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Agrarianism, Dualism and Economic Development

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AGRARIANISM, DUALISM AND ECONOMIC DEVELOPMENT

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Agrarianism, Dualism and Economic Development*

I Introduction

From the very beginnings of our science, a major target of economists has been the achievement of a better understanding of the economy's growth performance. It is therefore only natural that the recent resurgence of interest in development, after the long neo-classical interregnum, has been marked by some effort to glean as much of what is helpful as possible from the analysis of an earlier day. This has been especially true since both the old writers and the new increasingly seem to be in agreement that the real world essence of a developing system cannot be meaningfully "captured" by conventional aggregative analysis and that the search for significant intersectoral relations and intersectoral asymmetries may well provide the key to the enhanced understanding we are seeking.

Nevertheless, when endeavoring to extract the maximum transferable knowledge from the writings of the physiocrats and the classicists, for example, we must keep ourselves painfully aware of the fact that each such formulation is inevitably the product of the particular historical conditions and circumstances into which it was born. In other words, the transferability of any particular set of concepts is circumscribed by differences in the overwhelming social issues faced, in the tools available and, consequently, in the vision of the future presented. It is, moreover, circumscribed in terms of its usefulness or lack of usefulness for examining the spectrum of conditions and problems facing us in the contemporary less developed world.

It is in this general context that we think it useful to distinguish among three major types of economic systems, namely agrarianism, dualism

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and economic maturity. While the condition of economic maturity has been exhaustively treated by post-Keynesian growth theorists/1 and is not our major concern here, we believe the distinction between agrarian and dualistic economies to be of considerable importance in terms of a fuller understanding of the relevance of earlier writers to our present concern with growth in the less developed economy.

The central feature of agrarianism is the overhwelming preponderance of traditional agricultural pursuits. While other economic activities may be in evidence, they are of distinctly secondary importance in both a quantitative and qualitative sense. Non-agricultural pursuits, for example, include personal services, handicrafts, and other peripheral activities characterized by a modest use of capital. The agrarian economy is essentially stagnant, with nature and population pressure vying for supremacy over long periods of recorded history. Moreover, the prognosis for the future is likely to be "more of the same."

The central feature of dualism, on the other hand, is the coexistence, with a large agricultural sector, of an active and dynamic industrial sector. Not only does such industry use capital but both sectors undergo continuous technological change as they "interact" in the course of the growth process. The dualistic economy strives to adjust the historical preponderance of agriculture by gradually shifting its center of gravity towards industry via a process of factor reallocation. Its inherent condition is thus one of change and its vision of the future is the ultimate graduation into economic maturity.

It is our view that both the 18th century physiocrats and the classicists

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/1 e.g., Solow, R.M. "A Contribution to the Theory of Economic Growth," Quarterly Journal of Economics, February, 1956; Swan, T.W., "Economic Growth and Capital Accumulation," Economic Review, November 1956.

who followed were really addressing themselves to the problem of growth in an agrarian economy. The physiocrats' major contribution undoubtedly lay in the recognition - for the first time - that the growth of the economy must be viewed basically as an interrelated system of inter-sectoral flows. In their world, only the preponderant agricultural sector is capable of producing a surplus, as agricultural workers exploit the fundamental bounty of nature. Non-agriculture is peopled by the so-called "sterile classes" which cannot produce a surplus, but can only transform value created in agriculture. The owners of the land, the landlord, the nobility or the Church, "own" whatever "slack" there may be in the system, whether it be in the form of the emerging agricultural surplus or in the form of redundant manpower available for personal services, feudal wars, etc. These slacks are largely consumed by the propertied classes, either directly, in the form of food, or indirectly in the form of the output of the sterile classes, i.e. services and handicraft products, which are delivered in exchange for the wage goods provided. It is at least implicitly assumed that no marked changes in agricultural production techniques can occur and that the artisan and service sectors remain completely stagnant. Thus, to the physiocrats, growth was tantamount to the perpetuation of the cultural life of the ruling classes made possible by the assumed regularity of the circular flow mechanism described in their "tableau economique".

The classical school of economists was heavily influenced by its physiocratic predecessors and also turned its attention primarily to the analysis of the agrarian economy. As Schumpeter points out, before 1790 "all countries -- even England -- were predominantly agrarian".[/1] Thus, while the classicists certainly referred to the growth of

/1 Joseph A. Schumpeter, History of Economic Analysis, (Oxford Press, New York), 1954, p.565.

industry, their analytical attention was concentrated on distribution and on the long-run growth prospects of an undifferentiated monolithic economy dominated by agriculture. The tri-partite division of income, perhaps their major analytical contribution, is adduced in a setting in which "the typical capitalist...was the 'farmer' in the British sense, who rented land [from the absentee landlord] and hired laborers, received the product at the end of the year and turned over to the two other claimants their respective shares."/1 There is occasional reference to non-agricultural activities, now viewed as capable of producing a surplus along with agriculture/2 but as Schumpeter put it, "the manufacturing industry that economists beheld and reasoned about was all along the manufacturing industry of the artisan."/3

In the agrarian system there is yet no clearly discernible concept of industrial capital in the form of reproducible plant and equipment, but rather only the extension of production advances in the form of wage goods to industrial workers for the support of further production./4 Technological change is once again either ignored or considered to be of only secondary interest. Quite aside from the very considerable advance made by the classicists in terms of presenting a fully deterministic system capable of dynamic analysis they saw their problem in the physiocratic vein and their prediction of the ultimate stationary state was a prediction of continued

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/1 Frank H. Knight, "Capital and Interest," reprinted in Readings in the Theory of Income Distribution, Blakiston, 1946, p. 385.

/2 Even though Smith still exempted services as non-productive and sterile.

/3 P. 150. "No author," Schumpeter went on to say "not even A. Smith, had any very clear ideas of what the processes really meant that led to ...the Industrial Revolution." (op. cit.)

/4 Knight, op. cit. p. 386.

agrarian stagnation. "Both groups [the classicists and physiocrats] viewed production as the creation of a 'surplus' of tangible wealth...available for such 'unproductive' uses as the support of government and the cultural life. [And both] shared the popular belief that agriculture is the only activity which is really productive."/1

In sharp contrast to this essentially agrarian view of both the physiocrats and the classicists, modern writers, returning to a concern with growth in the underdeveloped world after the Second World War, have made dualism the central focus of their analysis./2 This emphasis is primarily borne of the fact that while analyzing poor and largely agricultural economies they have the vision of the wealthy and industrialized mature economy before them. Regardless of analytical differences among them, implicitly or explicitly they are interested in the process of transformation from an overwhelmingly agricultural dualistic economy to a mature industrial economy.

This dualistic outlook on growth is characterized by the incorporation of a set of new analytical facets of growth which are largely absent in the earlier agrarian way of thinking. While economic events involving the non-agricultural sector represent a diversion from the main stream of

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/1 Ibid., p.385.

/2 e.g., R. Nurkse, Problems of Capital Formation in Underdeveloped Countries; A. Lewis, "Development with Unlimited Supplies of Labour", Manchester School, May 1954; Fei, J.C.H. and Ranis, G. Development of the Labor Surplus Economy:Theory and Policy; Higgins, B. , Economic Development; Rosenstein-Rodan, "Problems of Industrialization of Eastern and South-Eastern Europe" Economic Journal, June - September, 1943.

agrarian thought, they occupy center stage in the dualistic framework of analysis. The postulation of two major production sectors (agriculture and industry) and the formal analysis of the asymmetrical structural relations between them, in fact, constitutes the heart of modern growth theory. The non-agricultural parasitic sector of agrarianism becomes a bona fide industrial sector characterized by the use and the constant augmentation of a stock of real capital. Another major change in emphasis consists of the introduction of technological change in both the agricultural and industrial sectors and the major role assigned to it in the analysis of the growth process. The classical problem of population pressures on the land is now dealt with in conjunction with the problem of labor reallocation from the agricultural to the industrial sector. Economic surpluses can now be generated in the industrial sector (i.e. profits) as well as in the agricultural sector, while the intersectoral channelization of this savings fund constitutes an essential ingredient of the dualistic framework of thinking. Finally, while the agrarian economy is essentially isolated from the rest of the world and impervious to stimuli from abroad, the dualistic economy enjoys the advantage of an international division of labor and the borrowing of technology from abroad.

Thus while agrarianism is primarily concerned with the maintenance and survival of a monolithic production structure, dualism sees its prime task as the analysis of the demise of the agrarian system through a radical change in the production structure. The agrarian view is one of resignation and fatalistic acceptance of the restraining hand of "natural law" while dualistic writers are gripped by a vision of the attainability of a better future through a fuller understanding of the growth process and the application of relevant growth promotion policies. In summary, both from the viewpoint of the technical equipment brought to bear, their assessment of the most pressing social problem of the day and their vision of the future prospects of the society as a whole, agrarian and dualistic thinkers diverge in a quite fundamental sense.

Each of the three systems, agrarianism, dualism and economic maturity is thus characterized by its own internal rule of growth, the analysis of which - except for the mature economy - is the major purpose of this paper. However, our interest goes beyond the mere taxonomy of growth behavior internal to each of these regimes. In fact, we believe that a fuller understanding of the growth phenomenon in its totality will be achieved by viewing these separate regimes as occurring in a natural historical sequence. Our efforts must thus be ultimately directed not only to the rules of growth internal to each regime but also, and at least as importantly, to the phenomena of transition from one phase to another. It is, in fact, in this latter context that research into growth-promoting policies is likely to be most relevant and fruitful.

In our particular case, we are of the view that an important type of growth proceeds via the natural sequence from agrarianism to dualism to maturity. For example, the agrarian pattern should by no means be viewed simply as a historical curiosity; in fact, it may be contended that a considerable portion of the present day underdeveloped world, particularly in Africa, finds itself in an essentially agrarian condition, with non-agriculture either totally absent or restricted to artisan handicraft and service activities. A really relevant theory of development must thus be able to analyze not only the workings of the dualistic economy and the conditions for a successful transition from dualism to maturity/1 -- but also the workings of the agrarian

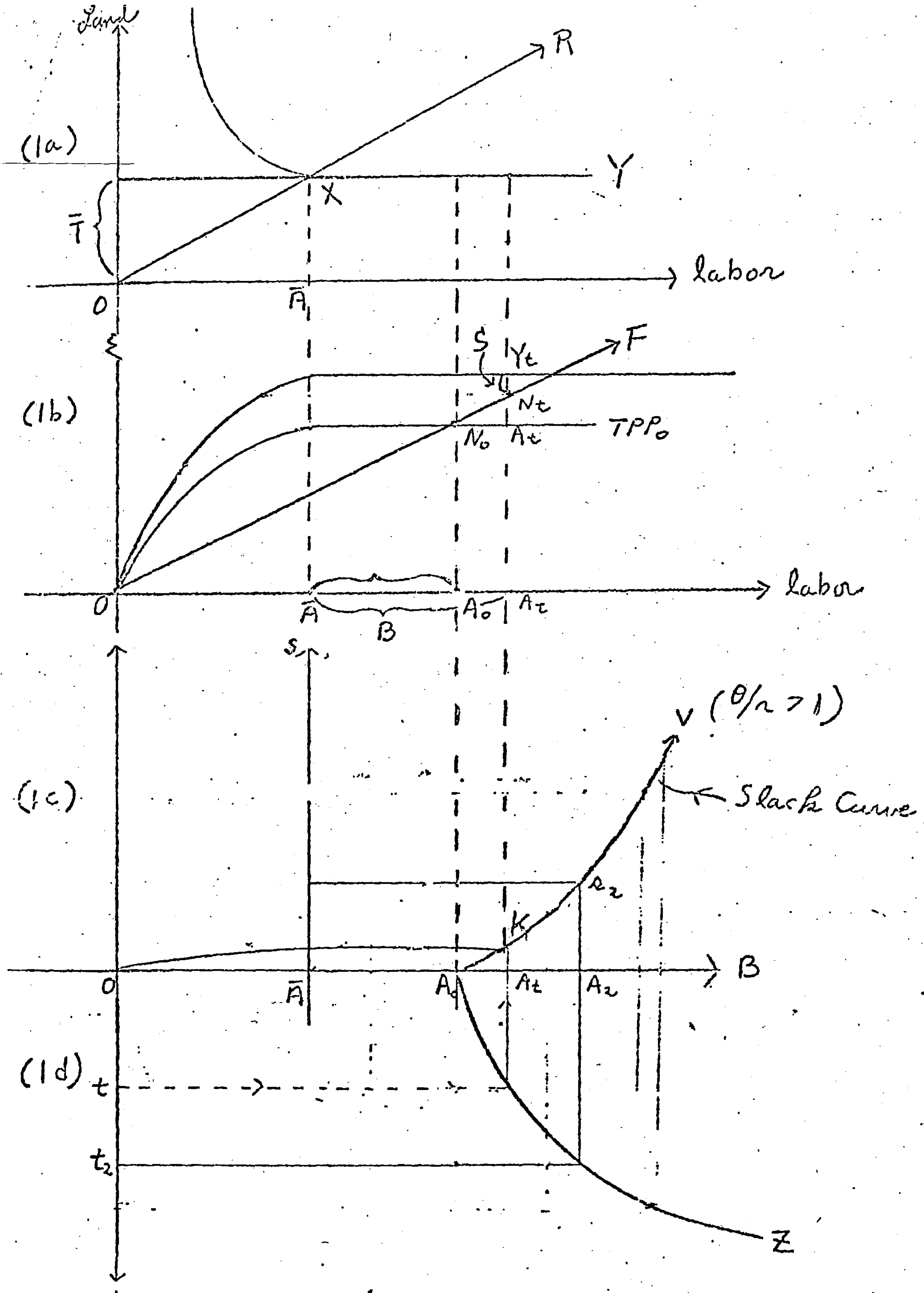
/1 We shall, however, not be concerned with this transition in the present paper. For a treatment of growth under dualism and the transition to maturity see Fei and Ranis, Development of the Labor Surplus Economy, R.D.Irwin, 1964.

economy and the transition from agrarian stagnation to rigorous growth under dualism. It is hoped that this paper will contribute to this undertaking. Section II will be devoted to an explanation of the workings of the agrarian economy and the rest of the paper to an analysis of the dualistic economy. In section III we present a preliminary bird's eye view of the dualistic economy. In section IV we concentrate on the industrial sector of the dualistic economy and in section V on the interaction between the agricultural and industrial sectors. Some conclusions arising out of our analysis are presented in Section VI.

II Development of the Agrarian Economy

The predominant form of economic activity in the agrarian economy is the production of agricultural goods by the application of labor L to land T. In diagram 1a, let labor (land) be measured on the horizontal (vertical) axis, and let the curve, indexed by Y be a typical production contour for agricultural goods. Following the classical tradition, let us assume that land is fixed (i.e. at $\bar{T}$). For this amount of land, let the total productivity of labor be represented by the curve TPP_o in diagram 1b. As is indicated in this diagram, at some labor input point (i.e. at $\bar{A}$) the TPP of labor levels off and becomes constant (i.e. the MPP_L approaches zero). Thus $O\bar{A}$ units of workers represent the non-redundant agricultural labor force. Any workers in excess of this amount do not make a positive contribution to output and thus represent the redundant labor force. /1

/1 The assumption of a zero marginal product of labor is made to facilitate our analysis of what will be called the "slack" phenonenon in the agrarian economy. There are those (e.g. Schultz, The Transformation of Traditional Agriculture, Yale University Press, 1964) who object to the notion of a zero marginal product on regional peak demand and other grounds; we do not insist on an MPP_L of precisely zero but we have little understanding for those who deny that there is a considerable redundary of full-time equivalent agricultural workers in many parts of the contemporary underdeveloped world as well as in the agrar..n past of other regions. If a man is needed only for the 2 month's harvest period, he can be considered 5/6 redundant.



Land
R
(1a)
Y
X
$\bar{T}$
labor
0
$\bar{A}$
S
Y_t
F
(1b)
N_t
TPP_o
N_o
A_t
labor
0
$\bar{A}$
A_o
A_t
B
s
V ($\theta/r > 1$)
(1c)
Slack Curve
e_2
K
0
$\bar{A}$
A_o
A_t
A_2
B
(1d)
t
t_2
Z
t

diagram 1

As long periods of time elapse, and crop practices improve somewhat from one generation to the next, i.e. technological change occurs, the TPP_L curve may shift upward to the position TPP_t (diagram 1b) at time t (from the initial position).[/1] This summarizes the basic production conditions encountered in the agrarian economy.

In order to analyze the problem of population pressure endemic to an agrarian economy, let time be measured on the vertical axis (pointing downward) and population (or labor force) be measured on the horizontal axis of diagram 1d (vertically lined up with diagram 1a). Suppose the economy begins with an initial population of OA_o. The magnitude of this population through time can then be represented by the curve A_oE in diagram (1d). Notice that the initial total output is A_oN_o units (diagram 1b). This determines an initial level of per capita consumption as indicated by the slope of the radial line OF. Notice also that at time t, with population now at OA_t and with total output A_tY_t (diagram 1b), an agricultural surplus of S ($=N_tY_t$) units appears if the initial consumption standard continues to obtain. We shall refer to S as the AS (agricultural surplus) as it is a genuine "surplus" of agricultural goods, after the consumption requirements of the agricultural population have been satisfied.

As we have indicated in the introduction, a central and key facet of economic life in the agrarian economy is the emergence and utilization of "slacks" in the dominant agricultural production sector. Such slacks can be seen to be of two kinds: agricultural goods not needed for the maintenance of traditional consumption levels and manpower not needed for agricultural production. Referring to diagram 1b, at time t, the surplus of agricultural goods is

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/1 Notice that in diagram 1a, the ridge line OR passes through point X vertically lined up with point A. The technological change depicted is assumed to be of the neutral variety (i.e. the output index in diagram 1a is simply "blown up" and the TPP_L curve in diagram 1b shifts up proportionally).

represented by S(i.e. the agricultural surplus) while the surplus of agricultural labor is represented by the redundant labor force, B, of $\bar{A}A_t$ units. The magnitudes of these two types of slacks can be indicated in diagram 1c. In this diagram, the vertical axis is now shifted to $\bar{A}s$ (origin at $\bar{A}$) with the redundant labor force measured on the horizontal axis and the agricultural surplus measured on the vertical axis. The magnitudes of the two types of slacks, through time, are indicated by the curve A_0V and shall be referred to as the <u>slack-curve</u>. For example at time t_2 (diagram 1d), when the total population has grown to OA_2 the redundant labor force is $\bar{A}A_2$ while the agricultural surplus is S_2A_2.

The above-described two types of slacks in the agrarian system are obviously of key analytical interest. This is due to the fact that they can both be used in any way the economy sees fit (or even wasted) without interrupting the workings of the production system in the dominant agricultural sector in any significant way. After all, the agricultural surplus S is an excess over consumption requirements and the redundant labor force B is an excess over the labor force which makes a positive contribution to agricultural production. It is this emergence and utilization of these slacks over long periods of time which determines to a large extent the ultimate fate of the agrarian system.

<u>The Emergence of Slack</u>

As far as the "emergence" of such slacks is concerned, we have depicted the case (in diagram 1c) in which both B and S increase through time. To investigate the conditions leading to this result, let us make the simplifying assumption that the production function in the agricultural sector is of the Cobb-Douglas type, i.e. $Y = e^{\theta t} T^{\alpha} A^{1-\alpha}$. With T constant, we can define the unit of measurement of output (Y), and obtain a production function of the

1.1) $Y = \begin{cases} e^{\Theta t}\Lambda^{1-\alpha} & \text{for } \Lambda > \bar{\Lambda} \\ e^{\Theta t}U & \text{for } \Lambda < \bar{\Lambda} \end{cases}$

where θ is the rate of technological change, $\bar{\Lambda}$ is the non-redundant labor force and U is the initial total agricultural output, (i.e. $U = \Lambda_o N_o$ in diagram 1b). We assume here that the initial population Λ_o is greater than the non-redundant labor force ($0\bar{\Lambda}$), i.e. there are some disguised unemployed or redundant workers in existence initially. Moreover, assuming the population to be growing at a constant rate r, we have

1.2) $\Lambda = \Lambda_o e^{rt}$

The initial per capita consumption standard C* is then defined by

1.3) $C^* = U/\Lambda_o$

The magnitude of the redundant labor force B is given by

1.4) $B = \Lambda - \bar{\Lambda}$

and the agricultural surplus is

1.5) $S = Y - \Lambda C^* = e^{\Theta t}U - \Lambda_o e^{rt} U/\Lambda_o = U(e^{\Theta t} - e^{rt})$

Using the population growth equation ($\Lambda/\Lambda o = e^{rt}$) to eliminate "t" from the above expression, we have

1.6) $S = U[(\Lambda/\Lambda_o)^{\Theta/r} - \Lambda/\Lambda_o]$

expressing a functional relation between Λ (size of population) and S (Size of agricultural surplus). This expression can be simplified when we define

1.7) a) $\Lambda_o = 1$ (i.e. the initial population Λ_o is defined to be one unit.) /1

b) $s = S/U$ (i.e. the unit of measurement of the surplus S is conveniently

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/1 Notice that under this convention, the magnitude $\bar{\Lambda}$ is the fraction of the initial population which is non-redundant.

defined in terms of the constant U)

Under the above simplifications, 1.6 becomes

1.8) $s = \Lambda^{\theta/r} - \Lambda$

Notice that this curve passes through the point Λ_o (now assumed to be "1") on the horizontal axis since s = o when $\Lambda = 1$ (diagram 1c). Finally we can derive the slack curve itself with the aid of relation (1.4) i.e.

1.9) $s = (\bar{\Lambda}+B)^{\theta/r} - (\bar{\Lambda} + B)$

Thus we see that the slack curve of diagram 1c is derived under the assumption that both technological change and population growth proceed at an exogenously given constant rate with $\theta > r$. We shall assume that this inequality holds./1

Let us return to the crucial question of how the economy disposes of its emerging slack. There evidently exist a series of possible alternatives with major significance for the future prospects of the agrarian system. We shall deal in this paper with only two major alternatives, i.e. what we shall call the consumption-population adjustment and the technological adjustment. We shall deal with these in turn.

Consumption-Population Adjustment

The most obvious method of utilizing the surplus is to devote all of it to increases in per capita consumption. This, in turn, may have the repercussions on the (no longer exogenous) population growth rate. To see this in greater detail let the possible increment in per capita consumption at time t (i.e. the amount of increase in per capita consumption possible over the "traditional" base year level) be given by the slope of the straight line OK (i.e. KA_t/OA_t) in diagram (1c). As the point K moves upward on the slack-curve,

/1 Notice that if θ is less than r the slack-curve is negative and decreasing through time. This means that the economy is not capable of generating either type of slack and hence the analysis of such an economy which cannot even maintain its initial consumption standard is not very interesting - though at times undoubtedly of historical relevance.

it is seen that the per capita consumption level . increases all the time.

In order to rigorously deduce the magnitudes of this increase, we can easily (using 1.1) calculate the rate of increase of per capita output ($_Y*$) as follows:

$$1.10)\ a)\ \eta_Y = \begin{cases} \theta + (1-\alpha)\eta_A & \text{for } \Lambda \leq \bar{\Lambda} \\ \theta & \text{for } \Lambda \geq \bar{\Lambda} \end{cases} \quad \text{rate of increase of Y}$$

$$b)\ y^{*} = \begin{cases} \theta - \alpha\, \eta_A & \text{for } \Lambda \leq \bar{\Lambda} \\ \theta - \eta_A & \text{for } \Lambda \geq \bar{\Lambda} \end{cases} \quad \text{rate of increase of } Y^* = Y/A$$

The relationship between the rate of increase of agricultural productivity (η_Y*) and the population growth rate (η_Λ) for the above two cases is represented in diagram (2a) and (3a), respectively. In both cases, we see that there exists an inverse relationship between these two magnitudes indicating the fact that the higher the population growth rate, the lower the rate of increase of labor productivity. The only difference between the two cases is that in the second, the more relevant to us here, because of the fact that labor are no longer operating, $\alpha=1$. Thus in diagram (3a) the curve linking η_Λ and η_Y* is a negatively sloped 45-degree line.

The situation pictured in diagram (1c) is thus related to diagram (3a) when labor is redundant. Since in the case of consumption adjustment all outputs are consumed, output per head (Y*) is the same as consumption per head. From diagram (3a) we see that per capita consumption will continue to increase (i.e. $\eta_Y*>o$) if and only if the population growth rate is less than the rate of technological change ($\eta_A<\theta$) which is the case depicted in diagram (1c).

When this consumption adjustment is assumed to take place and when the classical endogenous population growth theory is also accepted, we obtain what may be called the Leibenstein-Jorgenson thesis of the "low level equilibrium

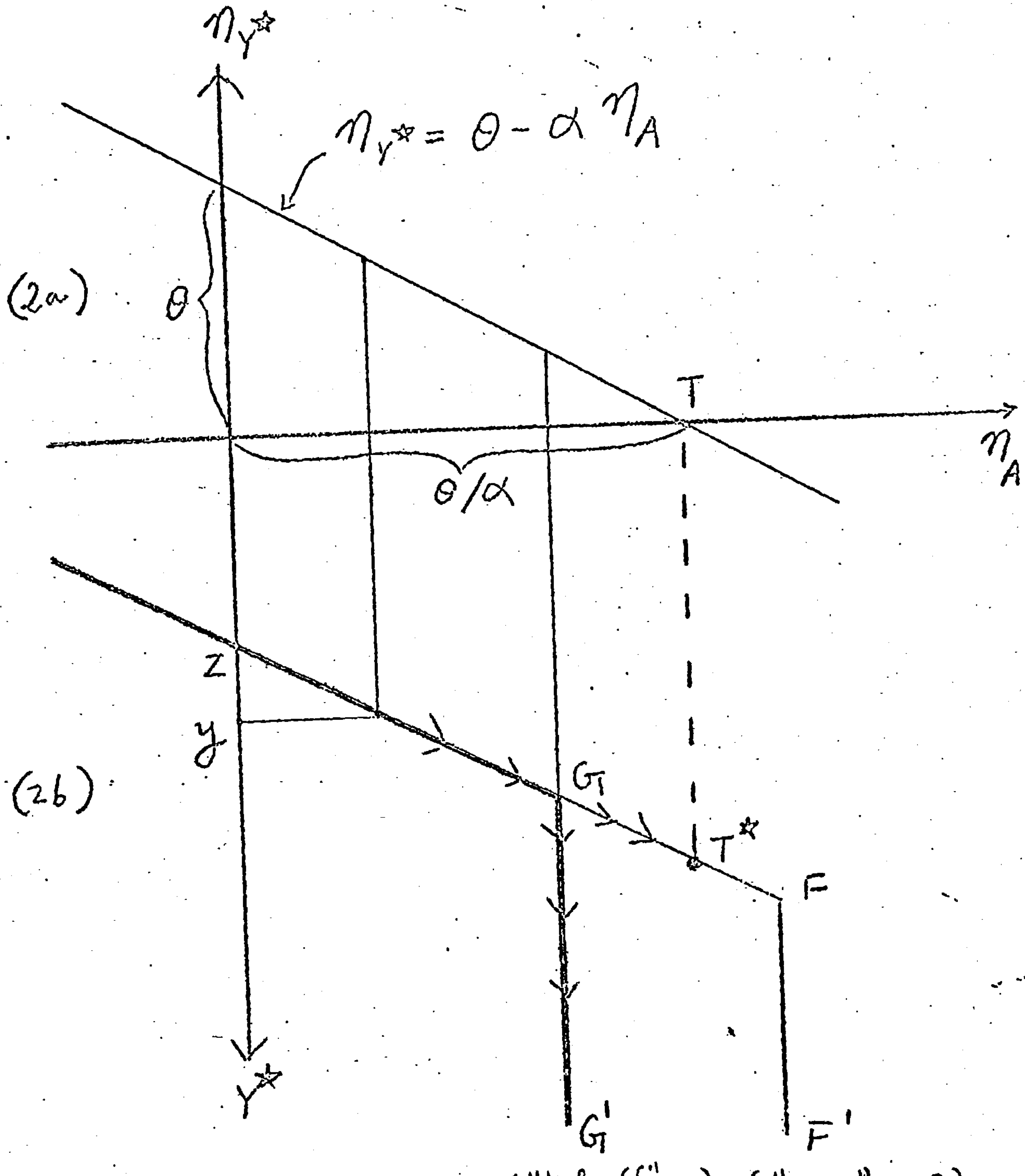
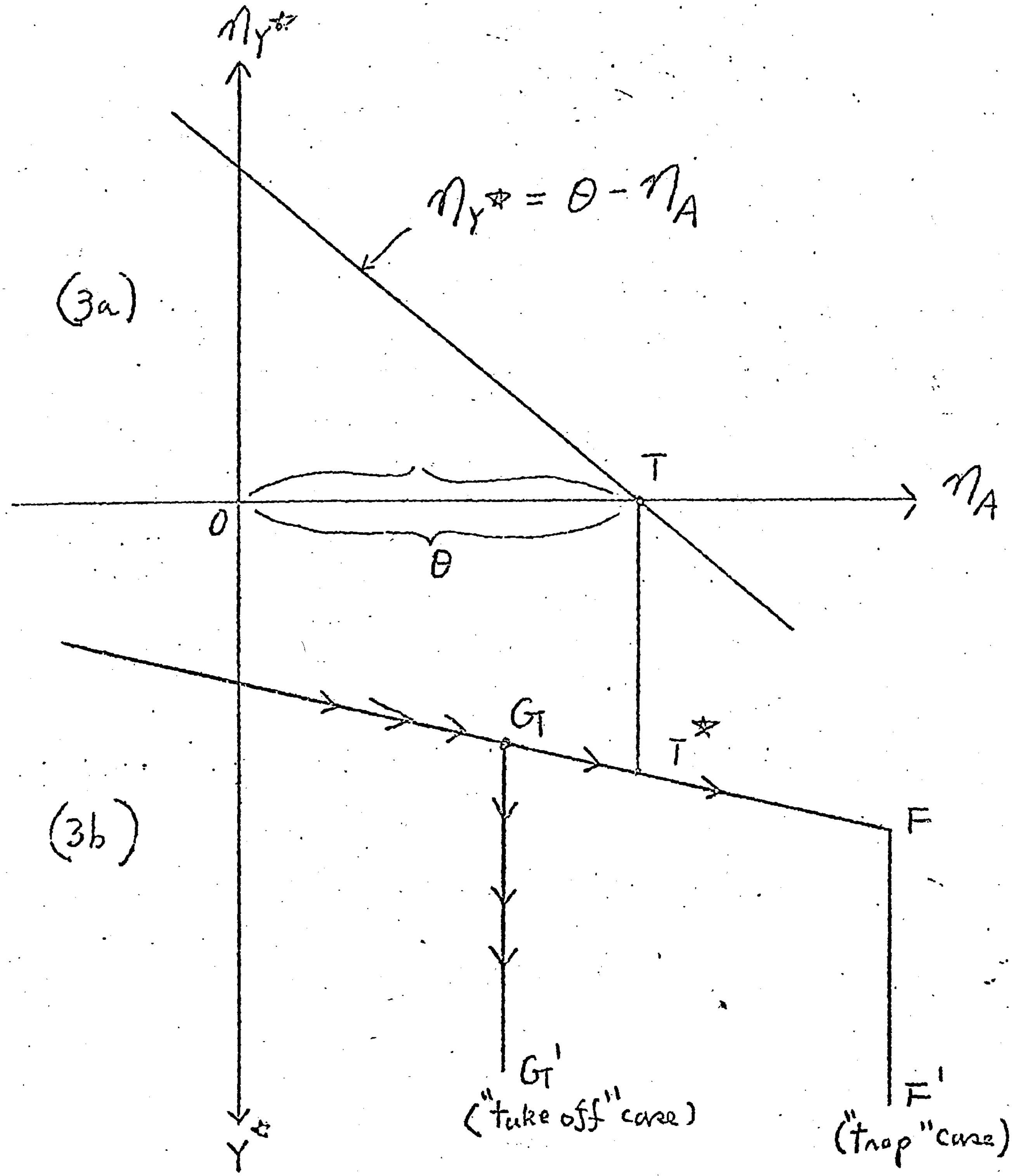

η_{Y^*}
$\eta_{Y^*} = \theta - \alpha\,\eta_A$
(2a)
θ
T
η_A
θ/α
Z
y
(2b)
G_1
T^*
F
Y^*
G_1'
F'
("take off" case)
("trap" case)

diagram 2



η_{Y^*}
$\eta_{Y^*} = \theta - \eta_A$
(3a)
T
η_A
0
θ
G_T
T^*
(3b)
F
G_T'
("take off" case)
F'
("trap" case)
Y^*

diagram 3

trap".[1] According to this thesis, population growth is assumed to be dependent upon the level of per capita consumption Y* in a manner described by the curve in diagram (2b). (In this diagram, Y* is measured on the vertical axis, downward and η_A, as before, on the horizontal axis.) Two possible population response curves are given by the two broken lines ZFF' and ZGG', which differ from each other in that in the first case the "turning point" (F) lies to the right of point T on the horizontal axis of diagram (2a), while in the second case the "turning point" (G) lies to the left of point T. The first case (ZFF') may be designated as the "trap" case, the second case (ZGG') as the "take-off" case.

In the "trap" case, starting from a low consumption per head level such as y (on the vertical axis of diagram 2b), the population growth rate implied is positive and hence per capita income and consumption will increase in the next period. In the next period, the higher level of Y* (or C*) leads to a yet higher population growth rate η_A, a lower, but still positive rate of increase of Y* (or C*); and so on. This process continues with the time path indicated by the arrows until point T* (and T) is reached when simultaneously per capita income (and consumption) increases cease ($\eta_Y{}^* = 0$) and the population growth rate reaches a stationary equilbrium. At this level of population growth rate θ/ϵ technological change and diminishing returns to labor just offset each other, keeping per capita output at a constant level. The economy is thus caught in a low level equilibrium "trap".

/1 H. Leibenstein, Economic Backwardness and Economic Growth, New York, 1957. Dale Jorgenson, "The Development of a Dual Economy", Economic Journal Spring, 1961.

In the "takeoff" case, starting again from such a point as "y" and the population growth rate implied thereby, the rate of growth of income (and consumption) per head is seen to be positive and hence the value of income (and consumption) per head will be higher in the next period. In diagram (2b), the growth path will be as before, toward point T*. However, at point G_1', before T* is realized, population is no longer responsive to the stimulus of increased per capita income (and consumption) - due to the fact that there exists a maximum rate of population growth.[1] In diagram (2b), the growth path will follow the arrows towards G' once the turning point G has been reached. This constancy of the population growth rate implies a constancy henceforth in the rate of increase of per capita income (and consumption). The agrarian economy has thrown off its Malthusian shackles and continues to increase its per capita consumption level; it may be said to have reached a "take-off".

/1 Jorgenson, op.cit., makes unnecessarily restrictive and unrealistic assumptions concerning this "turning point", namely that a saturation point for the per capita consumption of agricultural goods is reached at precisely the same point at which population growth becomes non-responsive to further increases in Y^*. He utilizes this consideration to show the necessity of the ultimate evolution of an industrial sector, a subject to which we shall return later. Moreover, Jorgenson stipulates a constant death rate and birth rate which rises with per capita income. In fact, what little we know about these matters indicates that the birth rate behaves rather unpredictably, and that it is the decline in the death rate -- related to preventive and public health expenditures (and not per capita income) which causes the rise in population growth. Though Jorgenson claims to be neo-classical, his acceptance of the consumption adjustment and Malthusian population thesis gives his framework a distinctly classical cast (i.e. especially when $\theta = 0$ or negligible).

Although the above interpretation of the Leibenstein-Jorgenson formulation does not adhere to the notion that there exists disguised unemployment or redundancy in the labor force in the typical agricultural production situation, their view can easily be adapted to the case where this phenomenon is accepted as an empirical fact. For this case a diagram similar to (2ab) i.e. diagram (3ab) can be constructed. The explanation of diagram (3ab) is self-explanatory, following exactly that just presented for (2ab). The only difference is that "the critical turning point" T or T* occurs where the rate of population growth (η_A) is equal to the rate of technological change (θ) on the horizontal axis. Thus if the point at which population becomes non-responsive to further increases in per capita income (and consumption) is to the left of T* (e.g. at C) we again have take-off; otherwise the economy is "trapped".

The two cases ("trap" and "take-off") can be represented in terms of diagram (4) in the following way. A system of slack curves indexed by θ/r_1 $\theta/r_2, \theta/r_3, \ldots$ are shown. These curves are constructed under the assumption that the rate of technological change (θ) is fixed but with varying rates of population growth (r). Clearly the higher the population growth rate, the flatter the slack curve θ/r. The different radial lines $OC_1, OC_2, OC_3, \ldots$ indicate different levels of per capita consumption. The growth path of the "trap" case is indicated by the path $C_1, C_2, C_3, \ldots$ (which intersects lower and lower slack curves and higher and higher levels of per capita consumption) gradually approaching a fixed per capita consumption level (represented by OC_4). In the "take-off" case, on the other hand, the growth path first follows C_1, C_2; however, once point C_2 is reached, the growth path bends upward and follows the path of a particular slack curve (in diagram 4 this is indexed by θ/r_2) as the population growth rate is now constant (at level r_2). The level of

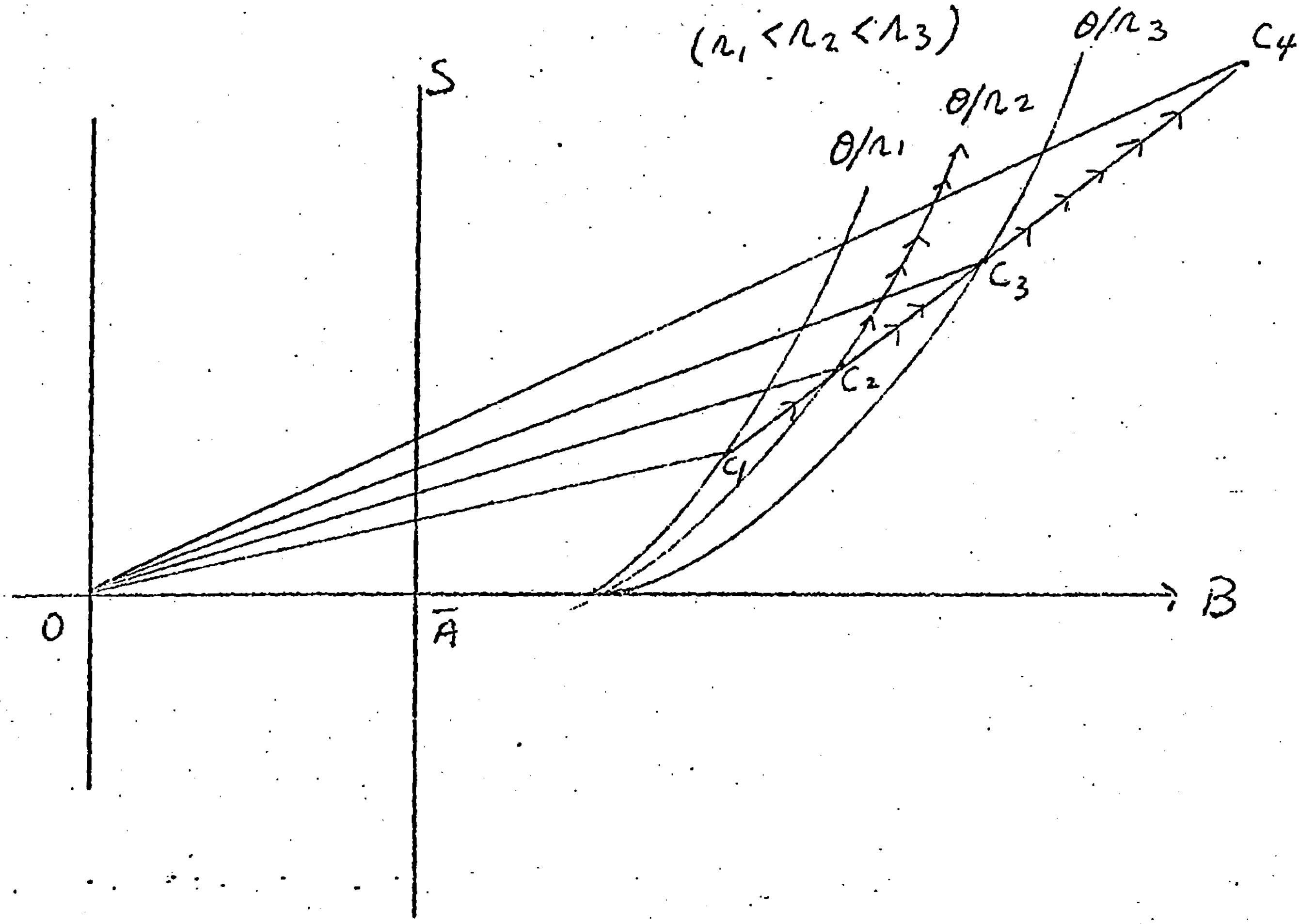


DIAGRAM 4

per capita consumption is then seen to be increasing monotonically and without bound.

What we have in this fashion interpreted as the Leibenstein-Jorgenson approach to the analysis of the agrarian economy represants an important contribution. Jorgenson's rigorously formulated dynamic model, in particular, permits us to distinguish precisely between the trap and non-trap cases in the monolithic agrarian economy and thus between continued stagnation and take-off. Nevertheless, the analysis appears to us rather suspect, largely because of the rather unrealistic or unduly restrictive assumptions on which it is based. First of all, the assumption is made that the entire increase in the agricultural surplus is used for consumption by farm labor. This may occasionally be true in a completely freeholder economy but is highly unrealistic given most land ownership and tenure arrangements in the agrarian economy. Secondly, the acceptance of the Malthusian type of population theory is, at least according to much modern demographic testimony, subject to considerable doubt. Thirdly, and most importantly, in this Jorgenson world the rate of technological change in agriculture is mysteriously fixed and constant. This assumption of progress in production techniques entirely unrelated to anything else in the system offends our sense of the real world. What it rules out is an important and perhaps more realistic alternative to the consumption-population adjustment mechanism as a method of disposing of the economy's agricultural slack. We shall call this alternative the "technology adjustment mechanism" and proceed to explore it at greater length in what follows.

Technology Adjustment

Any alternative adjustment mechanism is most conviently discussed in the context of a situation in which, initially, given a rate ofpopulation growth (r) and a rate of technological change (θ), per capita income is rising and slacks are being generated. Not only common sense but also the lessons of the physiocrats and historical experience imply that a full consumption adjustment is unlikely to occur. Moreover, alternative and more realistic ways in which the surplus may, in fact, be disposed of may have an important feed-back effect on agricultural productivity increase itself.

As we noted earlier, the physiocrats clearly saw the possibility of using the emerging agricultural slack for non-productive purposes, i.e. an expansion of so-called sterile activities. Thus, in terms of diagram (1c), as a particular quantity of redundant workers (B) and agricultural surplus (S) is generated, those who own the slack, i.e. the landlords, nobility, Church, etc. may utilize it to expand their consumption of services, handicrafts, and other luxury products. Alternatively, as the income of the ruling classes rises they may choose to enlarge the military establishment, wage war with their neighbors, build pyramids, construct churches or enhance the general "cultural attainments" of the society in some other way. There exists, in fact, an unlimited variety of uses to which the economy's slack can be put by those who have control over its disposition. This can be illustrated with examples from all parts of the globe which have undergone long centuries of typically agrarian existence prior to the Industrial Revolution. It is equally true, for example, of the Pharaohs of Egypt, the Moguls of India, the daimyos of Japan, and the feudal lords of medieval Europe.

It is our contention that the choice of such alternative uses of an economy's agricultural slack, besides being of interest in and of itself, may have a considerable impact on the productive performance of agriculture through its effect on the rate of technological change θ. In other words, as long as the economy is basically agrarian and not dualistic, i.e. its non-agricultural activities are stagnant and parasitic rather than innovatively dynamic, the rate of agricultural productivity increase may be adversely affected over time.

To explore this hypothesis a bit further, we should recall that technological change in the agrarian economy involves long-term, sometimes hardly perceptible changes in the state of the arts. The agrarian economy represents essentially a struggle between nature and numbers, with slight improvements in crop practices fashioned over the centuries and passed on from generation to generation. According to the testimony of agricultural economists this slow improvement trend of agricultural labor productivity θ can be sustained only if the agricultural infrastructure is kept in decent repair and improved upon. Irrigation, for example, the husbanding of the life-giving power of water while simultaneously reducing the excesses of droughts and floods has been one of the oldest concerns of man. Without proper irrigation and drainage facilities or where such networks have fallen into disrepair it is very difficult, if not impossible, to translate the slow but persistent accumulation of human experience on the soil, into secular, if slow, increases in productivity.

The human resource inputs of one period required to elicit such productivity increases in the next may thus be viewed as a very important ingredient of technological change. While a portion of the agrarian economy's labor force may, for example, be redundant in the sense of contributing to this year's output (using this year's state of the arts) it is not redundant, but in fact required, for a variety of activities which may render agriculture more productive in the future. The unemployed and underemployed in agriculture can and do play a major role historically in the digging of irrigation ditches, the construction of levees and dams, terracing, etc. -- and in simply keeping existing facilities from falling into disrepair. The magnitude of θ is thus, at least in considerable part, a function of the extent to which the underemployed agricultural labor force is engaged in long gestation period productivity-enhancing activities of the kind referred to.

It is this consideration which makes the determination of how the agrarian economy's slack is utilized so crucial. Clearly it is up to the owners of the agricultural surplus and those who have control over the human resources available, whether the slack is to be deployed in θ-enhancing directions or dissipated in high living and conspicuous consumption. But it is an almost definitional feature of the typical agrarian economy that the owning classes do not have a clear vision of the future and do not associate the routinization of secular productivity increases in agriculture with current allocation decisions about work and leisure with respect to the resources at their command. More likely, they respond to their rising income by increasing their demand for the products of the sterile classes. This manifests itself presisely in that the surplus of agricultural goods is used to hire away the surplus in manpower from agriculture-enhancing activities and towards the provision of more personal services, more luxury goods, more pomp and circumstance and, last but not least, larger armies and more wars. In the Middle Ages the tithe was extracted for the support of the Church, and the plethora of feudal payments extracted to support both the military and civilian manpower demands of King and baron. In Tokugawa Japan a high tax on land went almost exclusively for the support of the Court and the warrior classes./1 As surplus manpower is bid away in this fashion from such alternative pursuits as providing more water through better irrigation facilities and contributing to other dimensions of the agricultural infrastructure, the rate of agricultural productivity increase is bound to suffer. Thus, once we reject the (rather untenable) notion of a fixed, exogenously given, long term rate of agricultural advance, we can see that in the typical agrarian economy there are forces at work tending towards a secular decline in θ. We believe that this technology adjustment is based on a quite realistic view of the real long run problem of the agrarian society. Ultimately the downward pull exerted in this fashion can bring the system to a halt, quite aside from the danger of the demographic trap of the Leibenstein-Jorgenson (consumption-population-adjustment) school.

This hypothesis concerning "economic stagnation" brought about via "technology adjustment" may now be presented in a more rigorous formal fashion -- not for the sake of precise model construction but because only in this way can the "logical consistency" of the above ideas be put to the test. In diagram 5, let the slacks curve $\bar{A}FS$ of diagram 1c be reproduced. Let "d" denote a wage premium, i.e. the amount of excess pver the prevailing per capita consumption standard C*, which must be paid to the sterile worker wooed away from agricultural pursuits. Suppose the number of sterile workers is T; then the consumption per head of these workers is C*+d while the

/1 Thomas Smith, The Agrarian Origins of Modern Japan, Stanford University Press, 1959.

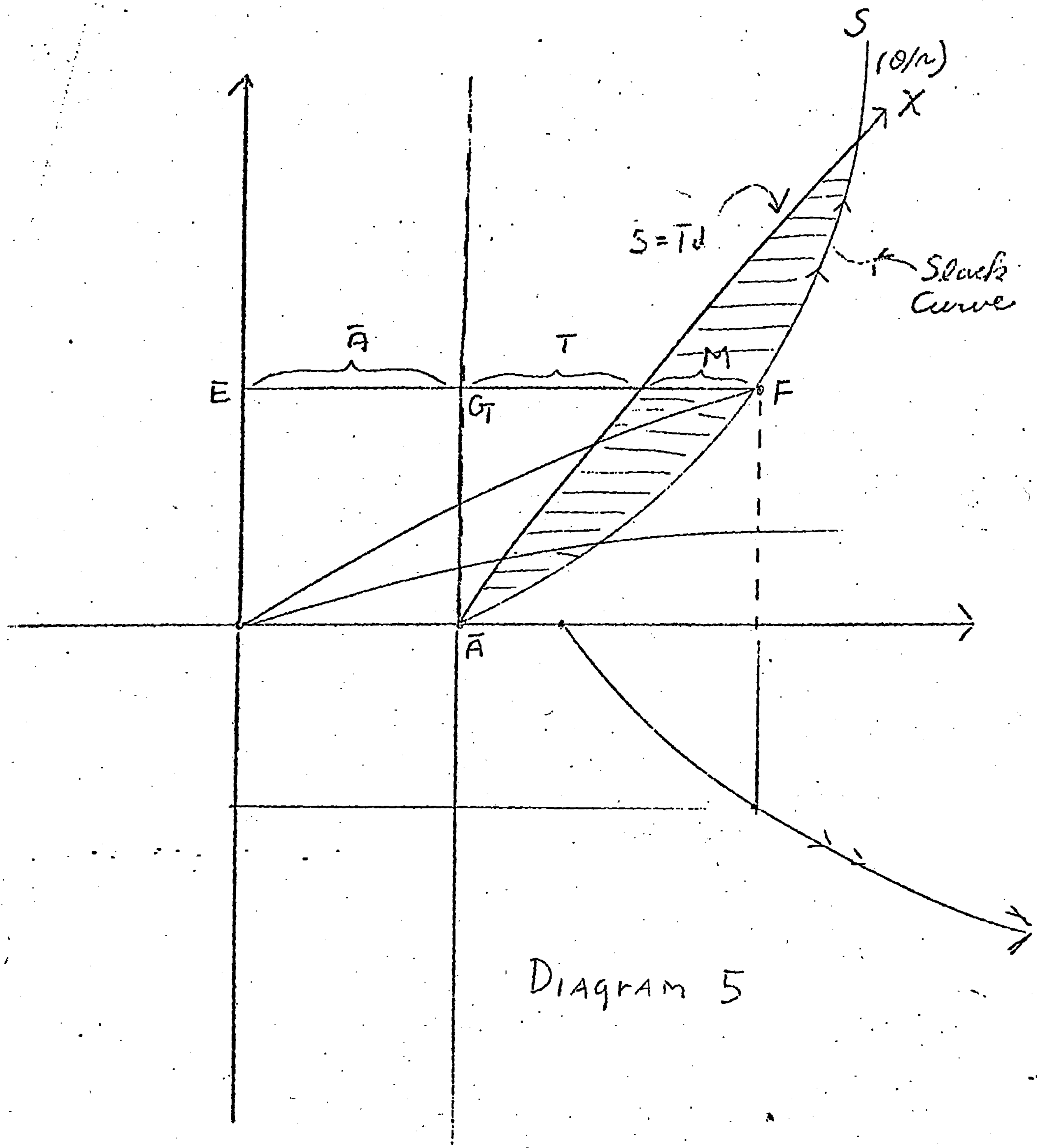


DIAGRAM 5

consumption per head of the non-sterile workers is C*. The postulation of a positive wage premium "d" is due to the fact that it generally takes a positive real social cost to mobilize, convert, and sustain each sterile worker (e.g. soldier, priest, artisan, feudal servant) who has been induced or forced to leave his dependent life in agriculture. Since agricultural surplus S is the amount of surplus of agricultural goods after making allowance for the consumption of the entire population at level C*, S represents the "fund" out of which the wages premium to the sterile workers can be paid. Thus if all the surplus food is used to draw off workers for a variety of parasitic activities, we have

1.11) $S=Td$

which is described by the straight line $\bar{A}X$ in diagram 5.

This line now permits us to determine the allocation of the economy's total labor force A at any point in time into three categories, non-redundant or productive labor $\bar{A}$, sterile redundant labor T, and non-sterile redundant labor M, i.e.

1.12) $A = \bar{A} + T + M$

For example, suppose point F represents a typical point on the slack surve (diagram 5). At F the entire population EF is seen to be divided into three portions: the nonredundant labor force $\bar{A}$, the sterile redundant labor force T (mobilized by the use of the agricultural surplus of $\dot{A}G$ units) and the non-sterile redundant labor force M.

Notice that the non-sterile redundant class (composed of M units of labor) represents redundant workers only from the static point of view, i.e., at any point in time they can be withdrawn from the agricultural sector without adversely affecting the total agricultural output of that year. However, from the dynamic point of view, they are productive in the sense that their removal from the agricultural sector will adversely affect agricultural productivity in future periods by causing θ to turn down as a consequence of a relative neglect of agricultural overheads. The basic notion here is that the gradual non-spectacular spread of new agricultural techniques is inhibited by the failure to maintain and improve irrigation and drainage facilities, feeder roads, etc. These activities are bound to be heavily labor using in the agrarian economy and once they are neglected, the long-run processes of slowly accumulating knowledge and passing it on from generation to generation are impaired.

In diagram 5, the (shaded) horizontal distances between the slack curve $\bar{A}FS$ and the straight line ($\bar{A}X$) (1.11) represent various possible magnitudes of such redundant non-sterile workers. From the concavity of the slack curve (as previously derived) we know that, given a fixed value of both innovation intensity θ and population growth rate (r), i.e. given a particular slack curve θ/r in diagram 5, the magnitude of the non-sterile redundant classes (M) will eventually decrease to zero as the absolute size of the economy's population continues to expand, i.e. the economy continutes to move "upward" along the slack curve. This means that, sooner or later, the agricultural sector will definitely begin to suffer from a "shortage" of this θ-maintaining type of labor and that the "dynamic efficiency" of agricultural activities cannot be maintained at the level of θ once M dips below a certain critical minimum level.

The above idea can be described rigorously by a behavioristic relation between θ and the labor force needed to sustain θ. For this purpose, let us denote $(A+M)/L$ by "q", i.e. "q" is the total non-sterile labor force as a graction of L. For simplicity, we can postulate an increasing functional relation between θ and q i.e.

1.13a) $q = Q(\theta)$ with Q' 0 where

b) $q = (A + M)/L = (L - T)/L$

which states that a higher level of θ necessitates the applicaiton of a higher fraction of the total labor force as non-sterile labor./1

Given fixed per capita consumption C*, the total consumption demand of the non-sterile workers is C*(A+M) or C*(L-T) and that of the sterile workers is (C*+d)T. Since total output is LY*, we have

1.14a) $C^*(L-T) + (C^*+d)T = LY^*$ which implies

b) $T/L = (Y^*-C^*)/d$ and hence (by 1.13b)

c) $q = 1 + (C^*-Y^*)/d = \phi(Y^*)$ with $\phi' < 0$

The last equation states that the value of q is uniquely determined by Y* (as indicated by the notation $\phi(Y^*)$). Furthermore, the value of q is inversely related to Y*. Together with (1.13a) we see that θ is a function of Y* and is, in fact, inversely related to Y* (i.e. as per capita output increases, the value of θ decreases). This may be written as:

1.15) $\theta = h(Y^*)$ with $h' < 0$.

/1 In further explanation of (1.13a), let L(T) be measured on the horizontal (vertical) axis of diagram 6. Since $T \leq L$, the relevant portion of the diagram lies below the 45-degree line OR. The radial lines indexed by q_1, q_2, q_3,.... are q-isoquants. The straight line UV, parallel to OR, is constructed such that the vertical gap between UV and OR is A (the non-redundant labor force). For a fixed value of "q" such as q_2, and for a population of L_o, the division of L_o into the three types of labor force T_o, M_o and A is indicated by the vertical line segments in the diagram. The same division is indicated for a population of a small size l_o (i.e. $l_o < L_o$) for the same value of q (i.e. q_2). We see $m_o/l_o < M_o/L_o$. This shows the "large country bias" of (1.13a), namelu, in order to maintain the same value of q (and θ) a large country must keep a larger fraction of its total labor force in the category of M-type labor than the small country.

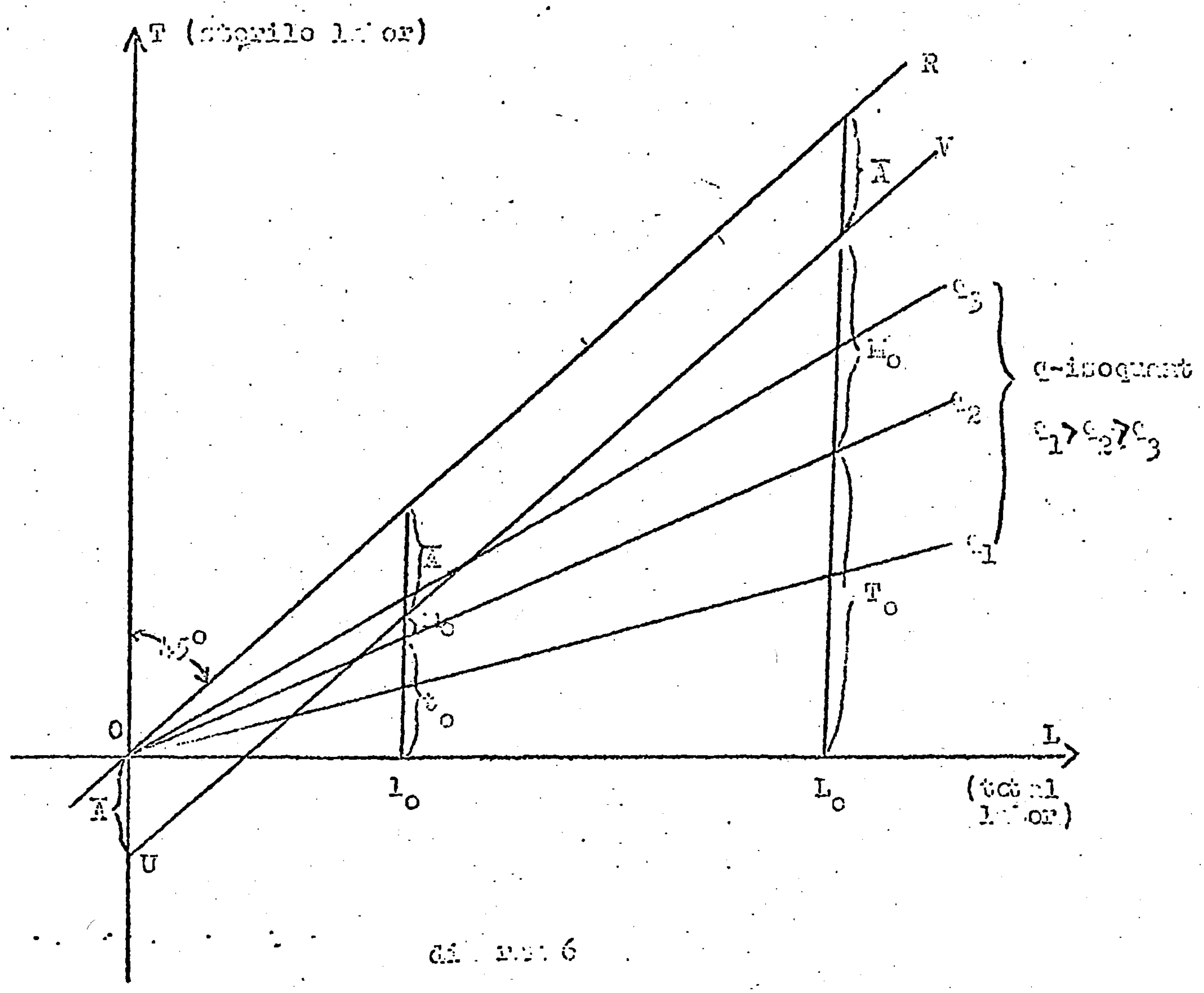


diagram 6

We shall refer to equation (1.14) as the innovation response curve since it specifies the level of innovational intensity in response to per capita income changes. Notice that the inverse relationship (which seems at first blush to run contrary to common sense) is due to a particular mechanism which we believe to be valid in the agrarian system, i.e. that increases in well-being of the propertied classes as reflected in higher per capita incomes and surpluses lead to an increase in demand for the services of the sterile classes to the extent that the agricultural productivity increases sooner or later suffer from the neglect implied. While there are good reasons to assume that such a relationship is inevitable in every agrarian society it seems reasonable in terms of the historical situations which come to mind e.g. Tokugawa Japan and medieval Europe. In both these instances the evidence points to the fact that the ruling classes did not concern themselves with the maintenance of progress in agriculture but rather devoted their energies to the "good life" and/or the making of war on their neighbors -- both activities

/1 Since curve $E_1E_2E_3$ cuts "higher and higher" member of the Y_1^* Y_2^* Y_3^* family.

making substantial demands on redundant labor resources./1

Turning now to diagram 7a, let the production function in (1.10b) be written as $\eta_{Y*} = \theta - r$ and represented by the positively sloped straight line. Notice that while η_{Y*} is plotted on the vertical axis the magnitude of θ is indicated on the horizontal axis. Moreover, since in our analysis, the population growth rate is assumed constant ($\eta_{\Lambda}=r$) the straight line is a 45-degree line which intersects both axes at distance r from the origin. In diagram 7b, vertically lined up with diagram 7a, let Y* be measured on the vertical and θ on the horizontal axis and let the innovation response curve (1.14) be represented by the negatively sloped curve. Moreover, let a vertical (dotted) line be drawn from point E to obtai point E' on the innovation response curve.

Our theory of stagnation via the technology adjustment mechanism can now be summarized with the help of diagram 7b. Starting from a point such as θ' greater than r, for example, the value of θ necessarily decreases (from θ' to θ'') because the value of η_{Y*} is positive (see diagram 7a). During this process, output per head (Y*) increases but at a decreasing rate (see diagram 7b). Eventually, the value of θ decreases to a stationary value (θ_o) at E equal in magnitude to the population growth rate (r)./2 The economy will

/1 It is readily admitted that in the present state of our knowledge, we do not know what, precisely, determines the magnitude of θ. However, we do think that the amount of non-sterile redundant workers available has an effect on θ. In diagram 6 we see that as M eventually shrinks towards zero the amount of such workers available must, at some point, become insufficient relative to other relevant magnitudes which are either increasing (i.e. per capita production (Y*) and total population (Λ)) or constant (i.e. non-redundant labor ($\bar{A}$)) to maintain the constancy of θ in the long run.

/2 Similarly, in the (unlikely) case that the initial θ is less than the population growth rate r (e.g. at θ'_1) θ will be increasing to the same stationary value.

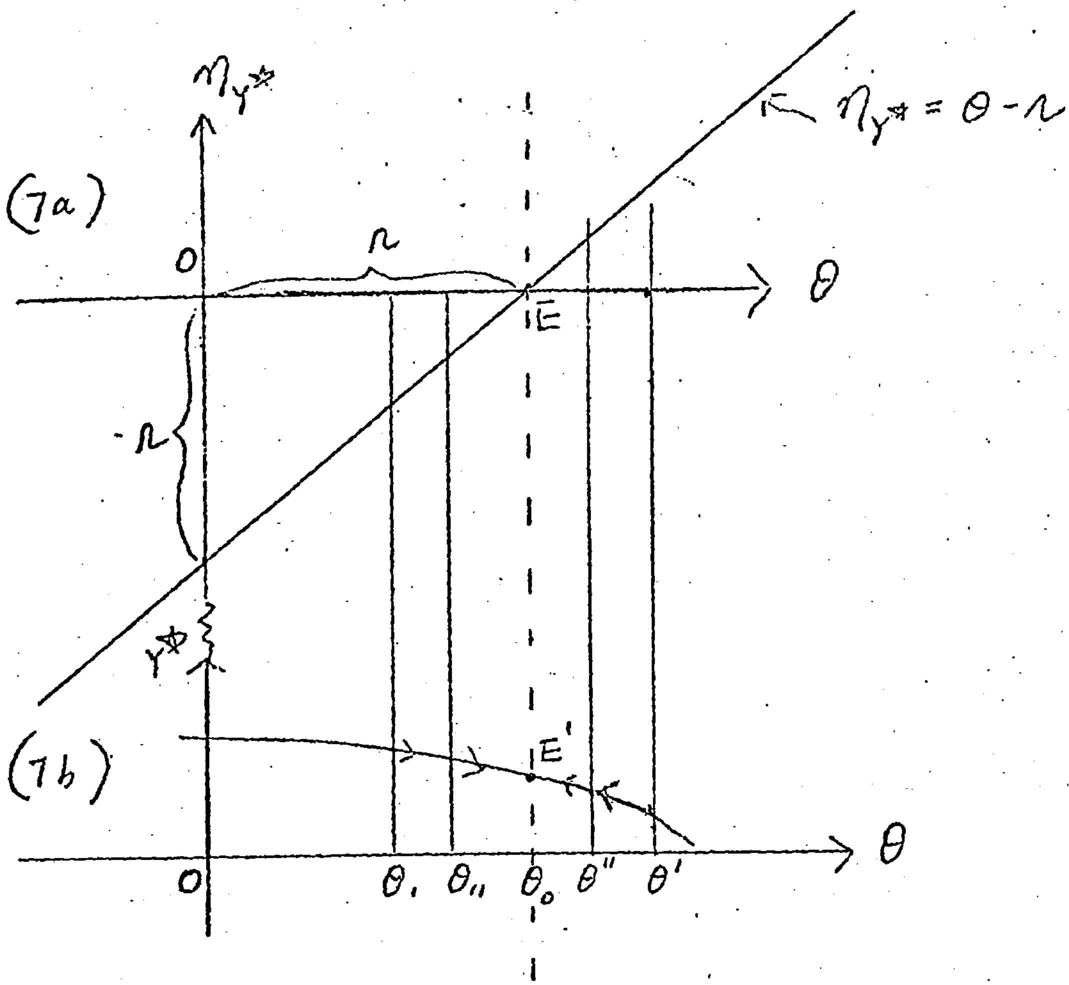

η_{γ^*}
$\eta_{\gamma^*} = \theta - r$
(7a)
0
r
θ
E
$-r$
γ^*
(7b)
E'
0
θ_1
θ_{11}
θ_0
θ''
θ'
θ

Diagram 7

can be expanding in a stationary equilibrium state characterized by the constancy of Y*. In this fashion, the phenomenon of long-term stagnation results from the working of the technology adjustment mechanism.

Up to this point we have been mainly concerned with understanding the workings of the agrarian economy and examining the plausibility of alternative mechanisms by which the system either escapes from its low level equilibrium trap or faces the prospect of long-run stagnation. This examination has been conducted,quite properly, in terms of various postulated real resource behavior patterns of the agrarian system. Equally important, however, in any discussion of the long run prospects of the agrarian system is the analysis of precisely how, given the fact that the economy is not trapped, the take-off is achieved. In this particular context it becomes a question of analyzing the nature of the transition from agrarianism to dualism. This is no longer a largely quantitative or real resource question but one that deals with the qualitative nature of structural changes that occur as the system moves from one regime to another.

With respect to the first, and relatively simpler line of inquiry, it will be recalled that we found the consumption-population adjustment mechanism wanting in realism. While we are quick to admit that objections of a somewhat similar nature could undoubtedly be raised against our own alternative technology adjustment mechanism, we find it more reasonable since it includes in the explanatory model certain historical features characteristic of the agrarian economy neglected in the Jorgenson-Leibenstein approach. This includes the existence of a non-consumed agricultural surplus, of non-agricultural production activities and the importance of the forces which determine .

the rate of technological change. What is perhaps indicated for the future is a partial synthesis of the consumption-population adjustment and the technology-adjustment mechanisms in exploring the long-run behavior of the agrarian system, i.e. both mechanisms may be at work to some extent in yielding the observed "trap" outcome. In the real world undoubtedly neither are all the potential surpluses consumed by the agricultural working population nor are they likely to be entirely diverted to support the luxury life of the propertied classes. The extent to which increases in per capita income lead to increases in per capita consumption, or to surpluses available for other purposes, will in fact depend on such institutional factors as the existing class structure, tenure arrangements, and the relative power of the landlord to adjust rental charges. Clearly, considerably more inquiry into such organizational characteristics of the agrarian economy is needed before we can be sure of the more precise causation of the observed long-run quasi-equilibrium in the system.

With respect to the second issue under consideration, the qualitative transformation of the non-trapped agrarian economy into rigorous dualism, even greater caution needs to be exercised. In Jorgenson's treatment, for example once the economy is no longer trapped by Malthusian pressures the emergence of the industrial sector is viewed as the inevitable consequence of continuously increasing per capita income and consumption levels. As the agricultural population's appetite for agricultural goods becomes satiated the transition from monolithic agrarianism to dualism is effected by workers somehow being "pushed out" into industry as a result of the increasing demand for industrial goods.

But an analysis of this transition is surely much more complicated than that and must be based on something more than a real resource (in this case consumer satiation)calculus. What is clear is that we cannot even hope to successfully approach so subtle a problem without a much clearer picture of the changing organizational framework within which the system then begins to perform the economic functions required of the successful dualistic society. Although Jorgenson, for example, claims to be talking about development in a dualistic economy he is really mainly concerned with the question, on the one hand, of what determines whether or not the agrarian system will be trapped; and on the other, of development in a removed industrial sector. There is virtually no analysis of the dynamic interaction between the two sectors; their fates are sequentially determined. Not only do agricultural savings play no role in the industrialization process but what happens outside of agriculture has absolutely no impact on what transpires over time. Clearly, what is required, if we are to make real progress in understanding the all-important transition phenomenon, is a prior understanding of the regime which follows. We therefore turn our attention in this paper to the dualistic economy, with particular emphasis on the interaction between the agricultural and industrial sectors.

III The Dualistic Economy: A Bird's Eye View

The dualistic economy exhibits structural characteristics which are markedly different from those of the agrarian economy -- in spite of the fact that both are underdeveloped and heavily agricultural. We shall first present a bird's eye view of the dualistic economy. Such a view will help us to identify an analytical framework needed for the study of growth under dualism as undertaken later. In the preliminary discussion here, we shall emphasize the contrast between agrarianism and dualism to gain a better understanding of the magnitude of the problem involved in the transition from agrarianism to dualism.

A major distinguishing feature of the dualistic economy relates to the coexistence of a subsistence agricultural sector and a commercialized industrial sector. In contrast with the subsidiary and "sterile" handicrafts and services of the agrarian economy, using virtually no real capital, the industrial production sector is a dynamic and vigorous (if initially small) sector in which real capital formation plays an important role. The basic problem in this economy is not one of how to satisfy the growing luxury tastes of the leisure classes in the presence of diminishing returns in agriculture but of how to shift the economy's center of gravity from agriculture to industry until the initially preponderant agricultural sector becomes a mere appendage to the mature system.

Specifically, the fact that real fixed capital is of such importance in the industrial sector of the dualistic economy is by no means as elementary and trivial an observation as may appear at first blush. This is true because with the advent of real capital, we introduce important new analytical facets, namely a new source of income (capitalist profits) and a new source of surplus (capitalist savings), both absent in the agrarian economy. Associated with this new source of income is a new propertied class, the industrial capitalist with ownership of the industrial capital stock being created out of the savings of the industrial sector. This emerging capitalist class is anxious to increase its ownership of the industrial capital stock as much and as quickly as possible. It is thus interested not only in siphoning off the new surplus for reinvestment in industry but also in enhancing the productive power of the new capital through the incorporation with it of as much technological change as possible. The owners of the industrial capital -- unlike the sterile classes in the agrarian society -- thus have an incentive to innovate or to adopt and adapt the innovations of others along the economy's industrial production functions.

It should be clear moreover, that the dualistic economy's total saving fund is composed not of one but of two kinds of surpluses, the industrial profits just referred to and the agricultural surplus defined as before in the context of the agrarian economy. It is this total saving fund which must then be allocated to the two sectors -- along with entrepreneurial activity -- to increase agricultural labor productivity in one sector, thus freeing labor, and to increase industrial labor productivity in the other, thus creating a demand for the allocated labor force. At the same time, given the consumer preferences of the typical worker, the output generated in the two sectors must be such as to prevent either a "shortage" of food, or of industrial goods as indicated by a marked change in the inter-sectoral terms of trade. Thus allocation decisions, taking into account both capital accumulation and technological change in each sector must proceed in a balanced fashion so as to avoid the overexpansion of either sector in the course of the reallocation process. With the economy's saving and entrepreneurial energies expended so is to ensure the synchronized forward movement of both sectors the prospects for success, i.e. a rate of labor reallocation in excess of population growth, are heightened.

While it is, of course, true that capital accumulation (as well as technological change) may play a role in enhancing agricultural productivity in the dualistic economy, we accept the evidence of such successful agricultural revolutions as that in Japan, Taiwan, Greece to the effect that physical capital plays a relatively less important role in agriculture while the labor-intensive adoption of new techniques, the application of fertilizer, etc. is considerably more important. Thus the net flow of capital resources (as well as labor resources) in the course of dualistic growth is out of agriculture and into industry.

Acceptance of this notion of a balanced inter-sectoral allocation process in the dualistic economy leads us directly to the idea that the ownership of industrial capital goods may be viewed as a possible reward for the generation of an agricultural surplus. Moreover, once the agricultural propertied classes, i.e. the landlords and nobility, begin to view the acquisition of industrial assets as more desirable than the making of war and the good life in the agrarian context, not only is the transition to dualism assisted directly but there is an important feed-back on the incentive toward further increases of agricultural productivity. No longer does the landlord view agriculture as an important but necessary evil to be put up with, but as a direct means of participating, along with the original industrial capitalist, in the ownership of the growing industrial sector.

These claims against the industrial sector are established in the course of facilitating the net flow of surplus (or savings) from agriculture to the rest of the economy. Surplus food is sold by the landlord in the intersectoral commodity market and the proceeds invested in the industrial sector. This is accomplished most easily in the case of the dualistic landlord[/1] who has one foot in each sector and directly owns and manages the newly created industrial production structure. Alternatively, the claims against the industrial sector can be acquired by the owner of the agricultural surplus through a system of financial intermediation, e.g. the purchase of savings certificates, bonds and stocks implying the more customary separation between ownership and control. But institutions of this type are difficult to establish in the typical underdeveloped economy, and once established, the extent to which such novel instruments of credit will really be accepted by a skeptical public is problematical. The most trusted financial intermediary is obviously one-self or one's close relatives and that is why the dualistic landlord (as encountered in Japan) or his counterpart may be of such importance for both the transition from agrarianism to dualism as well as for the continued growth of the dualistic economy. The dualistic landlord as agricultural entrepreneur has an increasing interest in innovating in that sector as the potentialities of industrialization become apparent to him; similarly as industrial entrepreneur he is anxious to innovate or to adapt the industrial innovation of others to the fullest extent possible. Technological change in both sectors is thus bound to yield increasing surpluses for the owning class and a more rapid accumulation of the desired industrial capital stock. In juxtaposition to

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/1 For a fuller analysis see Fei-Ranis, op.cit, Chapter 5.

the technology adjustment mechanism of the agrarian economy, which had a negative effect on θ, the dualistic economy is characterized by a technology adjustment mechanism which has a positive effect on θ. No longer are human resources and entrepreneurial attention pulled away from agriculture and squandered on luxuries and frills but productivity change in agriculture is viewed as a major engine for the balanced forward motion of the entire dualistic system. We may call this a positive technology adjustment mechanism.

One other facet of the emerging dualistic economy deserves further consideration -- namely the determination of the nature and rate of technological change in the industrial sector. As long as the economy is basically agrarian it is relatively insulated not only from change domestically but also from the rest of the world. Once the transition to dualism is under way, however, the economy becomes more fully exposed to the rest of the world, not only through the exchange of primary products for imported consumer and capital goods but also through the accompanying transfer of technology. As we have already pointed out, the incentive for adopting new and more efficient production functions on the part of the emerging class of industrial entrepreneurs clearly exists; but given the prior preoccupation of the propertied classes and their limited experience with industrial production they are likely to turn for help, at least initially, to the outside.

As Veblen pointed out long ago[/1] considerable advantages attach to the "late-comer nation" attempting to industrialize. Such an economy is in a position to survey the technological shelf already perfected by others and pick and choose that which seems most suitable -- without itself incurring the considerable cost of trial and experimentation. But, while innovations with the highest pay-off or yield are likely, at least initially, to emanate

/1 Thorstein J. Veblen, "The Opportunity of Japan," Essays in Our Changing Order (New York: 1934), pp. 248-66.

from abroad, this does not necessarily imply the adoption of the latest most up-to-date techniques known, nor the mere transplantation of processes from one country to another. As the 19th century Japanese experience well illustrates/1 technological transfers from the more advanced to the late-comer country are most effective when handled selectively, i.e. in some cases, the adoption of methods already rendered obsolete abroad by the substantially different factor endowment, together with the transfer of the latest ("most modern") methods, in others. The heavy borrowing of industrial technology from abroad in the early decades of the dualistic economy does not, moreover, preclude a considerable dosage of domestic innovational activity. Such activity will, however, be directed more toward the adaptation of imported techniques to different local conditions (e.g. the greater relative availability of cheap labor) rather than the creation, from scratch, of new methods of production.

The role of technological change both in terms of its intensity or strength and in terms of its slantedness or bias can thus be of very considerable importance in the early industrialization process. T. Watanabe concludes that "the most important causes for Japan's rapid industrialization can be found in the nature and growth of technological change"./2 Innovations, for example, were responsible for as much as 80% of the absorption of industrial labor during the early period in the case of Japan./3

/1 See, e.g. G. Ranis, "Factor Proportions in Japanese Economic Development", _American Economic Review_, September, 1957 for a fuller statement on the subject of this paragraph.

/2 "Economic Aspects of Dualism in the Industrial Development of Japan," _Economic Development and Cultural Change_, April, 1965.

/3 Fei -Ranis, _op.cit_, p. 125-131.

It is moreover, also a fact of life, as Veblen again points out, that the early advantage of the late-comer is ultimately dissipated. As the technological shelf of the more advanced countries is cleared of relevant techniques the annual rate of technological advance of the industrial sector of the dualistic economy is likely to slow down over time. As the dualistic economy becomes more and more industrialized, however, in the course of a successful labor reallocation process its domestic skill and ingenuity levels will be rising; increasingly as the importance of borrowed industrial technology declines the economy will thus be in a position to produce its own technological advances domestically. In fact, it may be said that it is the capacity to generate a sustained flow of indigenous technological change in a routinized fashion which marks off the mature from the underdeveloped society.

The above hopefully has served to illuminate many of the major facets of growth in the dualistic economy in a general way. In most startling contrast to the agrarian society is the emergence of a dynamic industrial sector. Let us, therefore, now concentrate on a fuller exposition of the workings of the industrial sector in the dualistic economy.

IV Development of the Industrial Sector of the Dualistic Economy

Production Conditions

Since the very essence of dualism implies that the complete interaction between the two production sectors lies close to the heart of the development process, the analysis of the industrial sector, as such, can at best provide only a partial and incomplete view. But we shall also try to indicate how this partial view fits into our more general equilibrium framework of thinking.

To the extent that real capital and technological change, together with the labor force, constitute the basic causation factors determining industrial output X, the production function for the industrial sector may be postulated in the general form as

3.1) $X = f(K, L, t)$

where $K(L)$ stands for capital (labor) and where "t" stand for time or the state of the arts. The explicit postulation of the time variable (t) is to enable us to formally analyze the phenomenon of technological change, i.e. changes in the production function through time. To simplify our analysis, we shall assume that (3.1) satisfies the condition of constant returns to scale (CRTS).

Since we will be concerned with a system of observable economic magnitudes related to the general function (3.1), it will facilitate our exposition to first introduce a system of "growth equations" related to these observable magnitudes. The essential economic magnitudes are obviously the "primary" variables of (3.1), industrial output (X), capital (K), labor (L), the various ratios derivable from these primary variables such as X^* (= X/L, industrial output per head), k(=X/K, output-capital ratio), K^* (=K/L, capital per head), the factor rewards w(real wage) and π (rate of return on capital), as well as various possible indices measuring the quantitative and qualitative aspects of technological change through tim Using the notation η_y to denote the rate of change of the time variable y (i.e. $\eta_y = \frac{dy}{dt}/y$), the system of growth equations which will be useful are[1].

3.2a) $\eta_y = \eta_K \phi_K + \eta_L \phi_L + J$ (rate of growth of industrial output)

b) $\eta_{y^*} = J + \phi_K \eta_{K/L}$ (rate of growth of output per head)

c) $\eta_k = J + \phi_L \eta_{L/K}$ (rate of growth of average productivity of capital)

d) $\eta_w = \epsilon_{LL} \eta_{K/L} + B_L + J$ (rate of growth of competitive real wage)

e) $\eta_\pi = \epsilon_{KK} \eta_{L/K} + B_K + J$ (rate of growth of competitive profit rate)

where the various notations used in the above equations are

3.3a) <u>static production concepts</u>

i) $\phi_L = L \frac{\partial Y}{\partial L}/X$ (labor elasticity of output)

ii) $\phi_K = K \frac{\partial Y}{\partial K}/X$ (capital elasticity of output)

iii) $\epsilon_{LL} = -L \frac{\partial X}{\partial L \partial L} / \frac{\partial X}{\partial L}$ (elasticity of w with respect to L)[2]

b) <u>dynamic production concepts</u>

i) $J = \frac{\partial X}{\partial t}/X > o$ (innovational intensity)

ii) $B_L = \frac{\partial X}{\partial t\, \partial L} / \frac{\partial X}{\partial L} - J$ (degree of labor using bias of innovation)

While the familiar production concepts need no further explanation, innovational intensity J is the "rate of change of output due to the lapse of time (or technological change) only" and the labor-using bias index B_L is the "deviation from neutrality of innovation as measured in terms of the rate of change of the marginal productivity of labor." In particular, it may be noted that the innovation is labor-using (labor-saving, or neutral) in the Hicksian sense when $B_L > o$ ($B_L < o$ or $B_L = o$).

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[1] For a full derivation and explanation of these growth equations see Fei and Ranis, <u>op. cit</u>, Chapter 3. We shall only be concerned here with a brief explanation of these equations.

[2] ϵ_{LL} is the partial elasticity of MPP_L (marginal productivity of labor) with respect to labor. Because of the "law of diminishing returns to labor", ϵ_{LL} is positive as defined. (It measures, for example, how fast the marginal productivity will increase, if labor is withdrawn or if capital is added).

The economic interpretation of the growth equations in (3.2) in terms of the concepts in (3.3) are straightforward enough. For example, (3.2a) traces the rate of change of industrial output to a capital contribution ($\phi_K \eta_K$), a labor contribution ($\phi_L \eta_L$) and innovational intensity (J). Equation (3.2b) traces the change of output per head (or the average productivity of labor) to innovational intensity (J) as well as to the rate of capital deepening ($\eta_{K/L}$, adjusted by the capital elasticity of output ϕ_K). Equation (3.2c) is symmetrical to (3.2b). Finally, equation (3.2d) traces the causation of the rapidity of the change in the real wage (η_w) to the intensity of innovation (J), the degree of labor-using bias (B_L) as well as to the rate of capital deepening ($\eta_{K/L}$) adjusted by the labor elasticity of MPP_L (ϵ_{LL}).

Before we apply these growth equations to the analysis of the industrial development process in the dualistic economy two remarks of a mainly methodological nature may be helpful. First of all, it is well to notice that growth equations (3.2) indicate the instantaneous rates of change of the various economic magnitudes involved. As such, they must be used with care in the analysis of the growth process. Specifically, it is useful to make the elementary distinction between the "seasonal", "cyclical" and "secular" characteristics of an economic time series and to keep in mind that for the analysis of the process of economic development the primary emphasis must be on the <u>secular</u> aspects of economic change. Thus, in observing the changes that take place in the industrial sector, the "correct" view point (at least for purposes of the present paper if not for development theory in general) is to emphasize change over a longer interval of time (say a decade or so) rather than year to year changes. Technically this means that in observing development-associated changes, it is essential to observe the recorded accumulated values (say over a decade) of such instantaneous rates of change--as given, for example, by the various growth equations in (3.2). Thus in what follows, we will be concerned with the magnitudes of a given variable, when we are given its rate of change. A useful general relation to remember in this connection is

3.4) $S(t) = S(o)\, e^{\int \eta_s dt}$

when S(o) is the initial value of S(t)[1]. We shall have occasion to make use of (3.4) in conjunction with the instantaneous rates of change in (3.2). Secondly, it is appropriate to remind the reader that the growth equations in (3.2) are general equations defined for the general production function (3.1). In the analysis of as complicated a real world phenomenon as economic growth we shall find it convenient later on to make somewhat more limiting assumptions about the precise nature of the production function in (3.1). In other words, certain observable results which can be derived for a special production function may or may not hold for the general case (3.1). For this reason, it should be clear that wherever a particular conclusion is not borne out by empirical fact it becomes essential to know whether we are refuting the special production function or some other conceptual aspects of our analysis not especially related to the specific type of production function postulated. It is, indeed, for this reason that we have adopted this round-about approach by first presenting the growth equations based on the general production function.

Technological Change

In follow-up of the above set of obiter dicta, we shall assume that the production function (3.2) takes on the following special form

3.5) $X = F(t) \quad K^{B} \quad L^{1-B} \qquad (0<B<1, \ \frac{dF(t)}{dt} \geq 0)$

i.e. that of the Cobb-Douglas with a (neutral) innovation factor F(t)[2].

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[1] Note that when t=o, S(t) = S(o), (3.4) can be easily verified by deriving η_S.

[2] The selection of the Cobb-Douglas function is, instinctively, the first choice of economists when attempting to simplify the analysis of the growth process (e.g. Jorgenson, "Development of the Dual Economy", Economic Journal, Spring, 1961). While Jorgensen assumes that the innovation level factor F(t) takes on the special exponential form $e^{\theta t}$, with θ given and constant, we believe this to be unrealistic for reasons given in the text.

for (3.5), the innovation intensity J is

3.6) $J = \eta_F$

In the case of a contemporary dualistic underdeveloped country, arriving on the scene as a late-comer anxious to borrow technology from abroad it is reasonable to postulate that J initially takes on a shape as indicated in diagram 8, i.e. monotonically decreasing to a stationary level "b" as the considerable advantage of the initial late comer status are gradually exhausted, i.e. as innovations become increasingly "domestically" generated rather than imported.[1] In particular, we can make the assumption

3.7) a) $J = b + ae^{-ut} \quad b \geq o,\ a \geq o,\ u \geq o$ with

b) $\eta_J = u/(1 + (b/a)e^{ut})$

While J is plotted (in diagram 8) above the horizontal axis, η_J is represented by the monotonically increasing curve below the horizontal axis. Thus the underlying assumption is the "deceleration" of innovational intensity. Applying (3.4), we can now calculate the innovation level factor as

3.8) $F = F(o)\, e^{\int Jdt} = F(o)\ e^{bt-(a/u)e^{-ut} + a/u}$

This is plotted in the same diagram and is represented by the concave curve which monotonically increases without bound. Finally, using (3.8), the production function of (3.5) takes on the following concrete form (through a redefinition of the unit of measurement of output):

3.9) $X = e^{bt-(a/u)e^{-ut}}\ K^B\ L^{1-B}$

General Strategy of Analysis

It must be our purpose to explain the process of the expansion of industrial

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[1] After reaching such a stationary level "b" it is perfectly possible--if not likely--for J to increase again after a time once the indigenous innovation capacities of the mature economy assert themselves in a routinized fashion.

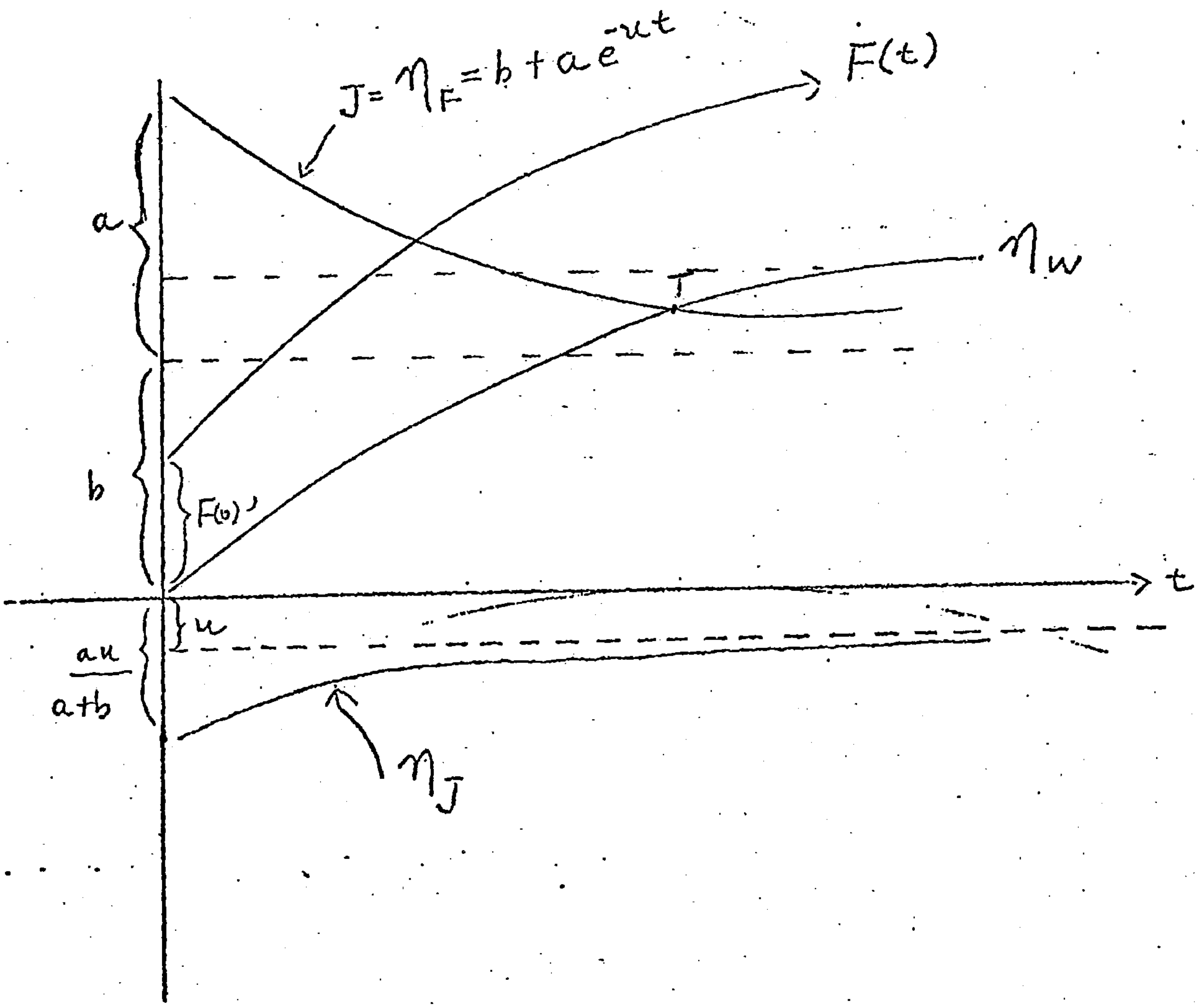

DIAGRAM 8

output X in relation to the expansion of the industrial labor force, the industrial capital stock, as well as innovational activity. In the above, we have made the basic simplifying assumption that technological change in the industrial sector is neutral and given exogenously. This leaves us with the major analytical task of how to determine a realistic causal order in the relationship among industrial output X, capital K, and labor force L.

Following the notion well accepted in the recent development literature on dualistic economies let us assume that the wage rate in the industrial sector (in terms of industrial goods) is determined exogenously, e.g. by conditions in the agricultural sector,[1] i.e.

3.10) $w = w(t)$

To understand the economic impact of $w(t)$ on the growth process, we must know the reasonable time pattern of the exogenously given $w(t)$ in the dualistic economy. For the case of historical Japan which most economists would agree represents one of the few well-documented cases of successful emergence from underdevelopment and dualism to economic maturity, the behavior of the real wage is given in diagram 9.[2] For this period, from the secular point of view, we can distinguish two phases of wage behavior as marked off roughly by a turning point around 1915. In the first phase (before 1915), we find a very moderate but persistent trend for an increase in the real wage. Although we can observe oscillations around that trend, such variations can be neglected as being of the "cyclical variety" not really pertinent to the secular view of the growth process.

However, what contrasts sharply with this first phase is the wage behavior in

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[1] The most celebrated example in this tradition is Arthur Lewis (op. cit.). This position was later elaborated by Fei and Ranis, op. cit.

[2] Reproduced from Fei and Ranis, page 263.

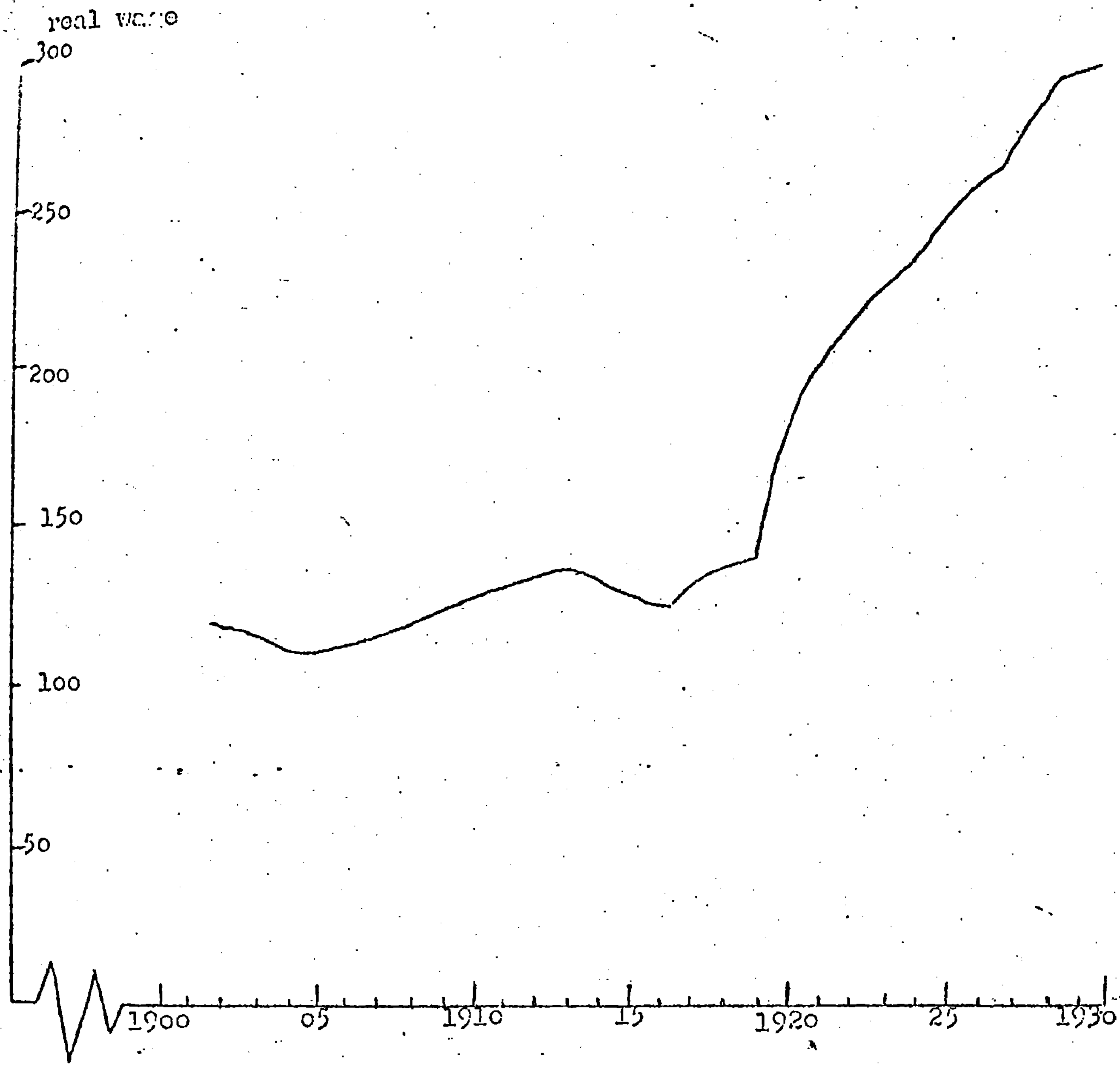

Diagram 9 Japan Real Annual Wages, 1902-1930, in 1913 Yen

(Five Year Moving Average)

the second phase (the period after 1915) which shows an unmistakable trend of rapid and sustained increases in the real wage. No matter what reasonable indices are adopted, the marked difference in the secular wage behavior between these two period cannot fail to convince us that development of Japan was characterized by the existence of two radically different stages of growth in the sense that the economic system really operated in two different "regimes" characterized by different rules of behavior.

While such inductive evidence alone does not have the power to convince us that all successful contemporary underdeveloped countries must necessarily follow the same two consecutive regimes of growth, proceeding from dualism to maturity, we have reason to believe that the historical experience of Japan is relevant to the labor surplus type of contemporary underdeveloped country./1 It is sufficient to state here that an adequate explanation (or justification) of the two regimes thesis must basically be related to what is happening simultaneously in the agricultural and industrial sectors (more precisely the interaction between the two sectors) of the dualistic economy. We shall return to this problem below.

For the time being, however, in analyzing the growth of the industrial sector let us make the simplifying assumption that the real wage can behave in two ways, either remaining constant or vigorously increasing. This first case is used to approximate the regime of Japanese growth for the period before 1915 contrasting sharply with the second phase in which the real wage increased markedly (see diagram 9). We may also make the simplifying assumption that in this second phase the real wage increases at a constant rate. Thus we

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/1 This thesis is fully elaborated in our book (op. cit.) esp. Chapter 7. The transition from dualism to maturity is not, however, essential to the main objectives of the present paper.

have

3.11) a) $\eta_w = o$ (constant industrial wage in phase one)

b) $\eta_w > o$ and $\eta_w = z \quad z > o$ (increasing industrial wage in phase two)

While some modest wage increases were, in fact, taking place in Japan during phase one, they are minimal when viewed in historical perspective. Nevertheless, we know that "natura non facit saltum." The rate of growth of w may thus be depicted not as a step-function but rising very gradually towards a stable level as depicted in diagram 8.

The analytical significance of the exogenously postulated industrial wage rate (3.10) is two-fold in terms of its impact on both capital accumulation and labor absorption. At any point in time, given capital (K) and labor (L) as well as the exogenously-given innovation level, we can determine industrial output X. With the real wage exogenously given, we can then determine the distribution of wage income (wL) and property income (πK). In this fashion we have determined one of the main sources of the economy's saving or investment fund once we identify saving with property income. Moreover, the addition to the capital stock in the next period is determined and thus we have quickly pinpointed the saving-behavioristic significance of w(t). Furthermore, with a given capital stock, we can determine the amount of labor which will be hired under competitive assumptions when the real wage is given. Thus we are able to determine the industrial labor force in the next period and stabilize the labor absorption significance of w(t). In this fashion, the dynamic growth path of the system is completely determined.

In summary, given exogenous innovation and wage behavior, we can determine all the significant growth processes of the industrial sector. In what follows, we shall investigate the qualitative aspects of this system--under the assumption that innovation behavior takes on the special form (3.7a), pertinent to the underdeveloped "late comer", and that the wage behaves in the special ways

(3.11ab) pertinent to the labor surplus type of dualistic economy. From this we shall try to deduce conclusions for certain observable economic magnitudes, with some effort to ascertain the extent to which the validity of such conclusions is due to the special assumptions of (3.9) and not valid for the general production function of (3.1).

With this purpose in mind, let us first dispose of a minor technical matter. For the Cobb-Douglas function in (3.5) we have (from 3.3)

3.12) a) $\phi_L = 1-\beta; \ \phi_K = \beta$

b) $\epsilon_{LL} = \phi_K = \beta =$

c) $B_L = 0$

Thus both the static and dynamic production concepts of (3.3) take on simpler forms. For example, (3.12a) states the constancy of the distributive shares, (3.12b) the constancy of the labor elasticity of the MPP_L and (3.12c) the neutrality of innovations in the Hicksian sense. All these follow from the Cobb-Douglas nature of the production function. It remains for us to show the significance for growth of these special properties.

Analysis of Capital Intensity and Labor Productivity

Let us first concentrate on an analysis of industrial output per head X^* and investigate the relationship between X^* and the wage rate w. From (3.2b) and (3.2d) we have

3.13) $\eta_{X^*} = J + \frac{\phi_K}{\epsilon_{LL}}(\eta_w - B_L - J)$

which is quite general. In case the production function is Cobb-Douglas we substitute (3.12) into (3.13) and obtain

3.14) $\eta_{X^*} = \eta_w$

i.e. the rate of increase of output per head is always the same as the rate of increase of the real wage. Applying (3.4) we can also obtain the following relationship between X* and w over any longer historical period of time

$$3.15) \quad \frac{X^*(t)}{w(t)} = \frac{X^*(o)}{w(o)} \quad \text{or} \quad X^*(t)/x^*(o) = w(t)/w(o)$$

which states that X* (t) and w(t) always increase proportionally.[1] This result permits us to predict that in case the industrial wage is constant (3.11a) output per head in the industrial sector is also constant; and in case the real wage is increasing (3.11b) output per head also increases and at about the same rate.

Turning now to an analysis of the behavior of capital per head K* in the industrial sector we have (from 3.2d):

$$3.17) \quad \eta_{K^*} = \frac{1}{\epsilon_{LL}} (\eta_w - B_L - J) \quad (\epsilon_{LL} > o)$$

which is, once again, a general equation. However, in case innovations are neutral in the Hicksian sense ($B_L = o$) we obtain

$$3.18) \quad \eta_{K^*} = \frac{1}{\epsilon_{LL}} (\eta_w - J) \quad (\epsilon_{LL} > o)$$

Thus we see that whether capital shallowing ($\eta_{K^*} < o$) or capital deepening ($\eta_{K^*} > o$) takes place in the industrial sector in the course of the development process depends on the comparative strength of two exogenous forces, namely the wage force (η_w) and the innovation force (J). An increase in the wage rate makes for capital deepening, (i.e., as we would intuitively expect, entrepreneurs substitute capital for labor) and high innovational intensity

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[1] Notice that their strict proportionality is due primarily to the Cobb-Douglas nature of production function. The more general relationship between w and X* is given by (3.13). When (3.15) is not borne out by empirical observations this should be interpreted as a refutation of the Cobb-Douglas production function.

makes for capital shallowing (i.e., as we would expect, more labor will be employed on a fixed amount of capital after innovation.) This simple analysis is, in fact, completely due to the assumption of Hicksian neutrality[1] and is not restricted to the Cobb-Douglas type of production function. When the Cobb-Douglas function is used, we obtain the simple result

$$3.19) \quad \eta_{K*} = \frac{1}{\beta} \quad [\eta_w - J]$$

Notice that when the real wage is constant (and innovations are taking place) capital shallowing must, of necessity, occur, i.e. $\eta_{K*} = \frac{J}{\beta}$. Moreover, if J gradually declines as the economy uses up its "late-comer" advantages the rate of capital shallowing also gradually declines. On the other hand, if the real wage is increasing we may reasonably assume, for the case of the poor labor surplus economy, that η_w starts from a small value and gradually increases to a stationary larger value as indicated by the η_w curve in diagram 8. Considered together with the J-curve in the same diagram, this leads us to expect, first capital shallowing, followed later (in diagram 8 after point T) by capital deepening in the industrial sector of the dualistic economy.[2]

Applying relation (3.4) to (3.19), we have

$$3.20) \quad a) \quad K^* = K^*(o) \qquad [\, e^{\int(\eta_w - J)}]^{\frac{1}{\beta}} \quad \text{or}$$

$$b) \quad \left(\frac{K^*}{K^*(o)}\right)^{-\beta} = \frac{w(t)/w(o)}{F(t)/F(o)}$$

---

[1] In Fei and Ranis, op. cit., we have analyzed the same phenomen in greater detail taking into consideration the possibility of innovational bias but neglecting the possibility of any variation in the wage rate in the labor surplus economy.

[2] This finding is supported by our preliminary statistical work on Japan (see Chapter 4 of Fei and Ranis, op. cit., although, as we have mentioned above, this analysis was based on the strict constancy of the industrial real wage assumption and the admission of the possibility of innovational bias.).

which shows the relationship between the "wage multiple" $w(t)/w(o)$, the "innovation multiple" $F(t)/F(o)$ and the "capital intensity-multiple" $K^*/K^*(o)$ over any given interval of time.

In summary, we see that of the two critical ratios K^* (capital per head) and X^* (output per head), the latter depends on the behavior of the "wage force" while the former depends on the behavior of the "wage force" as well as the "innovation force." Combining (3.20b) and (3.15) we have

$$3.21)\quad [K^*/K^*(o)]^{\hat{F}} = \frac{X^*/X^*(o)}{F(t)/F(o)}$$

Analysis of Saving and Capital Accumulation

Let us turn now to an analysis of the long-run behavior of the rate of growth of capital η_K. In the closed dualistic economy there are two main components of saving, i.e., (i) the profit component (π_1) which emerges out of industrial profits and the (ii) agricultural surplus component (π_2) which emerges out of the channelization of agricultural savings for the financing of capital accumulation in terms of industrial goods. Notice that in the dualistic economy which we envision, capital goods consist entirely of the output of the industrial sector, and thus both (i) and (ii) constitute the apportioning of a part of X as investment goods. In the case of the reinvestment of industrial profits (i), we have $\pi_1 = \hat{F}X$ (by 3.12a) and such industrial profits correspond directly to a portion of the output of the industrial sector. With respect to π_2, which originates in the agricultural sector in the form of surplus agricultural goods it is used by the owner of that surplus (e.g. the landlords) to exchange for industrial goods with workers in the industrial sector. In this way, surplus agricultural goods are used as a "wages fund" which finances the real capital accumulation in the industrial sector.[1] Based on this understanding of the nature of π_2 it is reasonable to assume that the amount of savings fund available from this source is related to the number of workers allocated to the industrial sector. Thus we may postulate, for the two components of the total savings fund,

3.22) a) $\pi_1 = \beta X$ (industrial component of the savings fund)

b) $\pi_2 = gL$ (agricultural component of the savings fund)

In 3.22b) g may be referred to as the surplus coefficient, as it measures the volume of the agriculture-derived savings fund per unit of industrial worker. Since we earlier assumed in the way of simplifying our analysis, that the total saving fund is devoted entirely to real capital accumulation in the industrial sector, the rate of growth of capital in the industrial sector can be written as

3.23) $$\eta_K = \frac{\pi_1 + \pi_2}{K} = (\pi_1/L + \frac{\pi_2}{L})K^* = (\beta X^* + g)/K^*$$

From this we can see that the rate of growth of capital is seen to depend on the surplus coefficient (g), on output per head X^*, [the behavior of which can be traced to the wage force (3.15)] and on capital per head, K^* [the behavior of which can be traced to both the wage and the innovation force (3.20b)].

Notice that the magnitude of the surplus coefficient "g" may not be constant through time; furthermore, both "g" and "w" are closely related to the availability of agricultural goods and the terms of trade between the agricultural sector and the industrial sector in the dualistic economy. To see this more fully recall that in times of a bumper crop, the abundant supply of agricultural goods in the intersectoral commodity market will tend to depress

[1] The precise method of this transfer, via the intersectoral commodity and the intersectoral finance markets, with the industrial worker giving up industrial goods (or claims against the industrial sector) to the landlord in exchange for the agricultural wage goods left behind is analyzed in detail in Fei and Ranis, op. cit. Ch. 3.

the agricultural sector's terms of trade. This will, on the one hand, make food cheaper to the industrial sector and hence lower the value of $w(t)$; on the other hand, when the owners of the agricultural surplus seek to exchange their food for industrial capital goods in the intersectoral commodity market they will be able to obtain only a smaller amount of industrial goods on a per unit of industrial worker basis. Thus both w and g fall. Conversely, a bad crop will raise the price of food relative to that of industrial goods and will cause both w and g to increase.

For purposes of simplification, we shall assume that the rates of change of w and g are the same, i.e.

3.24) a) $\eta_g = \eta_w$ and

b) $g/g(o) = w/w(o)$ (by 3.4)

When (3.24b), (3.5) and (3.20b) are substituted in (3.23), we have, after simplification,

3.25) a) $\eta_K = m[F/F(o)]^{1/\beta} \; [w/w(o)]^{\frac{1-\beta}{\beta}}$ where

b) $m = \beta X^*(o) + g(o)/K^*(o) > o$

Equation (3.25a) traces the determination of the rate of growth of capital to the two exogenous forces, wage behavior and innovation behavior. While a high level of innovational intensity sustained through time will contribute to a high rate of growth of capital, a high rate of wage increase will depress the rate of growth of capital. These results more or less confirm what we would expect intuitively to be the case, i.e. premature wage increases can choke off the industrial growth process.

Nevertheless, in the dualistic economy, the relationship between the real wage rate and the rate of growth of capital in the industrial sector is a complicated one. For even at the level of abstraction envisioned in this section, variation in the wage rate can affect η_K in various ways. On the one hand, an increase, [for example], in the wage rate will adversely affect the internal reinvestment potential within the industrial sector by depressing the industrial profit component (π_1) of the saving fund. On the other, the increase in the surplus coefficient (g) associated with an increase in the wage rate will favorably affect the agricultural sector's ability to provide developmental finance by raising the surplus component (π_2) of the saving fund. Moreover, all these "direct" effects of wage increases are intermingled with the "indirect" effect (on η_K) due to the impact that any wage increase will have on the employment of labor (under competitive rules) and the associated expansion of industrial output. Equation (3.25a) summarizes all these direct and indirect effects of the variation of the exogenous forces on η_K.

Notice that when the wage rate is constant, the innovation effect inevitably leads to a gradual increase of η_K through time. Thus in case the condition of an "unlimited supply of labor" prevails precisely (i.e. $\eta_w = o$) the (unlikely) failure of η_K to increase through time can only mean that the process of importing technology by this particular "late-comer" nation has been less than satisfactory. On the other hand, when the real wage increases through time, η_K may or may not increase through time.

In order to analyze the direction of change of η_K, the rate of capital acceleration can be calculated from (3.25a) as

3.26) $$\eta_{\eta_K} = \frac{1}{B}[J - \eta_w] + \eta_w$$

The two terms on the right-hand side of (3.26) can be analyzed separately. The second term (η_w) is positive (at worst zero) and thus causes η_{η_K} to increase. The first term always behaves like η_{K*} for, using (3.19), we can rewrite (3.26) as

3.27) a) $$\eta_{\eta_K} = \eta_w - \eta_{K*} \quad \text{or}$$

b) $$\eta_w = \eta_{\eta_K} + \eta_{K*}$$

Based on (3.27), we can analyze the term η_{K*} as before in connection with

(3.19). For example, in times of industrial sector capital capital shallowing (η_{K^*} o) we immediately conclude that η_K will increase through time. However, when capital shallowing gives way to capital deepening, we expect η_K to slow down its rate of increase or even decline. The rather neat result of (3.27b) can be viewed in another way when rewritten as

$$3.28a)\ \eta_w = \eta_{\eta_K K^*} = \eta_{\left(\frac{\pi 1 + \pi 2}{L}\right)}$$

$$b)\ \frac{w}{w(o)} = \frac{\pi 1 + \pi 2}{L} \Big/ \frac{\pi 1(o) + \pi 2(o)}{L(o)}$$

which shows that the results obtained in (3.27) are mainly due to the fact that the fractional increase in the real wage rate is equal in magnitude to the fractional increase of the per capita savings fund. Finally, from (3.25a) we see that when a reasonable function is postulated for w(t), it is possible to find the growth path of capital (K) by direct integration:

$$3.29)\quad K = K(o)e^{m\int (F/F(o))^{1/B}/(w/w(o))^{(1-B)/B}\,dt}$$

Turning to the rapidity with which the industrial sector expands its employment opportunities, the reader should recall that the rate of labor transfer when compared with the rate of population growth determines whether or not the center of gravity of the economy can be gradually shifted from the agricultural sector to the industrial sector./1 The basic labor absorption equation can be deduced from (3.2a) and, using the simplifications introduced in (3.12) yields

$$3.30a)\ \eta_L = \eta_K + \frac{J - \eta_w}{\beta} \quad \text{or (for } J = \eta_F\text{)}$$

$$b)\ \eta_L = \eta_K + \eta_{(F/w)\beta}$$

Since the rate of growth of capital (η_K), the first term on the right hand

/1 This CMEC (critical minimum effort criteria) is elaborated in Fei and Ranis, (op.cit.,) Chapter 6.

side of (3.30) has been shown to depend on the two exogenous forces in (3.25a), the rate of labor absorption (η_L) is also seen to depend on the same two forces. The analysis of the direction of change of η_L is thus already implied in our analysis of η_K and η_{K*}. For example, since we expect to see capital shallowing first, later giving way to capital deepening, (see above) and since in time of capital shallowing, η_K can be expected to increase through time we immediately conclude that we may expect η_L to be smaller than η_K and increasing with η_{K*}. From (3.30), we have

3.31) a) $\eta_L = \eta_{K(F/w)^{\beta}}$ and

b) $$\frac{L}{L(o)} = \frac{K}{K(o)} \left(\frac{F/F(o)}{w/w(o)}\right)^{\beta}$$

which is a general relationship among the various "multiples of increase" of L, K, F and w. Thus while higher innovation intensities (F/F(o)) cause the industrial labor force to grow at a higher rate than capital, a large increase in the wage rate has the opposite effect.

Finally, turning to the rate of growth of output, since according to (3.14) the productivity of labor and the wage rate are growing at the same rate, we have

3.32) a) $\eta_X = \eta_L + \eta_w$ or from (3.31b)

b) $$\frac{X}{X(o)} = \frac{K}{K(o)} \left\{\frac{F}{F(o)}\right\}^{\beta} \left\{\frac{w}{w(o)}\right\}^{1-\beta}$$

The latter expression (3.32b) summarizes the relationship among the various "multiples of increase" of X, K, F and w. Moreover, recalling our discussion of the direction of change of η_L, it is easy to trace the direction of change of η_X with the help of (3.32).

Intersectoral Interaction in the Dualistic Economy

In the above we have analyzed the process of development of the industrial sector of the dualistic economy--assuming that the industrial wage rate ($w(t)$) and the innovational intensity in industry ($J(t)$) are given exogenously. It is the purpose of this section to develop the analytical framework further to encompass the process of development for the dualistic economy as a whole. The focal point of such analysis must naturally rest on the interaction between the agricultural sector and the industrial sector.

A rigorously formulated growth model is, by necessity, a dynamic general equilibrium model explaining the way in which the time path of an interrelated system of economic magnitudes is determined. In the case of the dualistic economy, in particular, such a dynamic system must, in addition, be capable of emphasizing the asymmetrical nature of the relationship between the production processes in the two sectors. It is the purpose of this section to construct a formally deterministic growth model/1 encompassing all the essential growth-related phenomena at the aggregate level.

In spite of the fact that there are only two production sectors the growth process in the dualistic economy is, by its very nature, a very complicated phenomenon. For not only does this process involve production-centered phenomena (such as the use of capital and labor and the generation of innovational activities) in two production sectors separately but also, and crucial to the entire growth process, such intersectoral relations as

/1 Using this criterion of "dynamic determinism", the previous work of Jorgenson (op. cit.) and Fei-Ranis (op. cit.) may be contrasted. Both are concerned with generally the same phenomenon, yet while Jorgenson is "formally" more satisfactory than Fei-Ranis, this methodological formalism of Jorgenson is purchased at the price of overly simplifying the problem by not including what we believe to be some of the most essential growth-related phenomena. The real world is, of course, too complicated for any model. It is our purpose in the above to attempt a compromise between "methodological formalism" and "all inclusiveness."

the transfer of labor from the agricultural to the industrial sector; the intersectoral channelization of savings, and the possibilities of the intra-sectoral and intersectoral stimulation of technological change. Central to this process are not only the forces of production (i.e. the production functions of the two sectors) and consumption (i.e. the consumer preference function), but also the impact of such "exogenous" forces as population growth and the substantial possibility of importing technology because of the dualistic system's "late-comer" status. Finally, we should recall that all these real production, allocation, consumption and distribution decisions must be made within the context of a set of organizational devices to handle and coordinate the various disparate economic activities. For example, with respect to the particular institutional milieu of capitalism or the "mixed economy" this involves the use of wages and prices as instruments of stimulation and harmonization. When the workings of this entire system are to be understood, satisfying all the major conditions imposed by the real world, the dynamic general equilibrium model which emerges is, by necessity, a complicated and cumbersome one.

In order to introduce the model in its entirety, let us first present the following system of growth equations; our immediate task is to explain the economic significance of these equations individually and then to proceed to show that, collectively, they determine the entire growth process in an orderly fashion. (To facilitate our exposition a brief description of each variable and of the relationship in which it is involved is presented after each equation.)

3.32a) $Y = e^{\int \theta} A^{\alpha}$ (production function in the agricultural sector. Y: agricultural output; A: agricultural labor force, θ: innovation intensity in agricultural sector.)

b) $P = A + L$ (labor allocation equation. P:total population L:labor force in the industrial sector).

c) $S = Y - A\bar{w}$ (definition of total agricultural surplus (TAS). S:TAS;w:institutional real wage in terms of agricultural goods).

d) $V = T/L$ (definition of average agricultural surplus (AAS) V:AAS).

e) $\tau = gl/S$ (definition of terms of trade. τ:terms of trade (units of industrial goods exchanged per unit of agricultural goods)).

f) $w=\phi(V)$ (determination of industrial real wage. w: real wage in terms of industrial goods)

g) $g=\lambda w$ (determination of surplus coefficient. g:surplus coefficient;λ; proportionality factor between g and w).

h) $\theta = f(\tau)$, $\theta' \geq 0$ (intensity of agricultural innovation function).

i) $\eta_P = r$ (Population growth function r: population growth rate).

j) $X = F(t) K^{\beta} L^{1-\beta}$---(3.5)

k) $J=\eta_F = b+ae^{-ut}$---(3.6;3.7a)

l) $\pi_1=BX$-------------- (3.22)

m) $\pi_2=Lg$-------------- (3.22)

n) $\eta_K=(\pi_1+\pi_2)/K$-----(3.23)

o) $\eta_L=\eta_K / \frac{J}{B}$---------

see earlier discussion as indicated in text

Equation (3.32a) is the production function for the agricultural sector as deduced from a Cobb-Douglas function with neutral innovation

3.33) $Y=F(t)\, A^{\alpha}\, T^{1-\alpha}$ where

T stands for land and F(t) is the "innovational level" factor similar to F(t) in (3.5) for the industrial sector. Denoting the innovational intensity in the agricultural sector by θ, then

3.34) a) $\theta = \dot{F}/F$ (by 3.32k) and hence

b) $F=F(o)e^{\int \theta dt}$ (by 3.4)

When (3.34b) is substituted in (3.33), we obtain (3.32a) after redefining the unit of measurement of output and assuming land to be fixed. The reason that the intensity of agricultural innovation θ is formally introduced into the production function is because of our conviction, previously stated, that the analysis of changing innovational behavior in the agricultural sector is central to the performance of the dualistic economy. In this sense, the treatment given to agricultural innovations or θ is completely symmetrical to that given to industrial innovations or J. Nevertheless, the symmetry in treatment ceases when we proceed beyond this formal level. The basic difference between J in the industrial sector and θ in the agricultural sector is due to the fact that while J is assumed to be determined exogenously, the value of θ is determined endogenously. We shall return to this problem later, i.e. in discussing equation (3.32h).

Equations (3.32c)[1] and (3.32d) present definitions of S (or TAS, total agricultural surplus) and of V (or AAS, average agricultural surplus) respec-

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[1] Equation (3.32b) simply states that the total labor force (P) is to be allocated at all times to either the agricultural sector (A) or the industrial sector (L) while equation (3.32i) states that the total population is growing at a constant rate r. These two equations thus need no further explanation.

tively.[1] When a fixed real wage, in terms of agricultural goods $\bar{w}$, is given exogenously as the institutionally determined wage level, S is the surplus of agricultured goods after all the agricultural labor force has been fed at $\bar{w}$. Regardless of the ownership of the TAS it will be assumed that the entire amount (S) will be exchanged in the intersectoral commodity market for industrial goods. On the other side of this transaction are industrial workers who, after receiving their wage in terms of industrial goods, seek to acquire agricultural goods for purposes of consumption. We assume the initial wage in terms of agricultural goods to be "tied" to the agricultural wage whether at equality or allowing for a wage margin -- because of the reserve army of surplus agricultural labor overhanging the industrial labor market. Thus, the measure of availability of agricultural goods per unit of worker already allocated to the industrial sector is the AAS. Since the surplus coefficient "g" as defined in (3.22b) is the amount of investment goods originating from agricultural surplus, per unit of industrial worker (L), we see that the total expenditure, in terms of industrial goods, of all the industrial workers is gL. Thus, the terms of trade between the two sectors is gL/S as given in equation (3.32e).

The economic significance of the AAS lies in the fact that it is a measurement of the extent of commodity support that the agricultural sector furnishes to the industrial sector. The magnitude of the AAS directly determines the terms of trade when we know consumer preferences as well as the level of the institutional wage in terms of agricultural goods. While this relation is fully analyzed elsewhere[2], we shall only present a brief summary here.

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[1] TAS and AAS are defined in this same fashion in Fei and Ranis, op. cit.

[2] Fei and Ranis, op. cit. chapter 5.

In diagram 10, let agricultural (industrial) goods be measured on the vertical (horizontal) axis and let the indifference map of a typical worker in the industrial sector be given. Let the constant institutional level of the real wage $\bar{w}$ in agriculture be marked off on the vertical axis and let the price-consumption curve from the point $\bar{w}$ be constructed. In case the amount of AAS is known, its magnitude can be indicated by a point such as A on the vertical axis. This permits us to obtain point D on the price-consumption curve. It is then obvious that the slope of the straight line $\bar{w}$ D represents the terms of trade (T) between the two production sectors--for only at these terms of trade will the intersectoral commodity market be cleared, i.e., will the AAS be purchased by the typical industrial worker. This holds true under the assumption that the industrial wage <u>in terms of agricultural goods</u> is pinned at $\bar{w}$ units of food (i.e., the institutional real wage in terms of agricultural goods prevailing in the industrial sector not only is tied to the value of the agricultural real wage but--for simplicity's sake--is equal to it). The value of the real wage in terms of industrial goods then is OB and the value of the surplus coefficient is g, as noted on the horizontal axis. To be more specific, the economic interpretation of g is the amount of industrial goods which the typical industrial worker gives up in exchange for the surplus of agricultural wage goods he has left behind.

The above analysis shows that the industrial real wage in terms of industrial goods is controlled by the relative availability of agricultural surplus through a mechanism operating in the intersectoral commodity market. This functional relationship between the AAS and w is given by equation (3.32f) and is represented by the curve in the second quadrant of diagram 10.

As is indicated in this diagram, any increase in the AAS will depress the real industrial wage through a cheapening of food (i.e., a deterioration of agriculture's terms of trade). Moreover, we see that the surplus coefficient "g" is also a function of AAS and that the determination of "w" and "g" are really different facets of the same phenomenon involving the operation of the intersectoral commodity market. The relation between "g" and AAS is represented by the lower curve in the second quadrant of diagram 10. We see that a large AAS will depress "g" as well as "w" which means that a typical industrial worker will exchange less industrial goods for his agricultural wage bundle than before when the supply of food increases. We are thus upheld in our earlier assertion that w and g move in the same direction. In (3.32g) we add the simplifying assumption that they change at the same rate ($\eta_w = \eta_g$).

Equation (3.32h) states that the intensity of innovations in the agricultural sector (θ) is a function of and is positively related to the terms of trade, Υ as they are determined in the intersectoral commodity market. Intuitively, the economic justification for this assumption should be clear: a cultivator will make a larger effort in initiating new cultivation practices or imitating those initiated by others, (both resulting in a higher intensity of agricultural innovation), when the terms of trade are more favorable to the agricultural sector.

The motivation for an increase in the annual flow of agricultural innovations, as we pointed out earlier, is directly tied up with the opportunities perceived, on the part of the decision-making units in agriculture, for acquiring ownership of the industrial sector capital stock or industrial consumer goods. The incentive to increase agricultural productivity is enhanced if it becomes clear that the proceeds from such increases can be utilized to obtain assets in the industrial sector--either directly or through financial intermediaries--or to obtain industrial consumer goods previously imported, or not at all within the consumer's horizon. Once the relationship between either or both of these objectives and the human effort and toil involved in applying fertilizer and water, using better seeds, pesticides, crop rotations, etc., becomes clear, marked changes in agricultural productivity can be realized. As historical experience in such diverse cases as Japan, Greece and Mexico indicates, the dynamic outward-looking agricultural sector of the dualistic economy in which activities on the soil are not hermetically sealed off from the rest of the system can yield increases in θ over a decade larger than those achieved through centuries of inner-oriented agrarian isolation.

The importance of contiguity or "connectedness" between the agricultural and industrial sectors of the dualistic economy has been much neglected. If the owner of the surplus can see a way to invest directly in an extension of the industrial sector close to the soil and in familiar surroundings he is much more likely to choose the productivity out of which further savings can be channelized. The experience of nineteenth century Japan indicates that such intersectoral "connectedness" is much enhanced by the growth of decentralized rural industry, often linked with large-scale urban production stages via a putting-out system. The Japanese government's role, using the land tax, much referred to in the literature, was undoubtedly of considerable importance in financing social and economic overheads in the early Meiji period. But it was really the flow of private voluntary savings through a large number of small hands which was responsible --and increasingly so in the course of the nineteenth century--for financing of the prodigious Japanese industrialization effort. It was, in fact, mainly the medium-sized landlord, with one foot in the agricultural and one in the industrial sector, reacting to the inter-sectoral terms of trade and the changing relative returns to investments of his time and ingenuity, who propelled the dualistic system forward in a balanced synchronized fashion. As late as 1883 80 per cent of all Japanese factories were located rurally, with 30 per cent of the still agricultural labor force, moreover, engaged in rural industrial "side jobs."

A dualistic landlord, or his counterpart in another historical or socio-cultural context, not only eases the difficulties attending the required intersectoral financial intermediation but reduces problems attending the immobility of traditional rural labor, increases the potentialities of using efficient labor-intensive production functions and avoids the overexpansion of capital-hungry urban centers.[1] We do not wish to deprecate the conventional wisdom about the importance of government experimentation and research, of education and extension activities, all of which undoubtedly facilitate the propagation of technological change; but we do want to emphasize the importance of a motivational dimension without which the chances of a really dynamic balanced growth performance in the dualistic economy are considerably dimmed.

Herein, in fact, lies the essence of the difference between agrarianism and dualism. In agrarianism no active innovational inducement mechanism

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[1] For a fuller discussion of the role of the dualistic landlord in nineteenth century Japan, see Fei and Ranis, op. cit., Chapter 5.

is at play, no entrepreneurial group exists sensitive to surplus-generating opportunities within and outside of agriculture. In the dualistic setting, on the other hand, there exists an entrepreneurial classwith decision-making power and access to land which associates its personal well-being--either in the form of industrial consumer goods or ownership of industrial capital goods--in a clear and direct fashion with the continuous improvement of agricultural practices. Whatever the embodiment of such a group in any particular case, it is unlikely to either be very large in number or exhibit conventional Schumpeterian characteristics. But such entrepreneurs represent leader who are followedand imitated by the large mass of dispersed cultivators and make it possible for the dualistic economy to progress and ultimately graduate into economic maturity.

The above association obtained by deductive reasoning and buttressed by inductive evidence for the case of nineteenth century Japan must undoubtedly be subjected to fuller empirical testing. There seems to be little doubt about the general relevance of industrial proximity for agricultural productivity change in the United States.[1] With respect to less developed countries Nicholls has carried on some (as yet unpublished) work on Brazil which points in the same direction. The importance of the decentralized rural-oriented character of the Japanese industrialization effort has been

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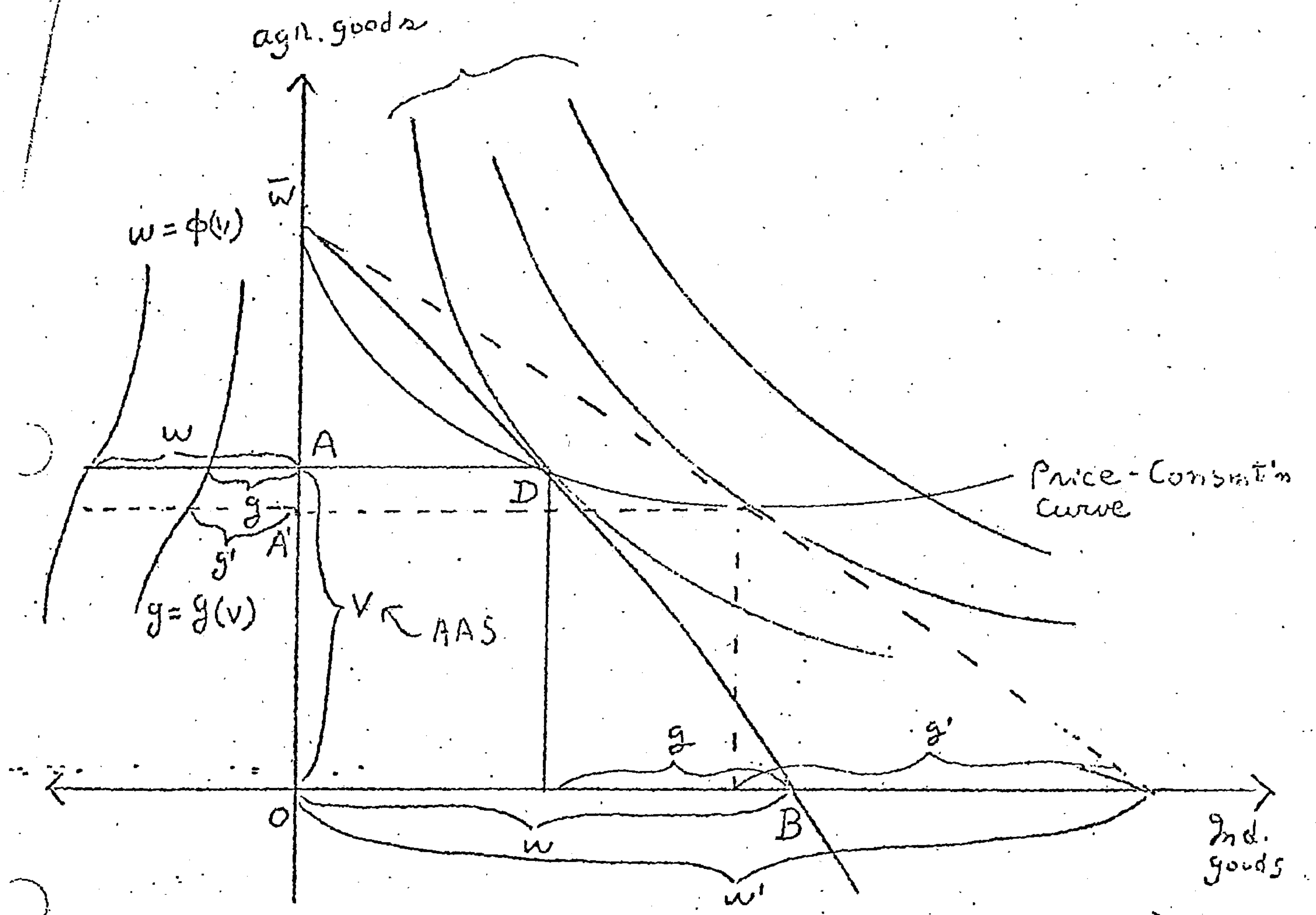
[1] See, for example, W. Nicholls, "Industrialization, Factor Markets and Agricultural Development," Journal of Political Economy, 1961. Also, W. Nicholls and A.M. Tang, Economic Development in the South Piedmont, 1860-1950: Its Importance For Agriculture, 1958.



agr. goods
$\bar{w}$
$w=\phi(v)$
w
A
g
A'
g'
$g=g(v)$
V
AAS
D
Price-Consmt'n Curve
g
g'
O
B
w
w'
Ind. goods

DIAGRAM 10

documented elsewhere at considerable length.[1] Even Schultz acknowledges that, "the process of development appears to have its mainspring in the industrialization complex,"[2] i.e., divergencies in the pattern of agricultural productivity change are related to the proximity to an industrial-urban complex. The decision-making units in agriculture must have a window onto the rest of the world if substantial technological change is to result.

Finally, returning to our equations on page 56, equations (3.32i to 3.32o) represent previously introduced growth equations relevant to the industrial sector. These equations include the production function (3.32j); an assumption concerning declining innovational intensity in the late-comer underdeveloped economy (3.32k); definitions of the two components of the savings fund (3.32l and 3.32m); the definition of the growth rate of capital (3.32n) and of the rate of industrial labor absorption (3.32o).

Having explained the above 15 equations individually let us now turn to the problem of the dynamic determinism of the growth process through the interaction of the forces summarized with the help of these equations. To assist us in achieving a firmer grasp of the workings of the dualistic economy as an organic analytical whole a fuller understanding of the proposed causal order of the economic forces at work may be helpful. In diagram 11 a causal order chart is presented. The heavy horizontal line marks off two adjacent periods, e.g., t=o (above the line) and t=1 (below the line).[3] In each

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[1] See Fei and Ranis, op. cit., and John P. Lewis, Quiet Crisis in India: Economic Development and American Policy, 1962.

[2] T.W. Schultz, The Economic Organization of Agriculture, New York, 1953.

[3] It should be realized that such demarcation into periods 0, 1, 2...etc., is exaggerated here for purposes of exposition. In any truly dynamic system changes are not distinct but occur continuously. What matters, however, is the order of causality.

period, we find three large circles including three clusters of economic concepts: agricultural sector concepts (circle on the left) industrial sector concepts (circle on the right) and intersectoral concepts (circle in the center). While this grouping is not exact, it may help us to develop a sense of order for the growing system as a whole. The various arrows indicate the assumed direction of causation (or the order of determination of the system). For convenience we use the notation (x,y) to refer to an arrow which initiates from concept "x" and points to concept "y". Finally, numbers (1, 2, 3....) are attached to the various concepts to identify their order of presentation in our discussion.

Let us begin with the initial values, at t=o, of population P(o), innovational intensity in agriculture $\theta(o)$, industrial labor force L(o), industrial capital stock K(o), the level of innovation in the industrial sector F(o) and the constant institutional wage in agriculture $\bar{w}$. The initial values of these six variables (and of only these) are assumed to be given. Let us now concentrate on the determination of the other economic magnitudes within the agricultural sector. Given the size of the total population P(o) and the total industrial labor force L(o), we can immediately determine the size of the agricultural labor force A(o) by using (3.32b). Since the initial intensity of agricultural innovation $\theta(o)$ is given, this, together with A(o), determines total agricultural output Y(o) by using the production function (3.32a). We can then proceed to determine the size of the agricultural surplus by using Y(o), A(o) and the institutional wage $\bar{w}$ according to (3.32c). In this way all the concepts in the agricultural circle at time t=o can be determined.

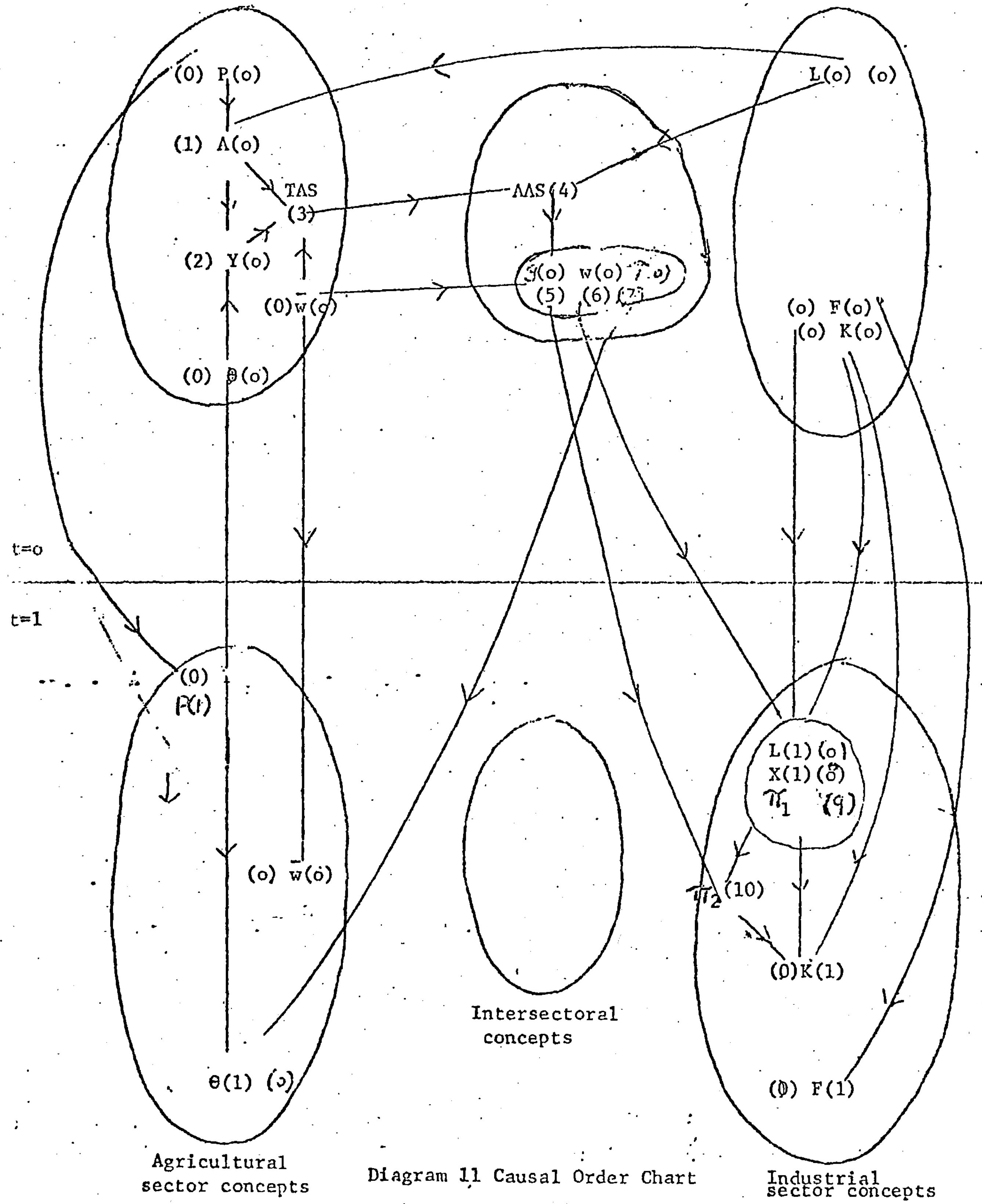

Diagram 11 Causal Order Chart

Next, given total agricultural surplus TAS and the size of the industrial labor force, we can, by using (3.32d), determine the magnitude of the average agricultural surplus AAS. The AAS concept represents a crucial link between the two sectors of the dualistic economy since, together with the institutional wage $\bar{w}$, it determines a set of three important economic magnitudes, namely the industrial real wage $w(o)$, the surplus coefficient $g(o)$ and the intersectoral terms of trade $\widetilde{T}(o)$. This in fact completes the determination of all the concepts in the intersectoral concept circle at $t=o$.

Turning our attention now to the industrial sector, we can see from the industrial sector circle at $t=1$, that the size of the previous period's industrial capital stock $K(o)$, the level of innovation $F(o)$, together with the wage rate $w(o)$ determine the amount of industrial labor absorbed in this period $L(1)$, as per equation (3.32o). This, in turn, determines industrial output $X(1)$ and industrial profits $\pi_1(1)$ by use of the industrial production function (3.32g) and the distribution equation (3.321). Furthermore, the surplus coefficient $g(o)$ and the industrial labor force $L(1)$ together determine the agricultural surplus contribution to the total savings fund $\pi_2(1)$ in accordance with equation (3.32m). Once we know the total savings $(\pi_1 + \pi_2)(1)$ we can then determine the capital stock in the next period $K(1)$. Furthermore, the level of innovation in the next period $F(1)$ is determined as we have assumed that the innovation activity in the industrial sector is exogenously given according to (3.32k). In this fashion all the concepts in the industrial circle at $t=1$ are determined.

To complete this discussion of determinism, we see that the total population at $t=1$ is given by (3.32i). However, what is most significant is that we can determine the level of innovational intensity $\theta(1)$ as a phenomenon directly related to the activities in the intersectoral commodity market, i.e., the term of trade $\Upsilon(o)$ and the innovation intensity in the previous period $\theta(o)$ determine the innovation intensity $\theta(1)$ (and hence the level of technology) in this period according to (3.32h).

In this way we see that there are altogether fifteen variables (P, A, L, Y, S, θ, V, g, w, T, X, π_1, π_2, K, F) to be determined by the fifteen equations on page 56. Furthermore, we see that the five variables (P(o), L(o), Q(o), F(o), and K(o)) whose initial values are assumed to be given at t=o (i.e., which are indexed by causal order "o") are again determined at t=1. This means that we can then start the whole cycle once again and determine all the magnitudes in the next round (t=2). Finally, the reader should note that there are seven variables (numbers 1-7) which appear in t=o but not in t=1; and there are three variables (numbers 8-10) which appear in t=1 but not in t=o. This means that there can be no problem of inconsistency through overdeterminacy in any sub-system of the above equation system.

VI Conclusion

The main purpose of this paper has thus been to contrast two definable regimes of economic activity relevant to the problem of development, i.e., of agrarianism and dualism, and to explore the rules of growth peculiar to each. In this pursuit we have endeavored to draw as much as possible on the growth-theoretic implications of the work of both the physiocratic and classical schools as well as the more modern writers concerned with development in the less developed world.

The reasons for this inquiry are clear. On the one hand, it is our belief that agrarianism represents not only an important, if neglected, state of economic organization in the historical past but also accurately describes the modus vivendi of substantial portions of the contemporary underdeveloped world. On the other hand, we firmly adhere to the view that the growing interest in the analysis of growth under conditions of economic dualism constitutes a big step forward in our understanding of the essential facets of the growth process. Finally, we are convinced that in the idealized life cycle of historical development, a successfully evolving economic system is likely to proceed from agrarianism through dualism to economic maturity.

To bring our overall framework somewhat closer to the real world and to the possibilities of empirical verification we have, moreover, endeavored to move toward the evolution of a fully deterministic system to explain long-term agrarian behavior as well as a deterministic model to describe the dynamic interaction of both sectors in the growing dualistic economy. This attempt to proceed from a general framework to a deterministic model must clearly be viewed as a preliminary effort. Future work in this area should probably proceed in two directions. On the one hand, more help is required from the economic historian with respect to determining the mainsprings of behavior in earlier agrarian systems and much more inductive evidence is needed on the behavior of contemporary agrarian as well as dualistic societies. On the other hand, we need to develop more convincing theorems, by deductive reasoning, which can be proved (or disproved) by statistical data. For example, in (3.11), we postulated a pattern of real wage behavior for a dualistic economy purely on inductive grounds (i.e. based on the experience of Japan as summarized in diagram 9). Whether or not such a pattern is really to be expected should clearly be the result of a deductive investigation of a model structure such as the one defined by the equations system 3.32)/1.

/1 On this particular issue (i.e. the establishment, deductively, of a "turning point" along an initially horizontal wage curve for a dualistic economy), See Fei and Ranis Chapter 7.

Thus the above attempt to describe the dynamic rules of growth of the agrarian and dualistic systems, taken separately, must be viewed as representing merely our best, and undoubtedly inadequate, thinking in the present state of our knowledge. Moreover, the reader should note that we have had even less definitive to say about the problem of the transition from one regime to the other. The reasons for this should be equally clear, namely, while the task of explaining the "machinery" which moves the system under conditions of agrarianism or dualism is challenging enough in and of itself, an adequate explanation of the transition from one regime to the other is considerably more "deep" and complicated. The questions here go beyond an analysis of what specific economic functions need to be fulfilled for a system to operate in a prescribed fashion, and extend to asking how specific and rather fundamental changes can be achieved before the system can be expected to change its fundamental modus operandi. An analysis of what permits an economy to graduate from agrarianism to dualism, in other words, requires a change in the method of traditional analysis. It requires proceeding beyond the resources framework in which the economist is at home, to the mutual interaction between the economy's human agents, the institutional framework within which they organize themselves, and these economic functions proper. For example, we have not even scratched the surface in understanding the full workings and changing nature of the crucial innovations inducement mechanism in either agriculture or elsewhere without which our progress is bound to be limited.[1] To bring this matter closer to home we must know more about the tenure and other institutional aspects in agriculture which make it more likely for θ- enhancing activities to replace θ-obstructing activities as a routine matter. What is ultimately needed is a new deterministic transition theory to go along with any satisfactory deterministic theory of agrarianism and dualism, taken separately.

Our paper frankly espouses the notion that development is likely to proceed via the transition first, from agrarianism to dualism and, then, from dualism to maturity.[2] Yet we think we differ from the stages theorists in that we proceed from a fairly well defined analytical framework within which precise questions can be asked concerning the functions that need to be performed within each stage as well as to effect the transition between any two stages. Parts of our framework may well be inadequate and will need to be modified or replaced as more evidence is accumulated and better theorizing becomes possible. But retention of such an analytical framework is essential if a satisfactory refutable theory (or set of theories) of development is some day to emerge.

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[1] This, incidentally, is still lamentably the case even for the mature industrial system.

[2] The conditions for success in the latter transition have been elaborated earlier (Fei and Ranis, op. cit., Chapter 7). "The Life Cycle of Economic Growth".

ERRATA SHEET FOR PAPER

AGRARIANISM, DUALISM AND ECONOMIC DEVELOPMENT

by John Fei and Gustav Ranis

to be presented at the Iowa State Conference

1) p. 8, footnote 1, for "redundary" read "redundancy".

2) p. 10, add "type" at bottom of page.

3) p. 11, line 3, for "A_o" read "OA_o".

4) p. 13, line 3, for (Y*) read (η_Y*).

5) p. 13, in equation 1.10)b) for η_Y read "η_Y*".

6) p. 13, middle of page, eliminate "because of the fact that labor are no longer operating."

7) p. 15, line 6, for "G_1" read "G".

8) p. 23, equation 1.13a) should read "Q'>0"

9) p. 38, line 1, for $\eta_y = \frac{dy}{dt}/y$ read "$\eta_y = \frac{dy}{dt/y}$"

10) p. 38, equation 3.2a) and 3.2b) for "η_y and η_y*" read "η_x and η_x*".

11) p. 38, equation 3.3b)ii) eliminate "-J".

12) p. 40, equation 3.4 should read "$S(t) = S(o)\, e^{\int \eta_s dt}$".

13) p. 40, equation 3.5 for "U" read "O".

14) p. 44, line 13, should read "distribution of X into".

15) p. 52, equation 3.28, all <u>1</u> and <u>2</u> are subscripts of π.

16) p. 64, line 1, delete "Even".