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ECONOMIC DEVELOPMENT OF TRADITIONAL CHINA

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Economic Development of Traditional China

by

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China was an agrarian society before the penetration of Western influences in the nineteenth century. Economic development for several centuries from the Sung dynasty to the middle of the Ch'ing dynasty (960-1800) was basically the development of an agrarian economy. There are two crucial facets of this development. On the one hand, the development involves an agricultural sector and a non-agricultural sector (i.e. commerce, light manufacturing, and government) -- a structure which may be referred to as agrarian dualism. On the other hand, in the more basic agricultural sector, the essential growth phenomenon involves population pressure, intensive land cultivation, and technological change.

In contrast to the "epoch of modern growth" (i.e. an expression used by Professor Simon Kuznets to identify a particular growth tpye of Western Europe after industrial revolution), the development of a pre-industrial agrarian economy is characterized by slow growth and structural stability. The population growth rate was probably around or less than .5% (and seldom over 1%) which was approximately 1/4 of the modern population growth rate around 2%.[1]

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[1]For the growth rate in the eighteenth and nineteenth centuries, see Ping-ti Ho, Studies on the Population in China, 1368-1953 (Cambridge, Mass., 1959), pp. 64, 270, 277. For estimations since 1400, see Dwight Perkins, Agricultural Development in China (Chicago, 1969), p.81, table S.I. colimu a. A 1% population growth rate results in the doubling of the total population for every 69 years. Thus in 700 years, the total population would have increased by $2^{10}=1024$ times!

The rate of expansion of the cultivated area was even slower so that in the Ming period (1368-1953), China already felt the pinch of population pressure in certain regions. [2] This pressure was partially offset by the change in agricultural technology in the land saving (or labor using) type, without which population could not have multiplied in the long run.[3]

In spite of the continuous growth in the size of population and intensive land cultivation, China had exhibited considerable structural stability in this long period. Increase in agricultural labor productivity and per capita consumption standard was hardly noticeable if occurred at all.[4] The dualistic structure of population allocation between the agricultural and non-agricultural labor forces probably had maintained a fixed proportion. There appeared to be a "self controlling servo-mechanism", or "invisable hand" which operated constantly to bring about the amazing structural stability in the mist of slow growth over centuries. The explanation of this "mechanism" constitutes the central issue of the theiretical reasoning of economic growth of agrarian dualism.

The contemporary theory of economic growth which came into being during the last 15-20 years envisions economic growth as natural results of the operation of an economic system. In an agrarian

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[2] See Ping-ti Ho, op.cit., p.139.

[3] D. Perkins, op.cit., pp. 13-36.

[4] D. Perkins, pp. 14-17; 80-84.

dualsim, this operation involves the simultaneous performance of the essential economic functions such as production, exchange, consumption, and income distribution. The self controlling mechanism mentioned above is merely a property of this operational system.

The theory of slow growth with structural stability will be developed in a few steps. To begin with, we will develop a wholistic perspective outlining the operational aspects of an agrarian dualism which will be emphasized in our paper (section I). According to this view, it is readily seen that the dualistic aspect of economy (i.e. the allocation of labor force between the agricultural and non-agricultural sectors) is crucially related to agricultural labor productivity p and per capita consumption standard c (section II). The determination of p and c are, in turn, traced to the production conditions prevailing in the agricultural sector in which labor and land are the crucial factors of production (section III). The analysis of the agricultural production also leads to an investigation into the determination of income distribution between the labor class and the landlord class. It will be shown that this income distribution, in turn, determines the labor allocation indicated in the first section (section IV). While these various facets (production, consumption, income distribution, and labor allocation) are significant in their own right, it is their relatedness and simultaneity that describe the operation of an agrarian dualism at any point in time.

Turning next to the dynamic (i.e. the growth) aspect of such a system, we shall first investigate the impact of the technological change in the agricultural sector (section V). The changing technology can offset the productivity depressing effect due to a more intensive land cultivation when population growth takes place. The logical necessity of slow growth with structural stability is but a manifestation of the internal servo-mechanism implied by such a system (section VI and VII). While we shall use the elementary diagrammatic method to outline our argument in the text, rigorous proofs will be relegated in appendices A abd B.

I. The Operation of Agrarian Dualism

We can use the economic tableau of the French Physiocrats to provide a bird's-eye view of economic aspect of agrarian dualism (see diagram 1). There are two production sectors producing total agricultural output (Q) and non-agricultural output (V). In the agricultural sector, labor (L) and land (T) are two primary inputs, the services of which flow into the agricultural production sector. The total agricultural output is used partly, Q_a, as consumption by the agricultural labor force (L) and partly, Q_n, by the non-agricultural labor force (W). This labor force, such as workers, merchants, soldiers, and civil servants, are supplied as inputs in the non-agricultural production sector to produce an output (V) which flows back partly to the agricultural labor force (V_a) and partly to the land owning class (V_t). The steady and circulating flows of goods and

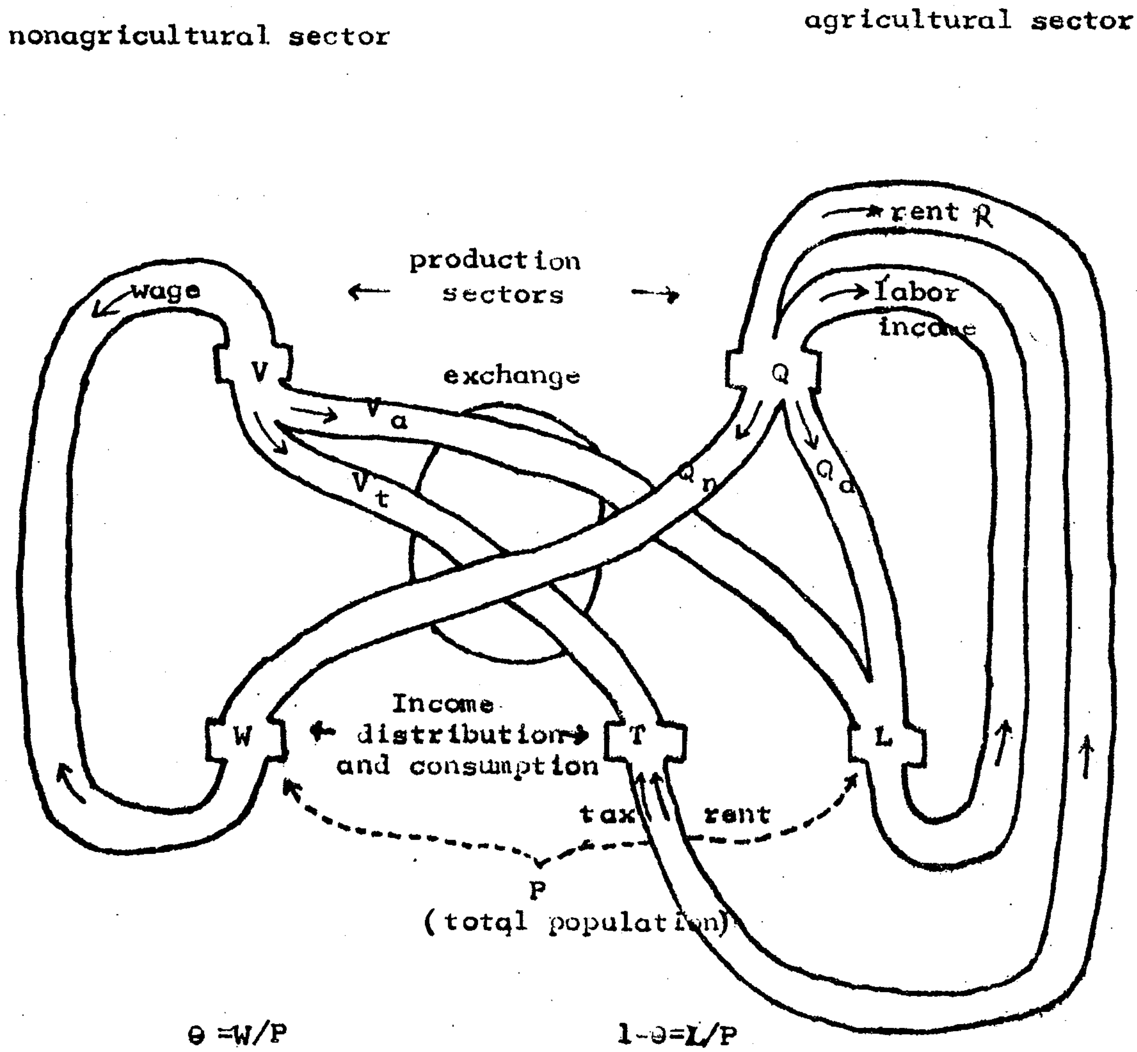
nonagricultural sector
agricultural sector
rent R
production
sectors
wage
labor
income
exchange
V
Q
V_a
V_t
Q_n
Q_a
Income
distribution
and consumption
W
T
L
tax
rent
P
(total population)
$\theta = W/P$
$1-\theta = L/P$

Diagram 1

services in this system provide an organic view of this operation of a dualistic agrarian economy.

The economic tableau provides an outline showing the relatedness of the essential economic functions which must be performed in any agrarian economy. These functions include production and consumption of agricultural goods, inter-sectorial commodity exchange (V_a, V_t, Q_n), the allocation of labor (W and L), as well as the distribution of income generated within the agricultural sector as rental payment to the land owning class and wage income to the cultivators. The Physiocrats made use of such a scheme to exalt the primary importance of the agricultural sector, as they believed a high agricultural labor productivity (p) and the emergence of an agricultural surplus (Q_n) were prerequisites for the prosperity and even the existence of the non-agricultural productive activities.[5] Such an emphasis on the supremacy of agricultural sector is quite in tune with the belief of traditional China.

From the analytic viewpoint, the economic tableau pinpointed certain essential economic magnitudes (or variables), the determination of which cinsistutes the focal point of analysis of modern growth theory. The formost is the productivity of agricultural labor force, $p=Q/L$, and the per capita consumption standard of agricultural goods, $c=Q/(W+L)$, where $W+L=P$ is the total population. It is the high agricultural productivity (p) relative to the per

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[5] For an analysis of the economic tableau, see Ronald L. Meek, "Problems of the Tableau Economique," in James A. Gherity ed., Economic Thought: A Historical Aethology (New York, 1965), pp. 115-149.

capita consumption standard (c) that leads to the emergence of an agricultural surplus and a high fraction of labor allocated to the non-agricultural sector, $\theta = W/P$ (the fraction of labor force allocated to the agricultural sector is $1-\theta$). At any point in time, the population pressure can be measured by the labor-land ratio, $L^* = L/T$, indicating the intensity of land cultivation. This intensity is important because the agricultural labor productivity (p) is inversely related to the population pressure (L^*) when the law of diminishing returns prevails.

If we denote the total rent payment to the land owning class by R, then the distributive shares of output received by the landlord and labor class are $\phi_T = R/Q$ (the economic rent share) and $\phi_L = (Q-R)/Q$ (the wage share in the agricultural sector) respectively. These shares are crucially related to the inter-sectorial labor allocation because it is only through the shares of income acquired by these classes that they can purchase the output produced by the non-agricultural labor force. The understanding of the economic forces that determine the above system of economic magnitudes -- Q, Q_a, Q_n, V, V_a, V_t, T, L, W, P, p, c, θ, L^*, ϕ_T, ϕ_L -- amounts to an appreciation of the operational aspects of an agrarian dualism.

II. Agricultural Productivity and Labor Allocation

In this economy, the demand of food is cP (total population times per capita consumption standard), while the supply of food is Lp (the agricultural labor force times productivity). Equating supply and demand ($cP=Lp$) and deviding throughout by P, we obtain

1) $c/p = 1 - \theta$ (e.g. $p=10$, $c=8$, $1-\theta=.8$)

The numerical example shows that the consumption standard is 80% of labor productivity and this leads to the same percentage of total labor force allocated as farmers -- usually thought of as typical for traditional China. This simple relation is shown in diagram 2 in which p (θ) is measured on the vertical (horizontal) axis. The distance OA on the horizontal axis marks of the unit distance which is the maximum value of θ. If p_o and c_o are the values for labor productivity and per capita consumption, then the value of θ_o is indicated by the distance OB where point B lies directly below point E which is the point of intersection between the straight line Ap_o and the horizontal line Ec_o.[6]

Suppose now through technological improvement, the labor productivity in the agricultural sector is raised from p_o to p', slowly but surely, the agrarian economy will make two possible types of adjustments. When θ_o is fixed, the consumption level will be raised vertically from E to E', i.e. an increase in the labor productivity leads to a higher consumption standard. Conversely, when c_o is fixed, the fraction of labor allocated to the non-agricultural sector will be increased from E to E'' (i.e. to the level of OD) indicating that the increased agricultural productivity will release more labor for the production of non-agricultural goods.

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[6] From the similarity of the triangles ABE and AOp_o, we see $EB/AB=Op_o/OA$ or $c_o/(1-\theta)=p_o$ which satisfies equation 1.

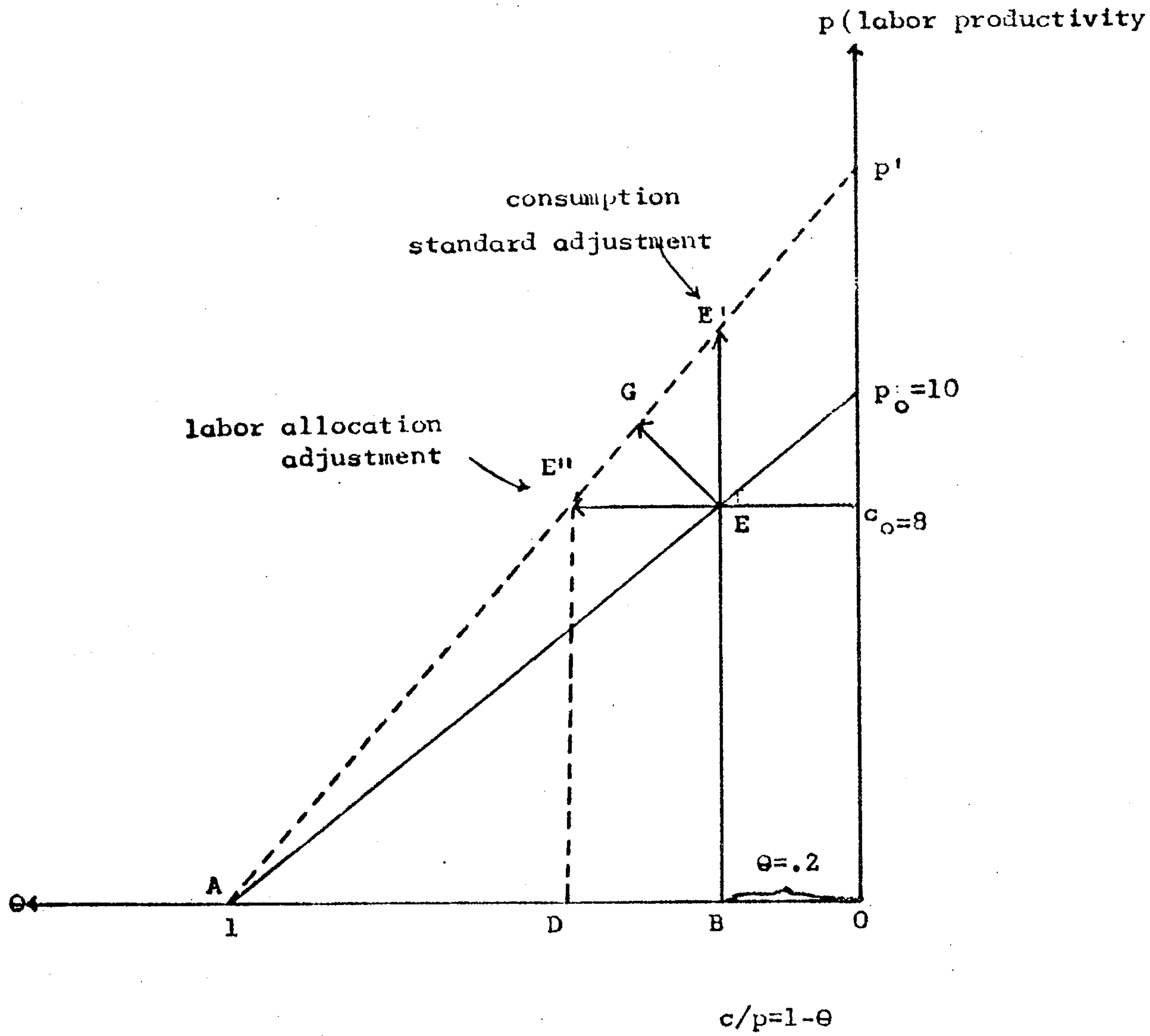
p (labor productivity)
p'
consumption
standard adjustment
E'
G
p₀=10
labor allocation
adjustment
E''
E
c₀=8
θ=.2
θ
A
1
D
B
O
c/p=1-θ

Diagram 2

Usually, it is some combination of the "consumption standard adjustment" and the "labor allocation adjustment" that will take place (e.g. the adjustment from E to G). Thus in order to understand labpr allocation, it is important to know the economic forces that determine the agricultural labor productivity (p) and the per capita consumption standard (c).

III. Labor Productivity, Real Wage, and Consumption Standard

In the traditional economy, the major economic forces that determine the agricultural labor productivity (p) is the intensity of land cultivation (L*). In diagram 3a, let land T (agricultural labor force L) be measured on the vertical (horizontal) axis. At the input point E_o (i.e. with $L_o=50$, $T_o=100$), the total output is $Q_o=200$ as indicated by the index of the isooutput contour line. Thus at E_o the labor productivity is $p_o=200/50=4$ units of agricultural goods.

A key fact of traditional China was the increase of agricultural labor force at a rate faster than the increase of cultivable area of land. To denote the land shortage, we can first imagine that more population is added on to a fixed amount of land, $OT_o=100$, as indicated by the sequence of points E', E_o, E"...on the horizontal line. The law of diminishing returns is shown by the convexity of the total output curve in diagram 3b. Thus with L'=20, the total output of 100 units leads to a labor productivity of p=100/20=5 which is the slope of the dotted line OQ'. The convexity of the

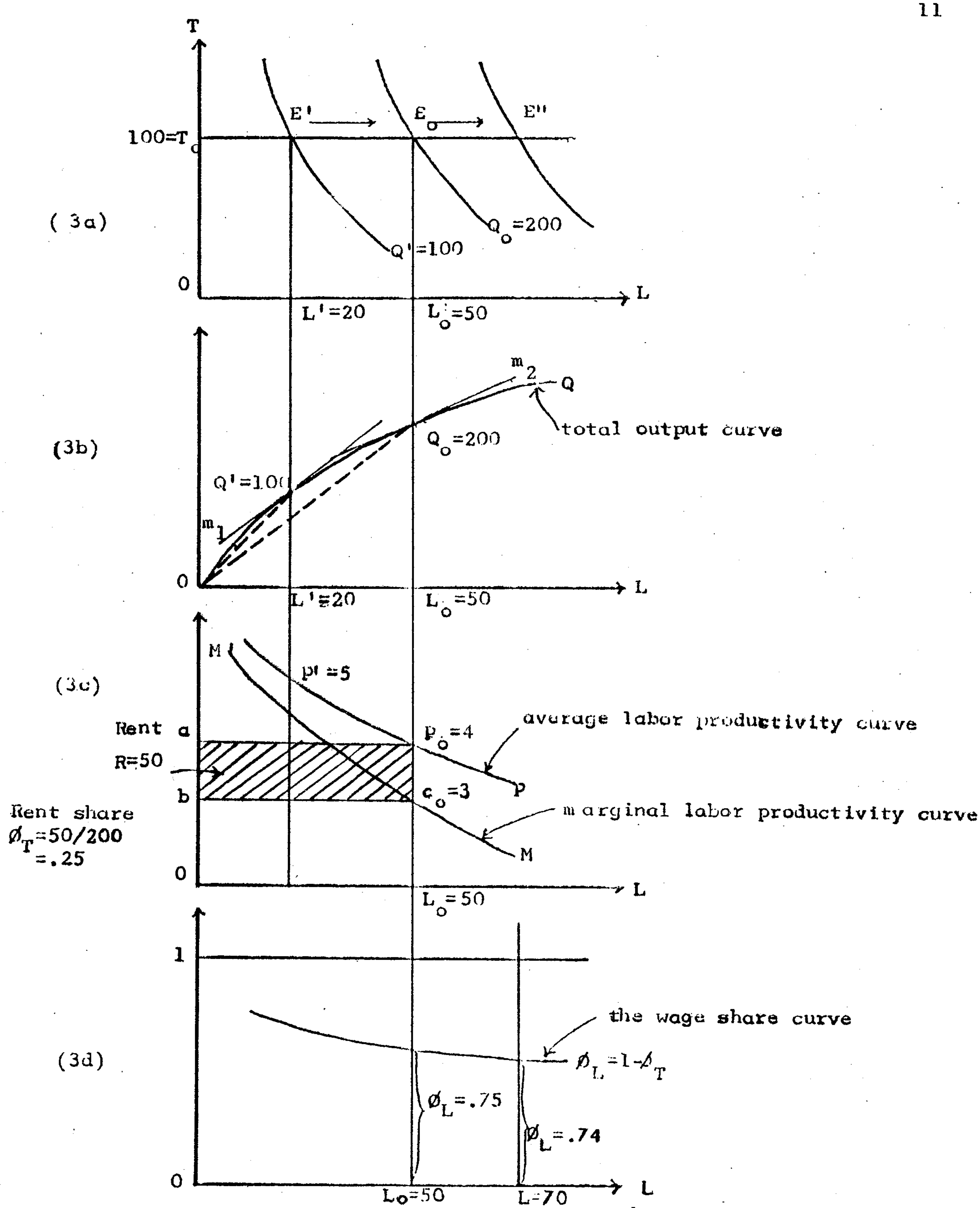
T
100=T_o
E'
E_o
E''
(3a)
Q_o=200
Q'=100
0
L
L'=20
L_o=50
m_2
Q
total output curve
(3b)
Q_o=200
Q'=100
m_1
0
L
L'=20
L_o=50
M
p'=5
(3c)
Rent a
P_o=4
average labor productivity curve
R=50
b
c_o=3
P
Rent share
ϕ_T=50/200
=.25
marginal labor productivity curve
M
0
L
L_o=50
1
the wage share curve
(3d)
$\phi_L=1-\phi_T$
ϕ_L=.75
ϕ_L=.74
0
Lo=50
L=70
L

Diagram 3

curve (i.e. the law of diminishing returns) immediately leads to the diminishing labor productivity p (e.g. OQ_o is less steep than OQ'), associated with a more intensive land cultivation.

The diminishing average productivity of labor is shown more clearly by the negative sloped curve (i.e. the average labor productivity curve) in diagram 3c. Right below this curve is the other negative sloped curve MM' (i.e. the marginal labor productivity curve). When 50 units of labor are used, for example, the marginal productivity of labor is $c_o=3$ units which are the additional amount of output being added with the addition of one unit of labor.[7] It meausres the productive contribution of labor "at the margin", and under a market orinted condition it equals in magnitude to the wage rate.

The acceptance of marginal productivity theory of real wage tantamount to an interpretation of traditional China as an agrarian economy at a "higher" (or later) stage of development. For certain assumptions in regard to the institutional background must be fulfilled if this theory is to be valid. Essentially, the organizational features of the institution must be sensitive to the shortage of land. Under this condition, pressures are generated for laborers to migrate

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[7]The marginal productivity of labor of 50 units is the slope of the line m_2 which is tangent to the total productivity curve at Q_o in diagram 3b. Rigorously, the law of diminishing returns (i.e. the convexity of the total labor productivity curve) states that the marginal productivity of labor decreases (e.g. the straight line m_2 is less steep than m_1) with intensive land cultivation. The diminishing average productivity of labor is a logical consequence of the law of diminishing returns. Note that at point Q_o in diagram 3b, the slope of the line m_2 is less steep than the slope of the dotted radial line OQ_o. Hence in diagram 3c the marginal labor productivity curve lies below the average labor productivity curve which are derived from the total output curve in diagram 3b.

whenever cultivated density is different between farms or even regions. Laborers migrate from the densely populated regions to sparsely populated ones in order to achieve a more efficient way of land utilization. Labor mobility in this way implies less of a personal attachment between the owner and the cultivators of land beyond an economic contractural relation (typical after Sung times). Under these conditions the services of both land and labor are valued or rewarded by an impartial market mechanism according to the respective productive contribution at the margin. (i.e. their respective marginal productivity).[8]

We demarcate China from the Sung period on as "traditional" to distinguish this period from the earlier one (T'ang and before). While there are many cultural differences between these two periods, the most essential economic characteristic of the "traditional" China was that it became a highly market oriented one.[9] Thus we may assume the relevance of the marginal productivity theory of real wage.[10]

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[8]The wage rate is 3 units of agricultural goods (c_o=3) because the output will be reduced (increased) by 3 units when one unit of labor is gone (or added).

[9]That the Sung dynasty marked the beginning of the "modern" period in Chinese history was maintained by Naitō Torajiro and his followers. See, Hisayuki Miyakawa, "An Outline of the Naito Hypothesis and Its Effects on Japanese Studies of China," Far Eastern Quarterly 14 (Aug. 1955), 533-552. The Japanese scholars, such as Sudō Yoshiyuki, emphasize particularly the emergence of the land tenancy and this view has been adopted by Mark Elvin, see Mark Elvin, "The Last Thousand Years of Chinese History," Modern Asian Studies 4,2 (1970), 97-114. For the emergence of a market economy, see Ch'Uan Han-sheng, "Chung-ku tzu-jan ching-chi," (The natural economy in medieval China) The Bulletin of the Institute of History and Philology, Academia Sinica, 10 (May 1943), 73-173

[10]The marginal productivity theory of real wage is not necessarily a modern theory of real wage for the industrial labor force. David Ricardo first purposed such a theory for the British agricultural sector as early as the beginning of the nineteenth century. At that time the British economy was still predominately an agricultural one. It is for this reason that the classsical economists, including Ricardo, regarded the bottleneck in agricultural production (due to shortage of land) as the limiting factor for the non-agricultural activities.

The determination of real wage leads immediately to the determination of the distributive shares for the wage ϕ_L and rent ϕ_T. In diagram 3c, when L_o=50 the total wage income is 3x50=150 (represented by the area of rectangle OL_oc_ob). The total rental income is represented by the shaded area of rectangle bc_op_oa (i.e. R=50x(4-3)=50 units). This leads to a rent share of ϕ_T=.25 and a wage share of ϕ_L=.75. In other words, the land owning class receives 25% of total agricultural output -- determined by the marginal productivity theory of income distribution to the two classes.

The two distributive shares ϕ_L=.75 and ϕ_T=.25 determined by the market principle reflect, in fact, the respective contributions to production by labor and land. The value of ϕ_T=.25 is the "elasticity of output with respect to land", i.e. the total output will increase by .25% when, with the same amount of labor, land increases by 1%. Similarly, ϕ_L=.75 is the "elasticity of output with respect to labor."[11] Thus when traditional China became market oriented,the income distribution to the two classes of economic agent (i.e. the landlord class and the labor class) reflected a production reality.

Diagram 3d indicates the value of the wage share by the wage share curve ϕ_L. It shows a slightly decreasing tendency. For example,

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[11] $\phi_L = MPP_L \times L/Q$, where $MPP_L = \Delta Q/\Delta L$ (with fixed amount of land) is the marginal productivity of labor. Thus $\phi_L = (\Delta Q/Q)/(\Delta L/L)$, which is the percentage increase of output per unit percentage increase of labor.

the wage share is 75% when L=50 and decreases to 74% when L=70. Usually, the modern economic theory seems to suggest that the distributive shares are fairly stable and vary only slightly even in the long run.[12]

IV. Income Distribution, Consumption Standard, and Labor Allocation

Referring to diagram 1, we see that when the labor and the land owning classes in the agricultural sector receive their respective distributive share generated by agricultural production, they will use the income to acquire agricultural goods and/or goods and services produced by the non-agricultural labor force. In regard to the landowning class, the economic rent R is usually syphoned off partly by land tax so that the rental income is partly spent by the land owning class and partly by the government.[13]

The tax income transferred to the government is spent mainly on payment for salaries of soldiers and civil servants who in turn will spend their income to acquire food (Q_n). The landlord's income

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[12] The case indicated in diagram 3d is referred to in economic literature as the substitution inelastic case. This means that in the production process labor is the poor substitute of land and hence when more labor is added to a fixed amount of land, the marginal productivity of labor or real wage declines at a rate faster than the decline of the average productivity of labor. In diagram 3c, this is shown by the fact that the gap between the p curve and MM' curve gradually widened, so that the labor receives a decreasing share of output. In our analysis later in this paper, we make this simplified assumption that the production condiction is "unitary elastic" meaning that the $\emptyset_L$ curve in diagram 3d is nearly horizontal or the labor share is stable as it is indepent of the intensity of cultivation.

[13] In traditional China, the rent was usually 50% of the yield of land. During the Ch'ing period, for example, in Su-chou and Sung-chiang areas, the output per mou was 2 shih of rice, and the land tax was, on the average, .3 shih per mou. Therefore, the tax was approximately 30% of the rent.

is also spent to acquire the services or the products produced by the non-agricultural labor force. Thus it is these expenditures on V_t which accomodate the agricultural surplus Q_n from the agricultural sector to sustain the non-agricultural labor force. The income of the labor class in the agricultural sector is spent mainly on food (Q_a). Whatever requirement they have for the non-agricultural goods tends to be mainly produced within the family or within the rural community. Their purchases of the non-agricultural goods (V_a) tend to be a rather minor item. Thus to simplify our analysis, V_a can be neglected as a first approximation. This means that we shall assume the wage income in agricultural sector will be spent mainly on food.[14]

The analysis of labor allocation in section II and the analysis of income distribution may now be combined to provide a wholistic view of the operation of an agrarian dualism. In diagram 4a, the average and marginal productivity of labor of diagram 3c are reproduced. In diagram 4b, we reproduce diagram 2 in which OA stands for the unit distance. For the agricultural labor force $L_o=80$, let us assume that the average productivity $p_o'=10$ and the marginal productivity $c_o'=8$. Note that the real wage $c_o'=8$ is assume to be

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[14]This theoretical simplification can be easily rectified. In the early 1950's, Taiwan farmers typically spent less than 20% of their income to purchase non-agricultural goods. With rapid economic development during the quarter of the century, 1950-1975, this percentage has increased rapidly to 80%. Thus a strong interaction between the farming families and the non-agricultural sector is decisively a phenomenon which occurs when a traditional economy takes off and moves into the epoch of modern growth.

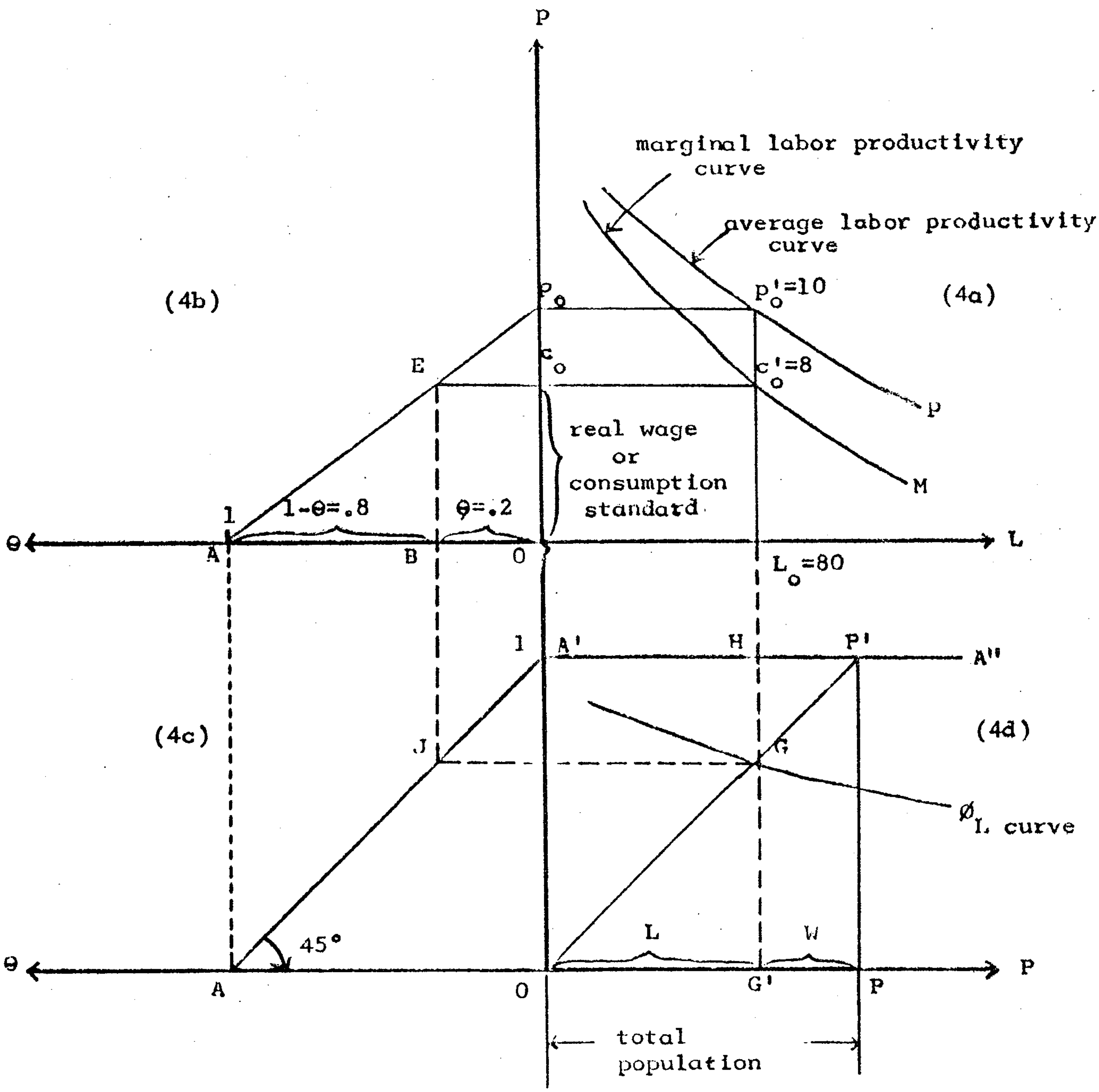
P
marginal labor productivity curve
average labor productivity curve
(4b)
P_o
$P_o'=10$
(4a)
E
c_o
$c_o'=8$
p
real wage or consumption standard
M
1
1-θ=.8
θ=.2
θ
L
A
B
0
$L_o=80$
1
A'
H
P'
A''
(4c)
J
G
(4d)
ϕ_L curve
45°
L
W
θ
P
A
0
G'
P
total population

Diagram 4

the consumption standard of food. When the points p_o' and c_o' in diagram 4a are projected horizontally to the points p_o and c_o on the vertical axis of diagram 4b, we encounter the same situation as shown in diagram 2. Thus we can determine the fraction of labor force $\theta=.2$ (see numerical example in equation 1). This fraction of the non-agricultural labor force (θ) is precisely the distributive share ϕ_T accruing to the land owning class. Namely,

2a) $\theta = \phi_T$

b) $1-\theta = \phi_L$ (proof: $\theta = \theta/OA = (p_o-c_o)/p_o = (p_o-c_o)L_o/p_oL_o = R/Q = \phi_T$)

Since the "landlord class" has acquired 20% of food in their distributive share, they obviously also acquire 20% of the total labor force for their exclusive use.

At any moment in time, suppose we know the total population (i.e. the total labor force P) of the whole economy, using the above result, we can determine the rule according to which this labor force is allocated as the agricultural labor force (L) and the non-agricultural labor force (W):

3) $P = W + L$

To show how we can solve this allocation problem, let us reproduce the ϕ_L curve of diagram 3d in diagram 4d, and let the total population P be marked off on the horizontal axis. In diagram 4c, the 45 degree line AA' is drawn so that the horizontal unit distance OA of diagram 4b is projected on the vertical axis of diagram 4d, i.e. OA'=OA=1. Let the horizontal line AA" be drawn to obtain the point P' in diagram 4d. Suppose the straight line OP' intersects the ϕ_L curve at G, then the non-agricultural population is G'P and the agricultural population is OG'.[15]

The common sense of the above thesis is as follows. When the total population is given, it must be allocated in such a way that the labor distributive share $\emptyset_L$ determined in the income distributive process (i.e. $GG'=\emptyset_L=.8$) must be the same as the fraction of the labor force in the agricultural sector determined in the allocation process (i.e. $AB=1-\theta=.8$) in consistent with the demand and supply of food for the per capita consumption and the labor productivity corresponding to the given allocation pattern (i.e. $c_o=8$, $p_o=10$).[16] Austere as it might seem, the simultaneity of the reasoning indicates the hard logic of a crucial operational aspect of an agrarian dualism in which production, consumption, income distribution, and labor allocation are not isolated phenomena. In order to understand the socio-economic significance of any one of them, one has to appreciate the relatedness of all of them.

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[15]From the similarity of triangles GP'H and PP'O, we have

$$\theta = W/P = HP'/OP = HG/P'P = HG = G'H-GG' = 1-GG' = 1-\emptyset_L = \emptyset_T.$$

The proof is complete by equation 2a) in the text. Thus the dotted horizontal line GJ intersects the line AA' at point J (in diagram 4c) which lies directly below point B in diagram 4b.

[16]In diagram 4d, for the given population OP, if more (or less) labor is allocated to the agricultural sector than OG', then the simultaneous condition cannot be satisfied.

V. Impact of Technological Change

The above analysis decribes the mode of operation of an agrarian dualism at any moment in time. The economic growth of traditional China is the growth of such a system through time as caused by a multitude of growth promotive forces. Paramount among these forces are population growth, increase of cultivable land and technological change in the agricultural sector. In this section we shall concentrate on the analysis of the impact of technological change which offset the productivity depressing effect when land is more intensively cultivated due to population pressure.

In diagram 5d, with time meausred on the vertical axis (pointing downward), the population growth curve shows a 2% growth rate ($r=2\%$) from an initial value of $L_o=100$. Similarly, in diagram 5b, the land growth curve shows a 1% growth rate ($j=1\%$) from an initial value of $T_o=10$. With the aid of the 45 degree line in diagram 5c, the quantity of labor and land through time are projected into diagram 5a as represented by the factor endowment path E_o ($L_o=100$, $T_o=10$), E_1 ($L_1=102$, $T_1=10.1$), E_2 ($L_2=104.04$, $T_2=10.2$)... Since population is growing at a faster rate than land ($r=2\% > j=1\%$), the intensive land cultivation is measured by the increasing population density: $L_o/T_o=10$, $L_1/T_1=10.09$, $L_2/T_2=10.2$...through time. This is shown by the fact that the radial lines OE_o, OE_1, OE_2... become less steep as the factor endowment path bents toward the labor axis. This intensive cultivation occurred in traditional China is a well recognized phenomenon.[17]

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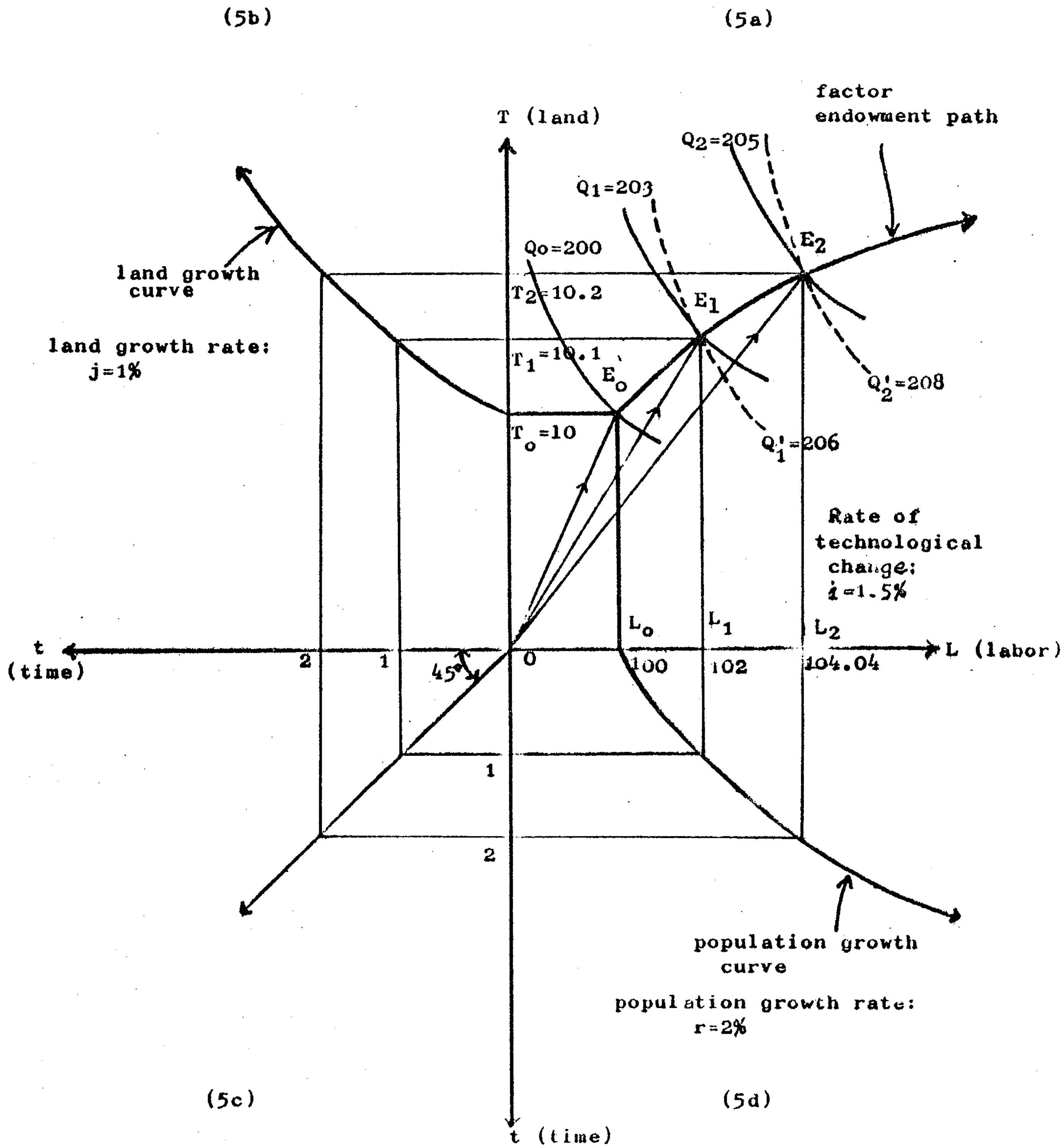
[17] See Ch'üan Han-sheng, Chung-kuo ching-chi-shih lun-ts'ung (Studies on the Chinese economic history, Hong Kong, 1972), pp. 539-541, 560, 628. Also see D. Perkins, p. 216 for population data and p. 240 for cultivated acreage data, both from 1400 on. If these data are used to estimate the cultivation density, the results show that it increased from 2.6 persons per hectare in 1400 to 3.2 in 1750 and to 4.7 in 1913.



(5b)
(5a)
factor
endowment path
T (land)
Q2=205
Q1=203
Qo=200
E2
land growth
curve
T2=10.2
E1
land growth rate:
j=1%
T1=10.1
Eo
Q'2=208
To=10
Q'1=206
Rate of
technological
change:
i=1.5%
Lo
L1
L2
t
(time)
2
1
45°
0
100
102
104.04
L (labor)
1
2
population growth
curve
population growth rate:
r=2%
(5c)
(5d)
t (time)

Diagram 5

The population pressure manifests itself as a socio-economic problem in that the agricultural labor productivity (p) decreases through time. In diagram 5a, the output at E_o, E_1, E_2... are Q_o=200, Q_1=203, Q_2=205... leading to a decreasing trend of the labor productivity $p_o=Q_o/L_o=2$, $p_1=Q_1/L_1=1.99$, $p_2=Q_2/L_2=1.96$.... This decreasing trend can only be offset by various land saving or labor using technological change, such as adoption of new seeds,[18] improvement of cultivation practices,[19] irrigation,[20] etc. In diagram 5a, the changes in technology are shown by the dotted production contours indicating higher outputs Q_1'=206, Q_2'=208... as compared with the output of Q_1, Q_2... without technological change. The rate of technological change (or innovation) is supposed to be i=1.5% (i.e. $Q_1'=1.015\times 203$, $Q_2'=1.015\times 205$).[21]

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[18] The studies of Ping-ti Ho on this topic are well known to students of Chinese economic history, see "Early-Ripening Rice in Chinese History," Economic History Review (December 1956); "The Introduction of American Food Plants into China," American Anthropologist (April 1955).

[19] See D. Perkins, pp. 37-53. For the agricultural improvements during the Sung period, see Sudo Yoshiyuki, Sodai keizai-shi kenkyu (Studies on the economic history of the Sung dynasty, Tokyo, 1962), chs. 1-6.

[20] See D. Perkins, pp. 55-78. For a detailed discussion on irrigation in traditional China, see Ch'ao-ting Chi, Key Economic Areas in Chinese History (second edition, New York, 1963).

[21] Note that in diagram 5a, the production contour lines for Q_1 and Q_1' pass through the same input point E_1. This means that the output after innovation (Q_1'=206) is 1.5% higher than the output before innovation (Q_1=203), inspite of the fact that the same amount of inputs (L_1=102, T_1=10.1) are used. The rate of technological change (i) measures exactly such a rate of increase of output when inputs are being held constant. If, in addition, the technological change is labor using or land saving, the dotted production contour after innovation is steeper than the solid production contour before innovation.

The strength of the triplet of growth promotive forces (i.e. population growth, land growth, and technological change) are measured by the triplet growth rates (r=2%, j=1%, i=1.5%) which together determine the rate of growth of labor productivity (h) through time. We can use the following equation to decribe their relations.(see Appendix A).

4a) $h = i' - \emptyset_T r$ where

b) $i' = i + \emptyset_T j$

The rate of increase of labor productivity (h) is determined by two factors. A high value of i', namely, a high growth rate of cultivable area (j) and/or a high innovation rate (i), leads to a high growth rate of labor productivity (h). Conversely, a high population growth rate (r), i.e. high population pressure, will depress the rate of growth of labor productivity. This depressing effect is proportionally related to $\emptyset_T$, the land share of income or the land elasticity of output. Thus a given population growth rate will depress the productivity growth rate to a greater extent if the land elasticity to output is larger (i.e. if land is more "important and indispensable" as a factor of production). The relation in equation 4a is illustrated by the following numerical examples.

Land share of income		$\emptyset_T=.25$				$\emptyset_T=.3$			
pop. growth rate / land supply & innovation		h							
		r				r			
		.005	.008	.01	.02	.005	.008	.01	.02
i'	.01	.00875	.008	.0075	.005	.0085	.0076	.007	.004
	.015	.01375	.013	.0125	.01	.0135	.0126	.012	.009
	.02	.01875	.018	.0175	.015	.0185	.0176	.017	.014
	.025	.02375	.023	.0225	.02	.0235	.0226	.022	.019

With the alternatives of $\emptyset_T$, r, and i' indicated at the margin, the values of h, calculated from equation 4a are shown in cells. With a given value of i', h is smaller when r is larger. When $\emptyset_T$ increases from .25 to .3, the values of h decrease if the values of r and i' remain the same.

Equation 4a is shown by the straight line AB (i.e. <u>the productivity response curve</u>) in diagram 6a with h and r measured on the vertical and horizontal axes respectively. We see that when i' is fixed (i.e. the rate of increase of land and the innovation rate are given), the higher the population growth rate, the lower the rate of increase in agricultural labor productivity. There is a critical value of population growth rate, $r_c=i'/\emptyset_T$, marking off two phases of population pressure. In the low population pressure case ($r<r_c$), the agricultural labor productivity increases through time (h is positive). Conversely, in the high population pressure case ($r>r_c$), the agricultural labor productivity decreases (h is negative). Precisely at point E ($r=r_c$), the population pressure is cancelled out by the rate of increase in land supply and the rate of innovation,

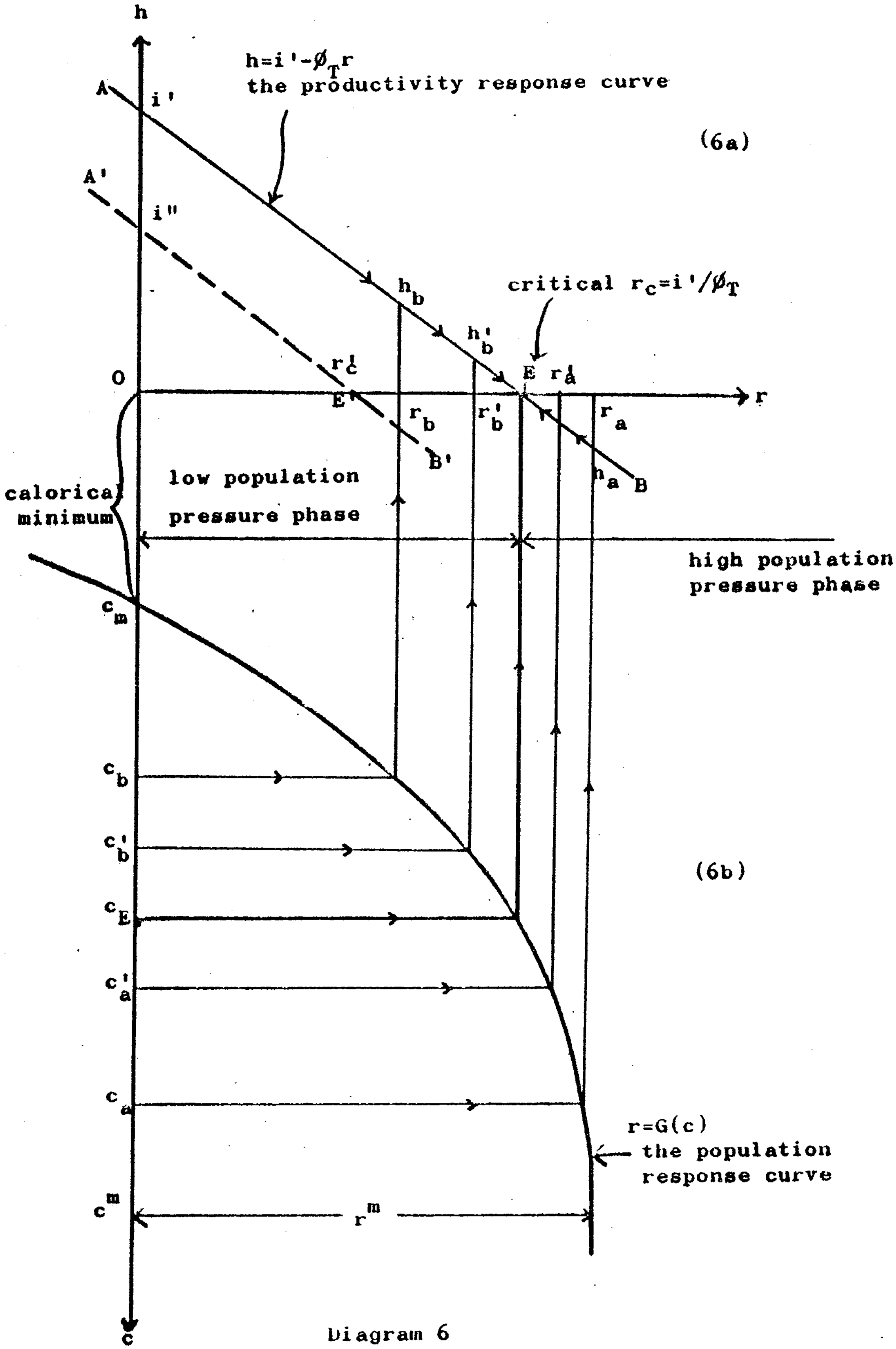
h
h=i'-Ø_T r
the productivity response curve
A
i'
(6a)
A'
i"
h_b
critical r_c=i'/Ø_T
h'_b
O
r'_c
E
r'_a
r
E'
r_b
r'_b
r_a
B'
h_a
B
calorical
minimum
low population
pressure phase
high population
pressure phase
c_m
c_b
c'_b
(6b)
c_E
c'_a
c_a
r=G(c)
the population
response curve
c^m
r^m
c

Diagram 6

leaving a stationary or constant labor productivity through time.

From the long run historical perspective, the necessary condition for the population to increase over several centuries in an agrarian society is that the supply of food on a per capita basis must keep pace with population growth. Such a state of growth (i.e. an expanding population with a constant agricultural labor productivity indicated by point E in diagram 6a)will be referred as a stationary state. In the stationary state, there is a delicate balance of the three growth promotive forces.

Note that in the stationary state, the population growth rate takes on the critical value r_c:

5) $r_c = i'/\phi_T = (i+\phi_T j)/\phi_T = (j+i)/\phi_T$

which is partly traced to the increase of land acreage (j) and partly to technological phenomenon (i and ϕ_T). Thus with the exhaustion of land frontier (j=0), the population growth rate (r_c) of traditional China is essentially a technological phenomenon. In China, population grew by a much slower rate during the first millennium between the Han and T'ang dynasties than in the later period. In this earlier period, the critical population growth rate is indicated by $r'_c < r_c$ at E'. The dotted line A'B' shows that the slower population growth rate in the earlier period was brought about by a lower rate of $i'' < i'$. This indicates a lower rate of agricultural technological change for that period.

VI. Consumption Standard, Population Growth, and Stationary State

In the long run the stationary state at point E will be reached automatically because the economy cannot stay away from this point for a very long duration in either direction. If the population growth rate is in the high population pressure phase, the agricultural productivity will decrease consistently through time. The supply of food on the per capita basis will become inadequate and this will, in turn, depress the population growth rate. Conversely, when the population growth rate is in the low population pressure phase, the agricultural productivity and per capita supply of food will increase and this will lead to an accelerated rate of population expansion. Thus when the actual population growth rate deviates from the critical value r_c, a "force" is automatically induced to restore it to the critical point.

The consciousness of the operation of such a force in an agrarian context was the core of Malthus's population theory.[22] According to this doctrine, the population growth rate is a variable endogenous to the economic system, namely, it is affected by the consumption standard. The British economists in the classical tradition accepted

[22]The Malthusian theory was developed in the early nineteenth century when Britain went through the initial stage of transformation from the agrarian economic structure of the pre-industrial era to what Prof. Kuznets calls the epoch of modern growth. It was at that time that population growth began to accelerate to the modern level. See Simon Kuznets, "Toward a Theory of Economic Growth," in Economic Growth and Structure (New York: W. W. Norton & Company, 1965), pp. 8-16.

this idea and formulated the so called "iron law of wages" (a somewhat misleading label.) This "law" can be specified as

6) $r = G(c)$

specifying that the change of population growth rate (r) depends upon the consumption standard (c). Equation 6 is represented by the <u>population response curve</u> in diagram 6b. The value c_m indicated on the vertical axis (pointing downward) is the calorical minimum consumption standard. When the actual consumption standard is less than the calorical minimum, the population will decrease ($r < 0$). On the other extreme, r^m is the maximum biological reproduction rate. When this level (r^m) is reached, at the consumption standard c^m, the population growth rate is no longer sensitive to the consumption standard. Between c_m and c^m, a higher per capita consumption standard leads to a higher population growth rate.

The productivity response curve and the population response curve interact against each other in a way that proceeds as follows. Suppose the initial consumption standard c_b leads to a population growth rate r_b (through the population response) that in turn leads to a positive growth rate of agricultural productivity $h_b > 0$ (through the productivity response). The consumption standard in the next period will increase, e.g. to the level c_b'. This will lead, in turn, through the population response and the productivity response to a growth rate of agricultural productivity h_b'. Thus starting from an initial point h_b in the low population pressure phase, the movement is always downward along the productivity response curve toward the critical point at E.

Conversely, if the consumption standard is at a higher value at c_a that leads to a negative growth rate of agricultural productivity $h_a < 0$ in the high population pressure region, the productivity and the consumption standard in the next period will decrease, e.g. to the level of c_a'. Thus whenever the population growth rate is in the high population pressure region, a force is automatically induced for an upward movement along the productivity response curve toward point E.

The population response and the productivity response represent a serve-mechanism through which the economy will be brought to the stationary state at point E. At this point the consumption standard will be sustained at the c_E level leading to the technologically determined population growth rate r_c. In the stationary state, the economy will exhibit a slow and steady population expansion while maintaining a constant level of per capita consumption standard and agricultural productivity. The stationary state is a stable one in that temporary deviation from this state will automatically provoke a pressure to cause it to move back to the stationary growth path.

From the Sung to Ch'ing dynasties, traditional China was in such a stationary growth stage. The relatively advanced state of agricultural technological innovation had overcome the bottleneck caused by the shortage of land space and "allowed" the population to expand steadily for more than seven hundard years. The expansion was, of course, not a smooth one but the fluctuations of population growth were about a steadily increasing trend which wa. perfectly consistent with the theory discussed above.

VII. Steady Growth with Structural Stability

The growth of traditional China results not only in constant levels of per capita consumption standard and agricultural productivity but also in a structural stability measured by the percentage of labor allocation in two production sectors. (θ and $1-\theta$). A slight modification of the theory in the last section can be used o explain this structural stability of agrarian dualsim.[23]

The fact that the theory mentioned in the last section need to be modified slightly is that in diagram 6, what is measured on the horizontal axis is the rate of growth of agricultural population instead of total population. However, we have shown in equation 2 in section IV that the share of population allocated to the non-agricultural sector (θ) is determined by the distribution of agricultural income, namely, $\theta = \phi_T$. When the distributive share ϕ_T

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[23]The theory outlined in the last section was first proposed by Prof. Jorgenson. See D.W. Jorgenson, "The Development of a Dual Economy," Economic Journal (June 1961). That theory was based on two limiting assumptions: (1) ϕ_T is constant, (2) the economy has only one production sector, namely, the agricultural production sector. In other words, Prof. Jorgenson had neglected the dualistic structure of an agrarianism. Thus to have a realistic theory for traditional China, the theory of Prof. Jorgenson needs to be modified in these two aspects. In appendix A, we shall prove that a stationary state will be reached in a dualistic economy by retaining the Jorgenson assumption of constancy of ϕ_T. In appendix B, we shall prove a general theory where this assumption is dropped as we allow ϕ_T to vary.

is constant through time,[24] the labor allocation in the two sectors remain constant. Under this assumption, the rate of growth of total population is exactly the same as the rate of growth of agricultural population. The economic interpretation of this stationary state with structural stability is that population response and the productivity response interact to bring about a steadily growth rate of labor productivity and consumption standard, while the forces of the income distribution is mainly responsible for the structural stability of dualism measured by the inter-sectorial labor allocation.

Summary

In this paper we designate the period 960-1800 in Chinese history as "traditional" and formulate a theory of economic development for this period. In this theory we envision the growth of an agrarian dualism as a consequence of the operation of an economic system.in which essential economic functions (production, consumption, exchange, resources allocation, and income distribution) are regulated largely by a market-oriented mechanism. Under the impact of sustained technological change and population response to consumption standard, the operation of such an economic system leads envitably to a

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[24] From diagram 6, we see that the productivity response curve involved the parameter $\emptyset_T$, thus in our analysis in the last section, when we auume that the population response curve remains unchanged, we have slready implicitly assume that $\emptyset_T$ is constant through time.

stationary state in the long run. In such a state, we logically find slow growth with structural stability. Namely, with a steady expansion of population, the percentages of labor force allocated to the two production sectors, the agricultural labor productivity, and the consumption standard remain relatively constant through time. The theory is probably not a far-fetched one in view of the fact that the theoretical deductions seem to befit the Chinese reality.

Appendix A

In this appendix we want to prove that the stationary state will always be reached in agrarian dualism under the assumption that ϕ_T is constant. Let the production function be specified in the Cobb-Douglas form:

A1a) $Q = A\,T^{\alpha}L^{1-\alpha}$

b) $\phi_T = (\partial Q/\partial T)\ (T/Q) = \alpha$

implying the constancy of the rent share as shown in A1b). The time paths of total population P, land T, and technological factor A are given by

A2a) $P = P_o\ e^{rt}$

b) $T = T_o\ e^{jt}$

c) $A = A_o\ e^{it}$

The total population is allocated partly as agricultural labor force (L) and partly as non-agricultural labor force (W):

A3a) $P = W + L$

b) $\theta = W/P, \quad 1-\theta = L/P$

Let c stand for the consumption standard as well as the real wage. The marginal productivity of labor implied by A1a) is equated to c to obtain

A4a) $c = A(1-\alpha)T^{\alpha}L^{-\alpha}$

b) $p = Q/L = AT^{\alpha}L^{-\alpha}$

where p in A4b) is the average productivity of labor in the agricultural sector. Equating the demand and supply of food leads to

A5a) $cP = Lp$ or

b) $1-\theta = c/p$ ...... by A3b), or

c) $1-\theta = 1-\alpha$ ...... by A4), or

d) $L/P = 1-\alpha$ ...... by A3b).

The fact that θ is constant through time is due to the distribution theory and is assured by the constancy of $\phi_T=\alpha$ in A1b), a property of the Cobb-Douglas production function.

Now, using η_x to denote the rate of growth of variable x, A5d) implies

A6) $\eta_L = \eta_p = r$ ...... by A2a), and hence

from A1a, we have

A7a) $\eta_Q = \eta_A + \alpha\,\eta_T + (1-\alpha)\,\eta_L$ or

b) $\eta_Q = i + \alpha j + (1-\alpha)\,\eta_L$ ...... by A2b,c)

c) $\eta_p = \eta_{Q/L} = i + \alpha j + (1-\alpha)\,\eta_L - r$

d) $\eta_p = i' - \alpha r$ ...... by A6) where

e) $i' = i + \alpha j$.

Equation A7d) is the productivity response curve of diagram 6. When the population response curve,

A8) $r = G(c)$ ...... by equation 6) in the text

is postulated, the interaction between the population response and the productivity response leads to the stationary growth as shown in diagram 6.

Appendix B

by

Chou Chien-fu

Our analysis in appensix A based on the Cobb-Douglas production function is a special case. In this appendix, we shall construct a general theory by assuming that the technological change is the land augmentation type. Thus we postulate

B1a) $Q = F(L, T^*)$ satifying constant return to scale (CTRS)

b) $T = T_o e^{\beta t}$

c) $\delta = \delta_o e^{\alpha t}$

d) $T^* = T\delta = T_o \delta_o e^{(\alpha+\beta)t} = T_o \delta_o e^{\alpha' t}$ where $\alpha' = \alpha + \beta$

Equation B1a) is a production function where the inputs are labor (L) in a natural unit and land in an efficient unit (T^*). Equation B1d) shows that T^* is the product of T (land in natural units) and δ (the efficiency of T in "producing" T^*). Equation B1b) states that the supply of land is increasing at a rate β; equation B1c) states that δ is increasing at a rate α, the land augmentation rate. The idea that innovation in traditional China is of the land augmentation type is more realistic than the assumption in appendix A.

For the analytical purpose , we want to stress output, agricultural labor force, and total population per unit of land in efficient unit, namely,

B2a) $q = Q/T^*$.... the output per unit of efficient land

b) $n = L/T^*$.... the cultivation density

c) $m = P/T^*$.... the total population density

Under the assumption of CTRS, the production function can be rewritten as

B3) $q = F(L/T^*, 1) = f(n)$ .... by B1a) and B2a)

Equation B3) shows that the productivity of efficient land is a function of cultivation density for the efficient land. This is shown by the increasing curve in diagram 7a. From B3) the production function can be written as

B4a) $Q = T^* f(n)$ implying

b) $\frac{\partial Q}{\partial L} = T^* f'(n) \frac{\partial n}{\partial L} = T^* f'(n) \frac{\partial (L/T^*)}{\partial L} = f'(n)$

which shows that the slope of the curve in diagram 7a is the marginal productivity of labor. This is shown by the negatively sloped curve in diagram 7b.

If c is the consumption standard, or real wage, in the agricultural sector, the competitive principle of income distribution implies

B5) $c = \frac{\partial Q}{\partial L} = F_L = f'(n)$

Thus the curve in diagram 7b also represents real wage and per capita consumption standard. The total demand for food at this consumption standard is cP which is equated to the total supply of food:

B6a) $Q = cP$ or dividing by T^*

b) $q = cm$ .... by B2a, c) or

c) $m = q/f'(n) = f(n)/f'(n)$ .... by B5)

Thus the total population density $m = P/T^*$ is a function of the cultivation density n, and is equal in magnitude to the ratio of average productivity of efficient land q to marginal productivity of labor f'.

Equation B6c) is represented by the curve in diagram 7c and is derived as the ratio of the curves in diagrams 7a and 7b,[1] Since q is an increasing function and F_L a decreasing function of n, we see the value of m increases when the value of n increases. This means that the cultivation density increases as the population density increases. Thus the curve is positively sloped and lies below the 45 degree line in diagram 7c. The percentage of labor force allocated in the agricultural sector is

B7) $1-\theta = L/P = (L/T^*)/(P/T^*) = n/m$

and is represented by the slope of the dotted lines OE_o, OE_1, OE_2 in diagram 7c.

The population response curve is

B8a) $r = G(c)$ where

b) $\eta_p = r$

and is represented by the curve in diagram 7d. From equation B2c), we have

B9a) $\eta_m = \eta_p - \eta_{T^*}$ or

b) $\eta_m = r - \alpha'$..... by B8b) and B1d)

The value of α' is marked off on the horizontal axis of diagram 7d. The long run equilibrium position in a stationary state is indicated

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[1]In diagram 7a, at E, $f(n)/f'(n)$ is represented by the ratio EB/ (EB/BD) = DB = m. Thus DB is the total population per unit of efficient land and OD is the non-agricultural labor per unit of efficient land, while OB is the agricultural labor per unit of efficient land.

by the rectangle $r_E c_E n_E m_E$ linking diagrams 7dbc . To see why this is so, the low population pressure phase and the high population pressure phase are first marked off in diagram 7d. Using the equilibrium rectangle, the same two regions are marked off in diagram 7c. If we start from a value m_1 in the low population pressure region in diagram 7c we will determine a value c_1 (with the aid of the dotted line along m_1, E_2, g_1, c_1) in the low population pressure region in diagram 7d. For this c_1, r is less than α' and hence equation B9b) implies that m will decrease to m_2 in the next period, and this leads to a higher value of c_2. Thus whenever one starts from any point in the low population pressure phase, the movement is upward along the population response curve in diagram 7d. Conversely, if we start from a low value of m_3 in the high population pressure region, it will lead to a high value of c_3 causing m to increase. Thus the equilibrium position of stationary state will be reached and is a stable one.

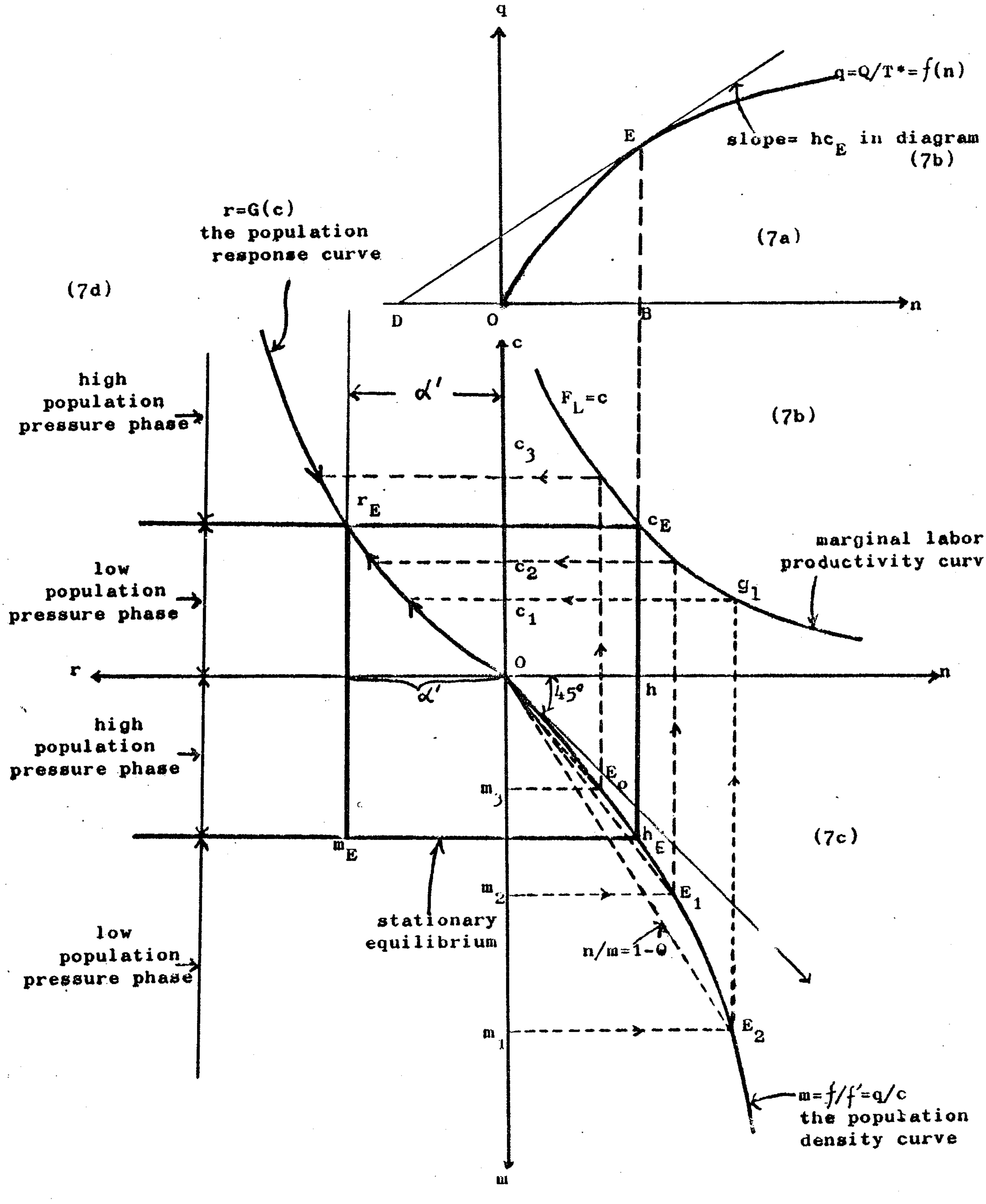
q
q=Q/T*=f(n)
E
slope= hc_E in diagram (7b)
(7a)
r=G(c)
the population
response curve
(7d)
D
O
B
n
c
α'
F_L=c
(7b)
high
population
pressure phase
c_3
r_E
c_E
marginal labor
productivity curve
low
population
pressure phase
c_2
g_1
c_1
r
O
n
α'
45°
h
high
population
pressure phase
E_o
m_3
h_E
(7c)
m_E
m_2
E_1
stationary
equilibrium
low
population
pressure phase
n/m=1-θ
m_1
E_2
m=f/f'=q/c
the population
density curve
m

Diagram 7