per village. These two indicators are the highest among the six provinces, because Jilin's rural industry is underdeveloped and planting crops is the main source of villagers' income. Sixty percent of the villages in Fujian adjusted their land, the lowest among the six provinces; each village carried out an adjustment on average 1.65 times, the second lowest among the six provinces. This is because Fujian, like Zhejiang, is located in southeastern China, where rural industry is most developed. The relatively large number of off-farm job opportunities in rural Fujian have reduced the pressure to adjust landholdings. Therefore, in the first ten years (1998–2008) of the second round of rural household contracts,

the proportion of villages in Fujian whose landholdings were adjusted dropped to 20 percent, and the average number of adjustments per village fell to 0.35. Jiangsu is also a province with well-developed rural industries. It underwent the same sort of changes in 1983–1997 and 1998–2008 as did Fujian. Since rural industries in the other four provinces lagged behind, changes in these provinces during the two periods 1983–1997 and 1998–2008 were not as rapid as in Fujian and Jiangsu. However, in the rural areas in the six provinces as a whole, the trend was toward a decline in land adjustments: the proportion of villages with adjustments and redistribution of land decreased from 72 percent in years 1983–1997 to 42 percent in years 1998–2008, and the average number of adjustments per village fell from 2.58 to 1.03. These declines were the result of the arable land per capita of China's rural population changing from decreasing to increasing in 1995, rather than the result of the state's prohibition of land adjustments and the lack of equal land rights. When the arable land per capita of the rural population stops decreasing and begins increasing, the pressure to adjust land naturally also decreases, or even gradually disappears. Even if equal land rights still exist at this time, that will not trigger land adjustments. On the contrary, when land adjustments and equal land rights became illegal during the second round of rural household contracts, the proportion of rural China's villages that adjusted land was still as high as 42 percent between 1998 and 2008, and in relatively poor Jilin, Shaanxi, and Sichuan, was even as high as 67 percent, 55 percent, and 56 percent, respectively. This is because when the arable land per capita of the rural population stopped increasing and began to decrease in 1995, this transition was inevitably out of sync between the provinces, and the per capita arable land in the undeveloped areas was still declining. Obviously, state law cannot change this trend of decline, but the trend can make state law inapplicable. Therefore, both equal land rights and land adjustments are the result of the trend of decreasing arable land per capita of the rural

population, and the neo-classical views on causation of Zhou Qiren and Liu Shouying cannot be sustained.

Table 11. Village Land Adjustment Status in Six Provinces of China, 1983–1997 and 1998–2008

	Jilin	Hebei	Shaanxi	Sichuan	Jiangsu	Fujian	Total
1983–1997							
Share of villages with land adjustments	81%	70%	75%	72%	75%	60%	72%
Share of villages without land adjustments	19%	30%	25%	28%	25%	40%	28%
Average number of adjustments per village	3.66	1.5	2.4	3.44	2.85	1.65	2.58
1997–2008							
Share of villages with land adjustments	67%	35%	55%	56%	20%	20%	42%
Share of villages without land adjustments	33%	65%	45%	44%	80%	80%	58%
Average number of adjustments per village	1.43	1.25	1.6	1.11	0.45	0.35	1.03

Source: Tao Ran et al., 2009: tables 2 and 3; total number of villages surveyed: 119.

The private landowner mentioned in Table 8 not only has all the property rights of the landholder, but also the right to buy and sell land. The landholder's exclusive rights do not themselves create $AY/N > S$, $AY/N = S$, and $AY/N < S$ households, nor do they create landless households. However, they do prevent land redistribution when different family population growth rates create $AY/N > S$, $AY/N = S$, and $AY/N < S$ family farms, and protect this farm structure which harms the most productive agrarian configuration. The short history between China's land reform and agricultural collectivization has shown that the right of landowners to buy and sell land can quickly and directly produce $AY/N > S$ and $AY/N < S$ households, but also can create landless households. If unchecked, the inevitable result would be the resurrection of polarization between the rich and the poor and class exploitation. Because the landholder's exclusive rights come at the expense of the per capita welfare of the collective, especially the employment and rations of the newly added population, China's economic reform, which has lasted for more than forty years, has not found an acceptable way to create landholders in the vast rural areas of China. And because the property rights of private landowners will cause Chinese history to regress and throttle China's development far more than the property rights of landholders, it is even more difficult to resurrect the private landownership system eliminated by Mao Zedong.

Conclusion

Boserup (1965) divided the history of cultivation into five stages according to land utilization: (1) the forest-fallow system, with a fallow period of about twenty-five years; (2) the bush-fallow system, with a fallow period of about eight years; (3) the short-fallow system, with about one year of fallow; (4) the annual cropping system, without a fallow period; and (5) the multiple-

cropping system, with two or even three crops on the same farmland every year. Assuming that the arable land area (*A*) remains unchanged, the land utilization rate (annual sown area) of these five farming systems is 4 percent, 12.5 percent, 50 percent, 100 percent, and 200 percent of *A*, respectively. Because the land productivity (*Y*) of each of these five farming systems has its own relative limits, these systems can also be divided by the absolute limit of *Y* (the highest limit of natural fertility). The annual labor input per hectare of the forest fallow system and its relative limit of *Y* are farthest from the maximum limit of natural fertility. Assuming that this distance is 5, it will inevitably maximize the growth potential of *Y*, wherein natural fertility makes the greatest contribution per kilogram of grain and manpower makes the least contribution. The annual labor input per hectare and the relative limit of *Y* in the multiple cropping system are closest to the highest limit of natural fertility. Assuming that this distance is 1, it will inevitably minimize the growth potential of *Y*, resulting in natural fertility making the least contribution and manpower making the greatest contribution per kilogram of grain (Pei, 2017: 368). China popularized multiple cropping in 1000 CE; its land utilization rate and land productivity (*Y*) have long been at the highest stage of farming history. This made it impossible to eliminate the *AY/N* = *S* population trap because population growth step by step decreased *Y*'s growth potential and the contribution of natural fertility per kilogram, while the contribution of manpower increased step by step. What has bedeviled China the most is that without the next farming system, the trend of shrinking sown area per capita of the rural population has become inevitable. During 1250–1700, England was in Boserup's third stage of farming history. This made it far more likely that it, rather than China, would escape the population trap, because it had more potential than China to improve *Y*, and it could replace the fallow system with the Norfolk annual cultivation system to expand the sown area per capita of the agricultural population. As long as

the sown area per capita of the agricultural population in a country stops shrinking and begins to expand, the country will inevitably escape from the population trap. However, as long this trend of shrinking continues, the country will inevitably fall deeper and deeper in the $AY/N = S$ population trap. The historical turning point of sown area per capita of the rural population from shrinking to expanding will only happen once in any country, and thus other changes are subordinate to this change. For example, the trend of declining arable land and sown area per capita of China's rural population has always been so difficult to change that China's feudal society lasted more than two thousand years, much longer than that of England. Therefore, other changes, no matter whether they are intentional or unintentional, are needed to reverse this trend. It is the opposite trend of the reduction and expansion of the sown area per capita of the rural population that has caused the huge differences between poor and rich countries in the average size of farms, labor productivity, per capita income, labor costs of food, the share of commercial grain in total grain output, division of labor, labor structure, population structure, property rights system, lifestyle, ideology, and more.

The agricultural and industrial revolutions in England, the private property rights of capitalism, and the market system were all the result of the reversal of the trend of the sown area per capita of the agricultural population from shrinking to expanding. This reversal began with the Black Death, which expanded the arable land per capita of the agricultural population from 3.15 acres in 1300 to 4.51 acres in 1380. This in turn immediately switched the labor input per acre from increasing to decreasing, the marginal returns to labor from decreasing to increasing, and labor productivity from negative growth to positive growth. This expansion also soon caused the feudal manor system to collapse, the peasants to escape from serfdom, and the lord to enclose and merge small family farms into large capitalist ranches. However, the enclosure movement

reduced the arable land area (*A*), so that arable land per capita of the agricultural population began to decline after 1380. The transfer of land property rights to serfs was to prevent this decline, because serfs changed from land users to landholders, which could not only prevent the lords from enclosing and reducing *A*, but also enable their exclusive rights to increase *Y*. But after production resumed, population (*N*) increased faster than *A* and Y. This not only caused the arable land per capita of the agricultural population to continue to decline, so that by 1600 it was smaller than in 1300, but also made *Y* close to the relative limit of the fallow system. If we refer to Figure 1 and Table 1, when the Black Death returned England from the $AY/N = S$ trap to the $AY/N > S$ pre-trap stage and expanded the farmland per capita of the agricultural population, the labor input per acre was moving from right to left and away from the relative limit of *Y*, indicating that both marginal returns to labor and labor productivity were increasing. In contrast, the reduction in the farmland per capita of the agricultural population between 1380 and 1600 caused labor inputs per acre to move from left to right and again approach the relative limit of *Y*. This resulted in the negative growth in labor productivity, diminishing marginal returns to labor, and the disappearance of the role of exclusive rights in increasing labor inputs. It was the interaction between the reduction of arable land per capita of the agricultural population and the limit of *Y* under the fallow system that caused England to return from $AY/N > S$ to $AY/N = S$. The evidence is that the share of the agricultural population rose from 67.22 percent in 1550 to 69.83 percent in 1600. England overcame this reversal by moving from the third to fourth of Boserup's stages of farming history (see Figure 2). This not only gave *Y* a new relative limit and growth level, making for an agricultural revolution in England, but also expanded the utilization rate of *A* from 50 percent to 100 percent, so that the sown area per capita of the agricultural population in 1871 expanded to 1.5 times its highest level in 1380 under the fallow system. The land of the

yeoman returned to the lord because his exclusive rights hindered while the lord's ownership promoted the expansion of the sown area per capita of the agricultural population. It was this expansion that led to an increase in the area per farmer devoted to producing commodity grain for the urban population, the increase in the share of commodity grain in total food production, the accelerated decline in the agricultural population share and the accelerated rise in the urban population share, and the simultaneous emergence of England's agricultural and industrial revolutions. This in turn promoted the division of labor, the exchange of commodities between agriculture and industry, and the formation of a capitalist market system.

China's development has far exceed that of England in all aspects because China has had a much longer history. For example, China's system of enfeoffment and a lordship economy was replaced by private landownership and a landlord economy during the Eastern Zhou dynasty from 770 BCE to 256 BCE (Li and Jiang, 2005). China's Grand Canal was built in the Sui dynasty in 581–618 CE, long before England had inland canals. The population of Xi'an, the capital of the Tang dynasty, and Bianjing, the capital of the Northern Song Dynasty, was much larger than that of London. Moreover, the market economy was more developed and emerged earlier than in London. When China developed from the fourth to the fifth stage of farming history, there was also an agricultural revolution in which *Y* rose sharply. This reduced China's rural population share to below 70 percent between 1067 and 1085 CE. The share, however, later returned to 90 percent. This was because when *Y* rose sharply, the sown area per capita of the rural population could not change from shrinking to expanding. As a result, *Y* was closer to the highest limit of natural fertility, and China fell deeper and deeper in the $AY/N = S$ trap. In England, on the other hand, the sharp increase in *Y* and the transition from shrinking to expanding sown area per capita of the agricultural population occurred simultaneously, and thus

the expansion and the decline in the share of the agricultural population formed a virtuous circle that propelled each other. This was because when the Black Death reduced the population pressure in England by half, it not only expanded the farmland per capita of the agricultural population and created a downward trend in the share of the agricultural population, but also greatly delayed the conversion of fallow land to cultivated land in the annual farming system. The evidence is that the fallow rate increased from 35.8 percent in 1300 to 42 percent in 1420. This made room for expanding the sown area, which in fact increased by 114 percent between 1600 and 1871. All this coincided with the English agricultural revolution. This expansion led to an increase in the share of nature's unpaid contribution embedded in grain and a reduction in labor costs, a decline in grain prices and wages, and a source of profit accumulation for industrialization—the basis for the English Industrial Revolution. On the contrary, the expansion of the sown area per capita of the rural population is the result of the Chinese industrial revolution, because the trend of the shrinking of the sown area of each farmer progressively reduced the contribution of nature to the farmer's products and progressively increased the labor cost. China's market economy, which developed earlier than that of England, could not reverse this trend. Instead, it caused food prices and wages to rise, and average social profits to drop to zero, resulting in the depletion of investment sources and economic stagnation. Therefore, China used forced accumulation to establish heavy industry, and then wielded its production capacity to reverse the trend of shrinking sown area per capita of the rural population.

The dual economy created by forced accumulation before China's reform was imbalanced in three areas: in the output structure of agriculture, light industry, and heavy industry; in the labor structure and output structure; and in the population structure and labor structure. Here the production capacity of heavy industry was the solution: correcting these three imbalances

required new investments, and the heavy industry investment of the previous period and the next period of investment were directly related. Furthermore, this direct connection to the next investment is determined not by the state's tendency of accumulation, but by heavy industry's production capacity relative to the consumer goods sector. The causality of this change has been confirmed by Chinese history. First, the industrial revolution of 1953–1978 reversed the output structure of agriculture, light industry, and heavy industry from 70:22:8 in 1949 to 25:32:43 in 1978, turning China from a poor agrarian country into a country with a strong investment productive capacity. Because the production capacity of heavy industry was able to determine the next stage of investment, China shifted from a planned economy to a market economy. Second, since China did not have a factor market for capital, labor, and land between 1979 and 1995, both its economic takeoff model and transition model were products of the unbalanced structure of agriculture, light industry, and heavy industry. One end of this structure was rural surplus labor, and the other was investment in heavy industry. The agricultural surplus value transfer chain connected the two ends. When the state began to raise the purchase price of farm products in 1979, the farm surplus value flowed in the opposite direction, transferring 13 percent and 22 percent of the state's investment sources before the reform to rural collectives and private investors, respectively. Raising the purchase price of farm products meant the state was abandoning mandatory accumulation. Yet, the investment rate did not decline but instead rose because it was determined by the production capacity of heavy industry. Therefore, it was the reverse flow of farm surplus value that released the structural tension of the dual economy, causing investment goods from heavy industry and 110 million surplus laborers from agriculture to shift to light industry and close the development gap. This shows that the production capacity of heavy industry not only corrected the imbalance in the output structure of agriculture, light

industry, and heavy industry, but also accelerating the industrialization of the labor structure. This reduced the share of agricultural labor from 71 percent to 52 percent. The absolute number of agricultural workers thus began to decrease after peaking in 1991, and the trend of shrinking sown area per farmer was reversed. But in this period the share of the rural population declined more slowly than the share of agricultural labor, because TVE workers did not leave the countryside. Third, the share of agricultural labor did not decline from 1995 to 2003, but the fall in the share of the rural population accelerated, from 71 percent to 59.5 percent. This was because the change in the sown area of each farmer from shrinking to expanding increased the number of people each farmer supported, thus accelerating the urbanization and industrialization of the population structure. Therefore, the absolute size of the rural population began to decrease after reaching a peak in 1995, and the sown area per capita of the rural population also switched from shrinking to expanding. The reduction in the rural population and the accelerated increase in the share of the urban population in turn increased the sown area per capita of the rural population and the share of commercial grain in total grain output. As a result, the labor structure was further industrialized, causing the share of agricultural labor to decline faster than that of the rural population during the years 2003–2008 (see Figure 9). In short, after the sown area per capita of the rural population stopped shrinking and began an epoch-making trend of expansion in 1995, China's three vicious circular causal chains turned to the English-style circular causal chains. Only then did a privatized market economy emerge.

China's logical causal chain was changed by forced accumulation. Forced accumulation in turn was the result of Mao's shift of property rights (see Table 8): rural households directly changed from landowners before agricultural collectivization to land users after collectivization. After Mao's death, peasant households began to change—again, referring to Table 8—from right

to left to yeomen, but whether they can continue to move to the left to become use-right lessors will be determined not by state law but by off-farm job opportunities. Table 9 shows that not only are such opportunities still limited, but regional differences are directly related to the differences in the impact of China's industrial revolution on the provinces. It is more difficult for households to move to the left to become landholders because the trend of shrinking sown area per capita not only causes the space for the establishment of exclusive rights to disappear, but also makes those rights reduce Y when costs exceed returns. This is caused by the limit of Y: when a farm suddenly changes from $AY/N = S$ to $AY/N > S$, its unit land labor inputs change from approaching to leaving the limit in order to make the marginal return on labor change from falling to rising and to increase profits. This will reduce the total grain output and threaten the survival of $AY/N < S$ households.

Because exclusive land rights harm per capita welfare, especially the employment and rations of the newly added population, China's more than forty years of reform has so far failed to turn rural farmers into landholders, let alone landowners. Could they become yeomen instead of the land users of the Mao era? This was obviously in contradiction with compulsory accumulation, because the purpose of compulsory accumulation was to transfer the surplus income from yeomen. Thus the transformation of farmers from land users to yeomen was the result of forced accumulation having completed its mission; or that farmers could become yeomen in the $AY/N = S$ trap, but then China would not have had an industrial revolution to escape this trap. And after forced accumulation withdrew from the historical stage, China's owner-cultivators still could not become English-style yeomen, because the property rights of England changed from right to left in Table 5: serfs directly changed from land users to landholders, and finally land returned to the owner. This was because England was at a much

lower stage of cultivation than China, and thus it not only had more potential to improve *Y*, but also could change the sown area per capita of the agricultural population from shrinking to expanding. This expansion not only enlarged the space for the establishment of exclusive rights, but also made those rights have the effect of increasing *Y* when the level of *Y* was very low. Indeed, the transfer of land property rights from lord to serf occurred when the Black Death caused the arable land per capita of the agricultural population to expand and the labor input per acre was far from the limit of *Y*, and hence *Y* had a huge growth potential. When England moved from the third to the fourth stage of farming history, land was returned to the manor lords, and not only did the sown area per capita of the agricultural population expand to 1.5 times its highest level in the third stage, but *Y* also had a new relative limit and a path to growth.

By virtue of China's thousands of years of private landownership, yeomen not only appeared earlier than in England, but also enjoyed more complete private property rights. But why was their land collectivized by Mao Zedong in 1956? This was the result not of Mao's subjective will but of the ever-shrinking sown area per capita of the rural population. And it was Mao who reversed this trend of shrinking to a trend of expanding, but in a way that involved the opposite of property rights in England. This was a painful process at first. In terms of time, it took four hundred years for England, from the Black Death in 1348 to about 1750 on the eve of its agricultural and industrial revolutions, to completely reverse the trend of shrinking sown area per capita of the agricultural population and launch a trend of expansion. It took China only about forty years to reverse the trend, from the "unified purchase and supply of grain" and agricultural collectivization in the mid-1950s to 1995. Judging from the degree of pain, even if we blame Mao Zedong for the failure of the Great Leap Forward, the subsequent famine and widespread death, and so on, the reversal of the trend in England was even more painful than in

China. It came at the cost of the death of half of the population with the Black Death, encircling sheep to, as Thomas More put it, “devour men themselves,” and eliminating the yeoman class. If Mao had not made a mistake, he could only have reduced the cost of reversing the trend. And it is precisely because all the Chinese people had paid the most painful price of hunger in the era when Mao used forced accumulation to reverse the thousands-year-old trend in China, all the leaders after Mao have been able to easily punt the boat along with the current after the trend was reversed.

In sum, the change in the trend of the sown area per capita of China’s rural population from shrinking to expanding was entirely man-made. The change in the trend in England was mainly caused by the Black Death and the fact that England was at a lower stage of agriculture than China. In the United States, Canada, Australia, and other land-rich countries, the changing trend was a gift from nature. The rich per capita land resources of these new continental countries made this transition the easiest to achieve and the least costly. Studying this shift in trends can unravel the secrets of how and when these countries moved from agricultural to industrialized societies. For example, when the trend in China changed in 1995, the arable land per capita of the rural population was 0.11 hectares. In 1380, when the trend in England was changed by the Black Death, the arable land per capita of the agricultural population was 4.51 acres (1.82 hectares). The gap between the two was 1:16.6. North and Thomas (1973) claimed that efficient organization was the source of the rise of Western countries. This, however, reverses history. The reason China became inextricably trapped in the vicious circle of $AY/N = S$ was not that its land use efficiency was lower than in Western countries—in fact, it was higher. The claim that capitalist markets and private property rights were the cause of the agricultural and industrial revolutions in England is simply self-deceiving. There is no issue of defining and distributing

property rights in Robinson Crusoe's world. Only when there are at least two people does this issue arise. As the population increases, it becomes more and more difficult to define and distribute property rights. Land property rights are always the result of the relationship between population and land resources. The World Bank's land reform in developing countries has failed because it violates this simplest common sense. The answer is to shift this policy to finding ways to change the trend of shrinking sown area per capita of the rural population. Only when the sown area per capita of the rural population stops shrinking and begins to expand will the causal chains of the three vicious cycles summarized in Table 1 become three virtuous cycles. As long as the sown area per capita of the rural population continues to shrink, the causal chains of those three vicious cycles will continue to exist. For example, adherents of neoclassical property rights theory often attack land adjustments in rural China. But as I have argued (Pei, 2004), if we do not adjust land but allow the rural household structure of $AY/N > S$, $AY/N = S$, and $AY/N < S$ to emerge and develop, it will delay the change of the sown area per capita of the rural population from shrinking to expanding. However, if the land is adjusted between $AY/N > S$ and $AY/N < S$ households, so that all households return to the Malthusian dynamic model of $AY/N = S$ under the trend of a reduction in per capita land, it will speed up this change. Once this transformation is realized, land adjustments to deal with population change will decrease and eventually disappear, and the space for the establishment of exclusive land rights will naturally appear. This has been confirmed by Chinese history. Therefore, any policy that can accelerate the transformation of the sown area per capita of the rural population from shrinking to expanding is a good policy, and any policy that delays and hinders this transition is a bad policy.

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