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> Exogeneity is an attribute of the chosen framework of thought, not an attribute of the events themselves.
> —R. C. O. Matthews, C. H. Feinstein and J. C. Odling-Smee

This paper puts forward a new Keynesian growth model, and with it analyses rapid growth and slowdown of the postwar Japanese economy. In the 1950's and 1960's, there was widespread interest among economists in the long-run economic growth. But by the 1970's, research interest in growth waned, despite the paramount importance of the issues. Progress in the world economy, however, has once again stimulated renewed work on growth in recent years. Continuing differential in growth rates between Japan and the U. S., for example, may indeed change drastically the world economic atlas in the next century: With growth rates of Japan and the U. S., 4% and 2.5%, respectively, by 2010 the level of real per-capita income in the U. S. would become two thirds of that of Japan.

It is then crucial to understand why the economy grows and why growth rates differ. To answer these questions, all the hitherto existing growth models, including recent 'endogenous' growth models, focus on supply side, ignoring demand constraints. This paper argues, however, that real demand constraint ignored by neoclassical theory is the key ingredient to understand the process of economic growth. It is often held that demand constraints, if they are important, play their role only in the short-run. Economics then falls apart in two parts which deal respectively with the short-run fluctuations and long-run growth. The problem of combining long-run and short-run is still a challenge to macroeconomics. Solow [1988], for example in his Nobel lecture argues as follows.

> It will not do simply to superimpose your favorite model of the business cycle on an equilibrium growth path. That might do for very small deviations, more in the nature of minor slightly autocorrelated "errors." But if one looks at substantial more-than-quarterly departures from equilibrium growth, as suggested for instance by the history of the large European economies since 1979, it is impossible to believe that the equilibrium growth path itself is unaffected by the short- to medium-run experience. In particular the amount and direction of capital formation is bound to be affected by the business cycle, whether through gross investment in new equipment or through the accelerated scrapping of old equipment. .... So a simultaneous analysis of trend and fluctuations really does involve an integration of long run and short run of equilibrium and disequilibrium. ....
>
> The most interesting case to consider is one where real wage and rate of interest are stuck at levels that lead to excess supply of labor and goods (saving greater than investment <u>ex ante</u>). This is the sort of configuration we have come to call "Keynesian." .... As you would expect, an important role is played by the investment function.

In this paper, we follow Solow's suggestion and set out an alternative theory of growth in which investment plays the key role. The observation that effective demand is the major determinant of output in the short-run leads us naturally to a model of demand-led growth.

Prior to laying out the argument, two general remarks are in order. First, one must note the importance of real demand constraints. The neoclassical theory simply ignores these constraints. Keynes' theory (Keynes [1936]) emphasizes real demand constraints, of course, but it is put forth in the context of the short-run where capital stock is unchanged. This paper argues that the real demand condition facing the economy, as well as technological progress on supply side, are in fact the key ingredients of any reasonable theory of economic growth and fluctuation. Real business cycle theory attempts to explain both growth and cycle in a single framework which focuses on supply shocks. In contrast, starting with the observation that real demand shocks are the major impulses in the short-run fluctuations, we attempt to explain growth in terms of demand.

The second remark concerns the role of the firm, in particular, the role of investment. In neoclassical theory, firms are nothing but veils, in that given an exogenous technological possibility set, households' preferences ultimately determine the outcomes of the economy. In fact, in recent years more and more emphasis has been put on households' utility maximization. The optimum growth model, once understood as a normative model, is now taken as a descriptive model of the economy. As a consequence, the saving rate or the time preference of the representative consumer is supposed to play the key role in the process of economic growth. This paper, in contrast, assigns the paramount role to firm. The consumers' elasticity of intertemporal substitution plays little role. We argue that in the process of growth and fluctuation, firms play a much more dominant role than households. In this respect, we follow Schumpeter [1934] who wrote

To be sure, we must always start from the satisfaction of wants, since they are the end of all production, and the given economic situation at any time must be understood from this aspect. Yet innovations in the economic system do not as a rule take place in such a way that first new wants arise spontaneously in consumers and then the productive apparatus swings round through their pressure. We do not deny the presence of this nexus. It is, however, the producer who as a rule initiates economic change, and consumers are educated by him if necessary; they are, as it were, taught to want new things, or things which differ in some respect or other from those which they have been in the habit of using.

Having stated these general remarks, we will outline an alternative growth theory in what follows.

1. The Role of Investment in Economic Growth

In a standard model of economic growth (Solow [1956, 1957]), supply factors such as population growth and the rate of technological progress ultimately determine the growth rate of the economy. Out of the steady state, an increase in the saving rate also accelerates the growth rate. And yet growth in population or the labor force is not actually quite so fundamental in explaining economic growth. By itself, population increase will not suffice to fuel growth, as is amply illustrated both in history and in the world today. The same also applies to the saving rate. What neoclassical theory lacks is, as is often pointed out, an independent investment function (Sen [1965]) and a role for demand therein. This paper argues that these factors are indispensable ingredients for a theory to explain economic growth when examined at least over a decade or two if not over a century[1].

It was almost half a century ago when Domar [1946] argued that the relationship between investment and output is two sided; investment augments production capacity on the supply side, but at the same time it must be accompanied by a level of demand sufficient to require the resulting increase in capacity. Studies on growth since then, however, have largely focused on the supply side, that is, the production function. As far as future demand to meet augmented capacity is concerned, it is normally taken for granted that supply creates its own demand. In fact, even the Harrod-Domar model, let alone neoclassical models, considers the growth path on which the shadow price of the demand constraint for investment is zero, despite the fact that the multiplier theory on which it relies presumes the contrary for production. This paper proposes an explicit analysis of the investment decisions of firms under a demand-constraint. It argues that even in the long-run the demand-constraint is important for investment, the engine for economic growth. The point can be explained with the help of a simple model.

The Model

To introduce investment into the theory of growth, we consider investment decisions of a firm. The model is standard except for one thing: the firm is demand-constrained but to some extent the growth of demand depends on current investment.

Investment is customarily identified as something which augments the production capacity of the firm on the supply side. This paper argues, however, that investment also raises the demand for firm's product to some extent. Put differently, in a monopolistically competitive situation, the demand curve facing the individual firm shifts upward when capital stock increases. Specifically, investment would expand future demand for the firm's product, perhaps through the introduction of new products, the improvement on quality of the existing products or the reduction of their prices. At any rate, it must be emphasized that this <u>demand-creating</u> aspect of investment is conceptually wholly different from the capacity-augmenting aspect of investment, since the former concerns the market for the product, and the latter the technology or production function. In reality, of course, the two can be related. The improvement in quality of products, for example, would often necessitate the adoption of new machines which embody improved technology. Investment can therefore augment <u>future</u> demand and at the same time carry embodied technological progress on the supply side.

The firm maximizes the following discounted sum of net cash flow:

$$\int_0^{\infty}\{D_t - w_t L_t - \Phi(\alpha_t)K_t\}e^{-\rho t}dt \tag{1}$$

D_t, w_t, L_t, K_t and ρ are respectively demand for the firm's product, real wages, labor, capital stock and the discount rate. α_t is the growth rate of capital stock:

$$\alpha_t = \dot{K}_t / K_t \tag{2}$$

We ignore depreciation for simplicity.

The adjustment cost associated with capital accumulation is assumed to be convex.

$$\Phi'(\alpha) > 0, \quad \Phi''(\alpha) > 0$$

$$\Phi(0) = 0, \quad \Phi'(0) = 1 \tag{3}$$

At each moment in time demand D_t is given. Demand grows exogenously at the rate of θ but its growth also depends on current investment.

$$\dot{D}_t = (\theta + \gamma\alpha_t)D_t \qquad (0 < \gamma < 1) \tag{4}$$

Equation (4) captures the demand-creating aspect of investment, its degree depending on parameter γ. Normalizing the units in such a way that $D_0 = K_0^\gamma$, we obtain

$$D_t = e^{\theta t}K_t^\gamma \tag{5}$$

On the supply side, output equal to D_t is assumed to be produced according to the Cobb-Douglas production function

$$D_t = \Lambda_t L_t^a K_t^b \tag{6}$$

where Λ_t is the technological progress factor. This production function does not have to exhibit constant returns to scale $(a + b = 1)$. In fact, we will underline the importance of increasing returns $(a + b > 1)$ later. We do assume, however, that b is larger than γ: the capital elasticity is greater on the supply side than on the demand side. As γ approaches b from below, the demand constraint becomes virtually nonexistent. Since we wish to stress the importance of the demand constraint here, the assumption is reasonable.

Since D_t and K_t are both given at time t, employment of labor is determined as follows.

$$L_t = \Lambda_t^{-\frac{1}{a}} D_t^{\frac{1}{a}} K_t^{-\frac{b}{a}} \tag{7}$$

The marginal product of labor at this level of employment is given by

$$\frac{\partial D}{\partial L} = a\Lambda_t L_t^{a-1} K_t^{b}$$

$$= a\Lambda_t^{\frac{1}{a}} D_t^{\frac{a-1}{a}} K_t^{\frac{b}{a}} = a\Lambda_t^{\frac{1}{a}} e^{\frac{(a-1)\theta t}{a}} K_t^{\frac{b+(a-1)\gamma}{a}} \tag{8}$$

It is assumed to exceed the real wage since labor employment is constrained by demand for products. The neoclassical theory, in contrast, having no such demand constraint equates real wages w_t to this marginal product of labor. If they are equal, $w_t L_t$ becomes aD_t and the labor's share is a. Therefore the factor share becomes independent of the technological progress Λ. This is the well-known result under the assumption of Hicks neutral technological progress. We assume, however, that real wages grow in parallel with the marginal product of labor as capital accumulates but their levels are below the marginal product. In this case, the factor share depends on the technological progress Λ even though Λ is Hicks neutral.

Specifically we assume

$$w_t = w_0 \, e^{\frac{(a-1)\theta t}{a}} K_t^{\frac{b+(a-1)\gamma}{a}} \tag{9}$$

where w_0 is taken as exogenous and is assumed to satisfy

$$w_0 < a\Lambda_t^{\frac{1}{a}} \tag{10}$$

We will discuss the determination of w_0 later.

Given w_t, we obtain

$$\begin{aligned} w_t L_t &= w_0 \Lambda_t^{-\frac{1}{a}} e^{\theta t} K_t^{\gamma} \\ &= w_0 \Lambda_t^{-\frac{1}{a}} D_t \end{aligned} \tag{11}$$

The capital share $R \equiv 1 - W_0 \Lambda_t^{-\frac{1}{a}}$ is defined as a ratio of profits to sales. This capital share depends on w_0 and Λ_t. An increase in real wages with unchanged Λ, of course, lowers the capital share. On the other hand, technological progress (an increase in Λ) raises the capital share only to the extent that it is not fully reflected in an increase in real wages. As noted above, with technological progress the marginal product of labor increases by $\Lambda^{\frac{1}{a}}$, and therefore if real wages proportionally increase, then the capital share R is left unchanged. Since sales D_t are demand-constrained (equation (5)) rather than supply-side determined (equation (6)), profits RD_t is not affected by technological progress, either. In any case, it is important to note that <u>there is no necessity that the factor share is related to a parameter of production function b in the demand-constrained economy</u>.

Using (1), (5) and (11), we obtain

$$\int_0^{\infty}\{Re^{\theta t}K_t^{\gamma} - \phi(\alpha_t)K_t\}e^{-\rho t}dt \tag{12}$$

as the objective function which the firm maximizes under constraint (2), (3) and the initial stock of capital. Assuming the existence of the solution, we know that it is unique and can characterize it as follows.

The optimum level of investment $\alpha_t K_t$ satisfies

$$\phi'(\alpha_t) = q_t \tag{13}$$

where the marginal q_t is defined as

$$q_t = \int_t^{\infty}\{R\gamma K_{\tau}^{\gamma-1} - \phi(\alpha_{\tau})\} \exp\{-\int_t^{\tau}(\rho - \alpha_{\nu})d\nu\}d\tau \tag{14}$$

q_t itself depends on the time path of α, or investment. On the assumption of existence of optimum path, the simultaneous determination of q and investment can be analyzed in the following way. For this purpose, we first define k_t by

$$k_t = K_t^{1-\gamma} e^{-\theta t} \tag{15}$$

which is nothing but capital-output ratio or capital coefficient K_t/D_t. Then the necessary conditions for optimality consist of

$$\dot{k}_t = [(1-\gamma)\alpha(q_t) - \theta]k_t \tag{16}$$

and

$$\dot{q}_t = (\rho - \alpha(q_t))q_t - \frac{R\gamma}{k_t} + \Phi(\alpha(q_t)) \tag{17}$$

The optimum path which satisfies the transversality condition is unique and is drawn by a bold line in the phase diagram (Figure 1). <u>In the long-run stationary state</u>, <u>the growth rates of capital and output both converge to</u> $\frac{\theta}{1-\gamma}$. The long-run q is equal to

$$q^* = \Phi'(\frac{\theta}{1-\gamma}) > 1 \tag{18}$$

The long-run capital-output ratio k^* satisfies

$$\frac{R\gamma}{k^*} = (\rho - \frac{\theta}{1-\gamma})\Phi'(\frac{\theta}{1-\gamma}) + \Phi(\frac{\theta}{1-\gamma}) \tag{19}$$

This relation is shown with respect to adjustment cost function in figure 2. The higher is the long-run growth rate α^*, the lower is the long-run capital-output ratio. We also note that $\frac{R\gamma}{k^*}$ is the profit rate on investment $R\Delta y/\Delta K$. Therefore, the higher is the long-run growth rate α^*, the higher is the profit rate.

The time paths of capital accumulation and output growth depend on θ, γ and R. Using the phase diagram, we can establish the following results. When θ increased, for example, the $\dot{k}=0$ schedule shifts up while the $\dot{q}=0$ schedule remains unchanged. As a result, given the current capital stock, investment rises. But in this process growth of output outpaces capital accumulation and it leads to a lower long-run capital-output ratio. Similarly we can find that the higher is γ or R, the higher is investment. When R increased, the long-run capital-output rises, which implies that the acceleration of capital accumulation is greater than that of output. The effect of an increase in γ on the long-run capital-output ratio is, however, ambiguous.

Finally, we note that changes in θ and γ permanently affect the growth rates of capital and output. In contrast, the effect of changes in R on growth rates is only transitory. The main generating force of growth in this model is therefore the exogenous growth of demand θ and the demand-augmenting factor γ. In fact, given demand conditions technological progress on the supply side (an increase in Λ) actually does not affect investment by itself if it is absorbed by an increase in real wages. One might expect that in the real economy technical progress would raise investment. This intuitively appealing result obtains either if technical progress not only augments efficiency on the supply side but also augments the growth rate of demand (an increase in γ) or if it raises the capital share. The kind of new technology which brings about the introduction of new products or improvement in the quality of existing products would certainly meet the first requirement.

2. Growth of the Macroeconomy

The preceding analysis of firm behavior can naturally be carried forward to a theory of growth of the macroeconomy. Above all, it leads us to focus on investment as the key variable. It also suggests that the most important ultimate factors in explaining economic growth are growth of exogenous demand θ and the demand augmenting power of investment γ. The long-run growth rate of the economy is $\frac{\theta}{1-\gamma}$.

On the micro level of an individual firm, the demand-augmenting effect of investment γ would perhaps rest largely on the firm's own innovations on the demand side. Most likely it is also mingled with technical progress on the supply side as in the case of the introduction of new products. On the macroeconomic level, investment done by any firm also generates income through the multiplier which augments the exogenous growth of demand for products of all the firms, perhaps mostly other firms than the one which did investment. We can explicitly illustrate aggregation in the case of steady state where all the firms share the same values of θ and γ.

For firm i (i = 1 ~ n), output Y_i is constrained by $e^{\theta t}K_i^{\gamma}$:

$$Y_i = e^{\theta t}K_i^{\gamma} \tag{20}$$

where K_i is the stock of capital of firm i.

The demand share of each firm σ_i is

$$\sigma_i = \frac{Y_i}{Y} = \left(\frac{K_i^{\gamma}}{\sum_i K_i^{\gamma}}\right) \tag{21}$$

Total output $Y = \sum_i Y_i$ must be equal to total demand. For the sake of illustration, we assume the simple multiplier for aggregate demand as in the Harrod-Domar model. Therefore we have

$$Y = (I + X)/s \tag{22}$$

where s is the <u>marginal</u> propensity to save. I and X are respectively total investment and other expenditures which are independent of income Y.

In steady state,

$$I = \sum_i \alpha_i K_i = \sum_i \left(\frac{\theta}{1-\gamma}\right) K_i \tag{23}$$

For X, we assume that

$$X = ce^{\theta t}(\sum_i K_i)^{\gamma} \tag{24}$$

where c is the scale factor defined later.

We next assume that each firm is small enough so that it does not take into account the effects on aggregate variables of its own investment. For example, when a firm makes investment decisions, it does not anticipate an increase in demand for its own product due to a rise in income which would be generated by its own investment. Then on this assumption, in steady state we have

$$\frac{(I + X)}{s} = \frac{\{K_0(\frac{\theta}{1-\gamma}) + cK_0^{\gamma}\}e^{(\frac{\theta}{1-\gamma})t}}{s} \tag{25}$$

where the initial values of K_i is K_0/n, and

$$\sigma_i = \frac{K_i^{\gamma}}{n(\frac{K_0}{n})^{\gamma}\ e^{(\frac{\theta\gamma}{1-\gamma})t}} \tag{26}$$

Therefore when the scale factor c in (24) is appropriately set to be equal to

$$c = sn^{1-\gamma} - (\frac{\theta}{1-\gamma})K_0^{1-\gamma} \tag{27}$$

demand for products and accordingly output of firm i, Y_i becomes

$$Y_i = \sigma_i Y = \frac{\sigma_i(I + X)}{s} = e^{\theta t} K_i^{\gamma} \qquad (28)$$

as is assumed in our model.

Since the firm's objective function (12) is not homogeneous of degree one with respect to K, we do not obtain the above steady state for arbitrary K_0. From equations (22), (23), (24) and (27), we know it must be equal to

$v^{*\frac{1}{1-\gamma}} n$.

The exogenous <u>marginal</u> saving rate s cannot be arbitrary, either. Since c must be positive, s must be greater than $(\frac{\theta}{1-\gamma})v^*$. Within the limit of this inequality, the <u>marginal</u> saving rate does not affect the steady state capital-output ratio v^*. v^* is uniquely determined by the growth rate of the economy, given the adjustment cost function Φ, and the capital share R (see equation (19)).

The <u>average</u> saving rate on the other hand must be equal to I/Y and therefore, equals $(\frac{\theta}{1-\gamma})v^*$. It is endogenous. Since v^* is a decreasing function of the growth rate $\frac{\theta}{1-\gamma}$, it is ambiguous whether the <u>average</u> saving/investment rate is increasing in growth rate or not. The less convex is the adjustment function of investment Φ, the more likely the average investment/saving rate is an increasing function of growth rate. In any case, the average saving/investment rate is endogenously determined[2] by growth rate, which in turn is determined by two ultimate factors θ and γ.

In this economy, aggregate demand depends on total investment and the other demand component X which is independent of income. X in turn depends partly on aggregate capital stock but at the same time grows at exogenous rate θ. Under certain assumptions, for each firm demand grows exogenously at the rate of θ but its growth also depends on current investment. Firms realizing this demand-creating aspect of investment in addition to demand constraints make their investment decisions. The previous analysis shows that in steady state the optimal rate of capital accumulation is $\frac{\theta}{1-\gamma}$. Therefore the steady state growth rates of capital and output become $\frac{\theta}{1-\gamma}$ in the economy as a whole, too.

This analysis sheds some light on an alleged puzzle of production function estimate of elasticity of output with respect to capital. In the neoclassical approach, under the assumption of perfect competition this elasticity should be equal to the capital's share and therefore be around 0.3. In time series regressions, however, one often obtains much higher value for this elasticity. Romer [1987], for example, using low frequency data (decade data from 1890's to 1970's) for the U. S. obtains 1.0 and then based on this estimate goes on to argue for the possible importance of positive externality associated with capital accumulation.

For Japan, even with annual data, one obtains high value for this elasticity. Shinohara and Asakawa [1974] estimate the elasticity for 21 manufacturing industries (1960-71). For the Japanese manufacturing industry as a whole, their estimate is 1.06. The estimate 1.0 for the 'capital elasticity' is certainly a puzzle from the viewpoint of the neoclassical production function approach.

In the present analysis, however, factor share has little to do with a technological parameter characterizing the production function. Moreover demand-constrained output Y grows as

$$\frac{\dot{Y}}{Y} = \theta + \gamma \left(\frac{\dot{K}}{K}\right) \tag{29}$$

With the growth rate of exogenous demand θ as a fundamental shock, optimally chosen $\dot{K}/K$ is approximately equal to $\theta/(1-\gamma)$. And therefore the regression coefficient of $\dot{Y}/Y$ on $\dot{K}/K$, $COV(\dot{Y}/Y, \dot{K}/K)/VAR(\dot{K}/K)$ becomes 1. The point is that in this model, first output is determined by demand, and second both output and investment respond to the same exogenous shock θ. In fact, an attempt to estimate the contribution of exogenously determined capital accumulation to output growth does not make much sense in the present analysis because investment is endogenously determined by the growth of demand. In any case, as already noted, the capital elasticity of output as a technological parameter has no bearing on the factor share in this model.

The Sources of Growth of Demand

The engine of growth in the economy is investment determined by demand-constrained firms. The ultimate determinants are then θ and γ. At firm level, a part of the exogenous growth of demand for its product comes from the growth of the economy as whole. For the macroeconomy, what are the sources of growth of demand θ? We argue that historically such sources of demand growth as follows were important in many countries including Japan: (1) population growth, (2) Lewisian dual structure, (3) major innovation such as railroad and (4) exports.

First, at least in the well-organized economy population growth is expected to augment the growth of demand. We already argued that population growth will not by itself suffice to fuel growth. In fact, population growth contributes to economic growth only by raising demand θ in the present analysis. It is certainly reasonable to conceive that under certain circumstances population growth augments the growth of demand. Keynes [1937], for example, argued that

> An increasing population has a very important influence on the demand for capital. Not only does the demand for capital--apart from technical changes and improved standard of life--increase more or less in proportion to population. But, business expectations being based much more on present than on prospective demand, an era of increasing population tends to promote optimism, since demand will in general tend to exceed, rather than fall short of, what was hoped for. Moreover a mistake, resulting in a particular type of capital being in temporary oversupply, is in such conditions rapidly corrected. But in an era of declining population the opposite is true.

Hansen [1939] in his presidential address at the American Economic Association also discussed the implications of population growth on demand. He argued that the American prosperity in the 1920's was sustained by high population growth and then for the 1930's, he went on to express his "conviction that the combined effect of the decline in population growth, together with the failure of any really important innovations of a magnitude sufficient to absorb large capital outlays, weighs very heavily as an explanation for the failure of the recent recovery to reach full employment." The important point is that population growth affects economic growth only to the extent that it raises or lowers the growth rate of demand.

Secondly, the Lewisian dual structure can also contribute to the growth of demand. In the Lewisian model (Lewis [1954]), an unlimited supply of labor is available at a 'subsistence' wage determined in the 'traditional' sector. Capital formation and technical progress in the modern capitalist sector therefore do not result in raising real wages, but in raising the share of profits, which in turn entails further investment. Instrumental in this cycle is high profit rate sustained by low real wages. This analysis, however, lacks the perspective on demand. We argue that the Lewisian dual structure could in fact contribute to the growth of demand. We will shortly provide an example of the post-war Japanese economy.

Thirdly, major innovations not only augment supply side of the economy but also raise demand. Hicks [1973], for example, in his Nobel lecture argues that the mainspring of economic growth is major inventions which generate investment booms. He points out that "one can certainly detect, in the nineteenth century, one major invention that gives a recognizable, and separable, Impulse--the railway."

Finally exports can be a substantial source of growth of demand. 'Export-led growth' is in fact a much discussed subject (see Beckerman [1962, 1966], Lamfalussy [1963], Thirlwall [1979] and Kaldor [1981]).

The neoclassical two-sector model, focusing on the supply side, would indicate that the trade accelerates the growth rate of the economy if it lowers the relative price of investment goods (see Corden [1971]). Instead, here we focus on exports as a source of growth of effective demand. In this regard, the record of the Japanese economy during the WWI provides an instructive example. In the 1910's, Japan imported most of advanced investment goods such as spinning machines. The War interrupted imports of such machines from Europe and as a result, their prices sharply rose, in some cases supplies completely cut: the war was therefore a major negative supply shock to the Japanese economy. And yet Japan enjoyed high growth during the war taking advantage of an unprecedentedly sharp increase in exports; the average growth rate of real GNP in 1915-18 was 7.6% while that of real exports 19.2%. This example well illustrates the export-led growth, which overwhelmed a large negative supply shock caused by the war.

Misalignment of exchange rate can play an important role for export-led growth. The persistent deflationary effect of overvalued pound in the interwar period is a well documented episode. In contrast, Japan could afford to almost completely 'wipe out' the Great Depression taking advantage of high growth of export driven by undervalued yen (Figure 3). Many economists (see, for example, Shinohara [1961]) indeed argue that growth of the prewar Japanese economy was basically export-led.

Under the fixed-exchange rate regime, the problem turns to the balance of payments constraint on growth (see Thirlwall [1979], for example). High growth of exports, by lifting the ceiling of the balance of payments constraint, encourages other expenditures, particularly investment and thereby raises the growth rate of the economy. In the U. K. things worked the other way; Beckerman [1962], for example, notes that "in the United Kingdom, although the average pressure of demand over the whole period has not been low by international standards, experience has taught all but the most ill-informed entrepreneurs that, however, high may be the rate of growth of demand in the short-run, it will not persist, since the external balance soon deteriorates, thereby requiring measures of demand restraint. He is also aware, more or less vaguely, that this is related to the United Kingdom's poor performance in export markets, and that this is, in turn, connected with the failure to prevent a continuous rise in relative prices by means of repeated doses of demand restraint."

International competitiveness with respect to quality and price is obviously very important for growth of exports. It is often postulated by analogy with industrial organization that a lower price contributes only to a once and for all increase in the market share, but not to a higher growth. This may be true for a firm in one industry but may not be true for the economy as a whole. Suppose that there are two goods in the world market; one high growth of demand, the other low growth. If offering lower price, the country captures the larger share of the world market for high growth product, then it can achieve higher growth. Exports may not be a necessary condition for high growth, as some economists who believe in a strong form of export-led growth might argue, but can be sufficient to sustain high growth for a decade or two by raising θ in our model. High exports may also be a manifestation of high γ.

Japanese Economy—A Case Study

To illustrate how our model works, we consider the postwar Japanese economic growth as a case study. The Japanese economy in the late 1950's and 60's enjoyed high θ, and as a consequence very high growth of the economy. The economic growth in this period was basically led by domestic demand. The factors behind high θ were (1) unprecedentedly high growth of the number of households (much higher than population growth) which was generated by internal migration in the Lewisian dual economy, and (2) the introduction of many consumer durables at progressively lower prices. If three generation of family members had lived in a traditional way within a single household, they would have needed only one of each consumer durable, say refrigerator. But when the youngs moved to urban areas and created a new household, they needed another of each consumer durable. In this way, internal migration, by generating unprecedentedly high growth of households, sustained high domestic demand. As the pool of labor in the rural agricultural sector was exhausted, however, internal migration subsided and, accordingly, an increase in the number of households decelerated. Meanwhile, the domestic market for then existing consumer durables saturated. It restrained not only growth of those industries producing consumer durables but also, through input-output channels, affected the whole manufacturing industry including iron and steel, and chemicals which had led the rapid economic growth beginning in 1955. In this way, both θ and γ substantially declined. This explains the end of the rapid growth period around 1970. Figure 4 shows the growth rate of real GNP and the number of migrants from rural agricultural to urban industrial areas.

This whole process can be illustrated with a simple model. The growth rate of the economy is $\frac{\theta}{1-\gamma}$. Noting that internal migration sustains high growth of domestic demand, we assume that

$$\theta = g + \dot{f} \qquad (30)$$

where g is a constant and f is the percentage of population in urban areas.

f changes in a logistic way, but its rate of change depends positively on the growth rate of the economy: As is well know, high growth accelerated migration from rural to urban areas (see Minami [1970]). Thus we have

$$\dot{f} = [\beta + \delta(\frac{\theta}{1-\gamma})](1 - f)f \qquad (0 < \delta < 1,\ 0 < \beta) \qquad (31)$$

From (30) and (31), we obtain

$$\theta = \frac{\beta(1 - f)f + g}{1 - (\frac{\delta}{1-\gamma})(1 - f)f} \qquad (32)$$

where

$$\frac{\partial\theta}{\partial f} \gtreqless 0 \quad \text{as} \quad f \lesseqgtr \frac{1}{2} \tag{33}$$

$$\text{and} \quad \theta \to g \quad \text{as} \quad f \to 1$$

Therefore as f monotonically approaches one, both internal migration and growth rate of the economy first accelerate and then decelerate. They are shown in figure 5. This is the basic mechanism of high growth of the Japanese economy in the 1950's and 60's, and it ended around 1970.

In the growth accounting, the positive effect of contraction of agriculture on growth is often taken into account (For example, Maddison [1987]). This positive effect, however, arises only because of the different pace of technological progress between agricultural and industrial sectors. In contrast, we argue here that unprecedently high growth of the number of households generated by internal migration sustained high growth of domestic demand in the postwar Japanese economy.

It is often argued that given the Harrod-Domar warranted growth rate s/v, lower long-run growth rate beginning the 1970's was brought about by an increase in capital/output ratio v. In our model, however, capital/output ratio v is an endogenous variable determined by the long-run growth rate $\frac{\theta}{1-\gamma}$. The higher is the growth rate, the lower is the capital/output ratio. Figure 6 in fact shows that the capital-output ratio was about 1 in the high growth period of the 60's, but then rose to about 1.6 in the 70's when the growth rate decelerated from ten to four percent. We emphasize that an increase in the capital-output ratio is the result of the slower economic growth, not the other way round.

3. Supply-side: Employment, Productivity and Increasing Returns

The growth rate of the economy is basically determined by investment, which is in turn induced by prospective growth of demand. Growth of employment is then determined in accordance with production function (7):

$$\frac{\dot{L}}{L} = \frac{1}{a}\left[(1-b)\left(\frac{\theta}{1-\gamma}\right) - \lambda\right] \tag{34}$$

when $\dot{Y}/Y$ and $\dot{K}/K$ are equal to $\frac{\theta}{1-\gamma}$ in the long-run. Here λ is the rate of Hicks neutral technological progress Λ.

Labor Market

In the short run, the growth rate of employment given by (34) is not necessarily equal to the 'natural' growth rate of labor force, n. In the long-run, however, we can conceive the following adjustment mechanisms. When $\frac{\dot{L}}{L}$ exceeds n, the labor market gets gradually tightened, whereas in the opposite case the unemployment rate would rise.

Specifically, we obtain

$$\frac{\dot{L}}{L} - n = -\left(\frac{\dot{u}}{1 - u}\right) \tag{35}$$

where u is the unemployment rate defined as $u = (L^S - L)/L^S$ (L^S is labor force). Here u is meant to capture the long-run tendency of changes in the scarcity of labor rather than the cyclical changes in the labor market conditions.

From (9) and (11), the rate of increase in real wage which keeps the relative share of capital R constant, ω^* is

$$\omega^* = \frac{\lambda}{a} + \left(\frac{a+b-1}{a}\right)\left(\frac{\theta}{1-\gamma}\right) \tag{36}$$

We assume that real wages grow at ω^* but high unemployment rate depresses the level of real wages and <u>vice versa</u>. Thus we obtain

$$w_t = e^{\omega^* t}(1 - u_t) \tag{37}$$

(36) and (37) lead us to

$$\frac{\dot{w}}{w} = \omega^* - \left(\frac{\dot{u}}{1-u}\right) \tag{38}$$

The change in capital share R is therefore

$$\dot{R} = (1 - R)\left(\frac{\dot{u}}{1-u}\right) \tag{39}$$

Now firms facing declining capital share endeavor to save labor costs by raising the rate of technological progress λ.

$$\dot{\lambda} = -h\left(\frac{\dot{R}}{1-R}\right) \qquad (h > 0) \tag{40}$$

The idea that technical progress may be stimulated by a scarcity of labor relatively to demand has been put forward by many; Robinson [1963], for example, argues that "when the urge to accumulate ("animal spirits") is high relative to the growth of the labour force, technical progress has a tendency to raise the 'natural' rate of growth to make room for it, so that near-enough steady growth, with near-enough full employment, may be realized." It has been also a popular topic in economic history. Kendrick [1961], for example, identifies an increase in the trend rate of productivity growth in the U. S. in the years following World War I, and interprets it as a response to labor shortage and increased wages brought on by restrictions on immigration.

In any case, from (34), (35), (39) and (40), we obtain

$$\dot{\lambda} = h[(\frac{1-b}{a})(\frac{\theta}{1-\gamma}) - n - \frac{\lambda}{a}] \tag{41}$$

This differential equation is asymptotically stable and λ converges to its long-run value λ^* which is equal to

$$\lambda^* = (1 - b)(\frac{\theta}{1-\gamma}) - an \tag{42}$$

In the long-run, changes in the rate of technological progress to save labor cost achieve the equality of growth rates of demand for and supply of labor. The higher is the growth rate of output and capital $(\frac{\theta}{1-\gamma})$, the higher is the rate of technological progress λ.

There is another mechanism to bring growth rates of supply of and demand for labor into equality; the <u>endogenous</u> labor supply. supply of labor L^S is now

$$L^S = PN \tag{43}$$

Here N is population whose growth rate n is exogenous. Participation rate P on the other hand is endogenous. P stands for not only participation rate in the usual sense, but also immigration of labor force from abroad, both legal and illegal, and mobilization of the 'disguisedly unemployed' in the dual economy. To the extent that at least a part of efficiency of labor comes from a characteristic of job rather than a nature of worker, supply of labor measured in efficiency unit depends on availability of different grades of jobs. This aspect of endogeneity of labor supply is also reflected in P.

In any case the growth rate of P, $p = \dot{P}/P$ is assumed to be endogenous. Specifically we assume

$$\dot{p} = - \Phi(\frac{\dot{u}}{1-u}) \qquad (\Phi > 0) \tag{44}$$

Replacing n by n+p in (35), we obtain from (34), (35) and (44)

$$\dot{p} = \Phi[(\frac{1-b}{a})(\frac{\theta}{1-\gamma}) - \frac{\lambda}{a} -n-p] \tag{45}$$

This differential equation is again asymptotically stable, and therefore p converges to its long-run equilibrium p^*.

$$p^* = \left(\frac{1-b}{a}\right)\left(\frac{\theta}{1-\gamma}\right) - \frac{\lambda}{a} - n \qquad (46)$$

The endogeneity of labor supply attains the labor market equilibrium in the long-run.

Productivity

Growth of labor productivity is determined as follows:

$$\frac{\dot{Y}}{Y} - \frac{\dot{L}}{L} = \left(\frac{\lambda}{a}\right) + \left(\frac{a+b-1}{a}\right)\left(\frac{\theta}{1-\gamma}\right) \qquad (47)$$

Likewise growth of total factor productivity, or the Solow residual, is

$$\frac{\dot{Y}}{Y} - \sigma\left(\frac{\dot{L}}{L}\right) - (1-\sigma)\left(\frac{\dot{K}}{K}\right) = \frac{\sigma}{a}\left[\lambda + (a+b-1)\left(\frac{\theta}{1-\gamma}\right)\right] \qquad (48)$$

where σ is the relative share of labor. In the standard model with constant returns to scale where the labor share is assumed to be equal to a, (48) becomes λ.

Suppose that λ is exogenous[3]. In this case, aside from exogenous productivity growth λ, productivity grows as the economy grows when there are increasing returns to scale $(a+b > 1)$. Higher growth of demand θ, through encouraging investment α, brings about higher growth of productivity. To be sure, θ may actually be closely related to λ, and therefore it is not correct to say that growth of demand is totally demand-side determined. The point is simply that increasing returns in the economy cannot be taken advantage of unless demand grows. Kaldor [1966] in his famous inaugural lecture made this point:

> The usual hypothesis is that the growth of productivity is mainly to be explained by the progress of knowledge in science and technology. But in that case how is one to explain the large differences in the <u>same</u> industry over the <u>same</u> period in different countries? How can the progress of knowledge account for the fact, for example, that in the period 1954-60, productivity in the German motor-car industry increased at 7 per cent a year and in Britain only 2.7 per cent a year? Since large segments of the car industry in both countries were controlled by the same American firms, they must have had the same access to the improvements in knowledge and know-how. This alternative hypothesis is tantamount to a denial of the existence of increasing returns which are known to be an important feature of manufacturing industry....

To make the economy-wide increasing returns compatible with the assumption of competitive equilibrium, the Marshallian externality is often postulated; see, for example, Romer [1986, 87]. Increasing returns at individual firm or industry level are, however, in fact very common in manufacturing industries. It would be best to mention some concrete examples.

Perhaps the best known classical example is the Silberston curve for the automobile production. Maxy and Silberston [1959], analyzing the British automobile industry, concluded that the unit cost of producing a car declined by 40% as production increased from a thousand cars per year to fifty thousand. The unit cost was found to decline further by 13% when production increased from a hundred thousand cars per year to four hundred thousand. For Toyota, the unit cost of producing a car adjusted for WPI was 760,000 yen in 1954 when 22,000 cars were produced while it declined to 420,000 yen in 1967 when 830,000 cars were made (Okada [1969]).

For many manufacturing industries, engineers have estimated the equation $\log C = a + b\log X$ (C: the total cost, X: the level of production) to find b close to 0.6. This result is known as the Six-Tenths Factor, with which the average cost declines by 40% when production doubles. Here we refer to Haldi and Whitcomb [1967]. Based on their survey of engineers' estimates of the scale coefficient b, they conclude that "out of a total of 687 scale coefficients, 618 (90.0 per cent) show increasing returns, and 50 (7.3 per cent) show constant returns. Only 19 (2.8 per cent) observed scale coefficients reflect decreasing returns." They report that in process plants, operating expenses for labor, supervision, and maintenance also show significant economies of scale. Consumption of utility services and raw materials, on the other hand, generally shows little economies of scale. These results for the U. S. economy are very similar to those for the Japanese economy reported in Echigo [1969]. Such economies of scale arise from indivisibilities of plant equipments and a family of geometric relationships which relate the material required for the building of equipment to the equipment's capacity. The amount of material required for 'containers', for example, depends principally on the surface area, whereas capacity depends on the volume inclosed.

Yet another example is the case of integrated circuit (IC). The unit cost of IC is believed to decline by 27.6% when its cumulative production doubles:

$$C_t = [\int_{-\infty}^{t} y_\tau d\tau]^{-0.276} \tag{49}$$

where C_t is the unit cost and Y_t is the production of IC at t. To be exact, this is an example of the learning curve rather than increasing returns, but it also brings about the advantage of greater production.

By the mid 1960's, the Japanese producers became ready to produce IC, but unlike the U.S., Japan lacked the military demand for IC. Instead in the late 60's and the early 70's, the most important source of demand for IC was hand calculators in Japan. In 1969, more than 50% of Japanese made IC was still used for hand calculators whereas 28.6% for computers. This order of demand share was not reversed until 1976 when the share of computers became 27.3% while the share of hand calculators fell to 18.5%. The point is that growth of Japanese IC industry was possible only because there was enough domestic demand for hand calculators which in turn sustained growth of demand for IC. Technical progress, rather than a purely supply side phenomenon, could lead to growth because it succeeded in boosting demand for IC through a particular final product, hand calculator. Increasing returns or the learning curve materialized as the <u>result</u> rather than the cause of growth.

When increasing returns are taken advantage of by demand-led growth, productivity growth becomes a result rather than a cause of economic growth. The very well-attested correlation between the rate of growth of productivity and the rate of growth of production, between industries as well as between countries has in fact been reported (see, for example, Salter [1960] for the U. K.). For Japan, in the cross-industry regression of TFP growth (1960-71) on the growth rate output (21 manufacturing industries), Shinohara and Asakawa [1974] obtain 0.4 (significant) for the coefficient; this estimate happens to be almost exactly equal to 0.45 found by Verdoon [1949], which is known as Verdoon's law. As is well known, there is a positive correlation between growth rates of the economy as a whole and TFP as well. A standard explanation is that high TFP growth bring high economic growth and vice versa. We argue, however, that given increasing returns, TFP may not be solely a cause of growth, but at least in part a result of demand-led growth. In fact, Fase and Van den Heuvel [1988], using the Dutch manufacturing data on labor productivity and output (1968.I - 87.IV), run causality tests and conclude that the causality from output growth to productivity growth cannot be rejected.

Once this point is granted, we are led to the possible 'virtuous' and 'vicious' circles of output and productivity growths in an open economy because TFP growth driven by output growth is most likely to entail a reduction of relative price. Houthakker [1979] in fact reports the significantly negative correlation between changes in output and relative price on the industry level for the U. S. For Japan, Shinohara and Asakawa [1974] in the regression of the average price change on TFP growth (1960-71) for 21 manufacturing industries, obtain significant -0.49 for the coefficient.

Lamfalussy [1963], argues for the thesis of virtuous and vicious circles of output and productivity growths to explain the different growth performances of the U. K. and E. E. C. in the 1950's.

> we found a close link between the export performance and the increase in productivity. It seems extremely likely that the faster growth of E. E. C. exports can be ascribed to the more rapid expansion of output per head in E. E. C. industries. This rounds off the argument and shows the 'virtuous' circle of Continental Europe's

growth: competitive advantage in world markets, leading to faster growth of exports; export-oriented growth, raising the share of investment in the national product; higher investment ratio, calling forth a faster growth in the productivity of labour and leading, therefore, to renewed competitive advantage in world markets. A competitive disadvantage, on the other hand, depresses the investment ratio, and therefore prevents productivity from rising fast enough; hence Great Britain's 'vicious' circle. The two orbits will remain distinct so long as money wages in the E. E. C. do not rise fast enough to offset the advantage the area derives from its more rapidly increasing productivity.

In terms of our model, TFP growth rate t is given by (48), which is rewritten as

$$t = \frac{\delta}{\alpha}\left[\lambda + (a+b-1)\left(\frac{\theta}{1-\gamma}\right)\right] \qquad (50)$$

To the extent that growth of demand depends on TFP growth t, we obtain the following relationship between $\frac{\theta}{1-\gamma}$ and t.

$$\frac{\theta}{1-\gamma} = g(t) \qquad g(0) > 0,\ g'(t) > 0 \qquad (51)$$

It is then possible, depending on g(t), that we obtain multiple equilibria of 'virtuous' and 'vicious' circles of high/low growths of output and productivity (Figure 7).

4. Conclusion

It is often taken for granted that Keynesian problem of demand deficiency is relevant, if any, only to the short-run. This paper argues to the contrary; demand constraints in fact matter even in the process of long-run economic growth.

All the hitherto existing models of economic growth focus on supply side, taking for granted that supply somehow manages to create its own demand. The model of this paper approaches the problem of growth from a different angle; it postulates that the engine of economic growth is investment and that investment in turn is constrained by expected growth of demand. In terms of causality, the investment and the rate of growth are simultaneously determined by two primary factors. The steady state growth rates of output and capital in this model depends ultimately on two fundamental factors, the growth rate of exogenous demand, and the strength of demand creating power of investment. We emphasize that exogeneity is an attribute of the chosen framework of thought, not an attribute of the events themselves. Recent 'endogenous' growth theories lead us to certain exogenous factors as ultimate determinants of economic growth. Our model focuses on θ and γ.

The growth rate of demand depends on many factors, some of which may be even accidental to the economy. In a particular example taken from the postwar Japanese experience (1955-70), a high growth of the number of households generated by internal migration from rural agricultural sector to urban industrial sector was the ultimate source of high growth of demand. Particularly important products for the purpose of growth in those days were consumer durables. The Japanese economy happened to be equipped with productive capacity to domestically supply those consumer durables.

Otherwise, high growth of demand for consumer durables would have resulted in high imports, and not have led to high economic growth.

It is also important to note that a steady increase in the real wages in the 1950's and 1960's contributed to high θ by making more households afford to purchase those consumer durables. For export-led growth, lower real wages may sustain high θ while for domestic demand-led growth higher real wages could contribute to raising θ. In any case, the demand-led growth cannot be simply seen as an outcome of the optimization of the 'representative' consumer. In particular, low rate of time preference, and/or high intertemporal elasticity of substitution have little bearing on high growth rate of the Japanese economy in the 1960's.

The second factor to determine the long-run growth rate of the economy is the strength of demand creating power of investment, γ in the model. The γ is essentially a measure of technological progress. It has been well understood since Solow [1957] that technological progress plays the crucial role in economic growth. The new 'endogenous growth theory' once again underlines the technological progress as the main spring of economic growth. In all the hitherto existing theories of growth, however, technological progress simply means augmentation of production on supply side. It is taken for granted that when the economy is able to produce more, given the same amount of inputs, it succeeds in selling increased products.

Endogenizing technical progress by focusing on supply side leads us naturally to identify, beside the time preference, the endowment of factor used intensively in R & D as the ultimate <u>exogenous</u> factor to explain economic growth. Thus, for example, <u>exogenously given</u> inputs that are used in intensively in R & D are conducive to innovation and growth while inputs that are used intensively in the manufacturing of traditional goods may discourage innovation and growth.

In contrast, we emphasize that the rate of growth depends crucially on the effect of technological progress on prospects of demand. We note that if technological progress occurred on the supply side under the unchanged prospects of growth of demand, it would mainly change the real wage, labor employment and the factor share, not the growth rate of the economy. In reality, however, technological progress embodied in new investment would not only augment productive capacity but also enhance the growth of demand. Technological progress on the supply side, for example, would lower production cost and thus price if it is not totally absorbed in the increase in the real wage. To the extent that lower price enables the country to capture the market for the product the demand for which enjoys high growth in the world economy, technological progress on the supply side leads to rising prospects of growth of demand. In the model, Λ increases while at the same time γ and/or θ increases.

Since increasing returns can be taken advantage of when demand grows, the initial technological advance on the supply side in one country can create 'virtuous' and 'vicious' circles of high/low growths of output and productivity across countries. Whether such a circle in fact occurs or not depends, among other things, on the degree of increasing returns, the price elasticity of the products, the growth rates of total demand for the products in the world economy. In any case, the present analysis does not imply convergence over time in the levels of per capita income across countries. Moreover we can easily explain that a country outgrows another as in the case of Japan and the U. K. in the postwar period. It is difficult to explain this phenomenon by increasing returns without demand constraints (Romer [1986, 87]) for in such a model, the late comer would never be able to catch up the more developed nation. Nor is it so reasonable to explain it by such drastic changes in factor endowment within a decade or two.

The Keynesian model of economic growth presented in this paper indicates that the key for growth is demand. It has obvious policy implications. To raise the growth rate, the economy must augment its prospects of growth of demand. For this purpose, it is first essential to identify kinds of product whose demand grows fast <u>in the world economy</u>. In every period in history, there are certain key products whose demand grow fast in the world economy while at the same time whose productions enjoy increasing returns: cotton, steel, automobile and perhaps currently IC based broadly defined electric machineries. Japan would not have been able to grow fast if it had succeeded in soy sauce industry. Free market may fail for a country to have such <u>key</u> industries: fixed 'set up' costs may exist, for example. Then industrial policy, including identification of key industries, becomes important.

NOTES

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1. Since a century is nothing but a succession of decades, it is doubtful that we can legitimately ignore these factors when we attempt to explain the growth process over a century. In growth over a century, however, all the economic factors are likely to be more strongly conditioned by exogenous events such as wars.

2. In the standard neoclassical growth model (Solow [1956]), the <u>exogenous average</u> saving rate positively affects the steady state capital-output ratio v^*. There the saving rate affects the steady state factor intensity, and substitution between capital and labor, under the assumption of full-employment of two factors of production, changes the capital-output ratio. In the present model, the exogenous marginal saving rate is not directly linked to investment. Substitution between capital and labor has nothing to do with the choice of capital-output ratio.

3. When the rate of technological progress is endogenous and converges to its long-run value λ^*, (42), growth of total factor productivity (48) becomes

$$\frac{\dot{Y}}{Y} - \sigma\left(\frac{\dot{L}}{L}\right) - (1 - \sigma)\left(\frac{\dot{K}}{K}\right) = \sigma\left[\left(\frac{\theta}{1-\gamma}\right) - n\right]$$

The point that TFP growth is basically driven by growth rate of output which is in turn determined by growth of demand still remains true.

Figure 1. Determination of Optimal Path

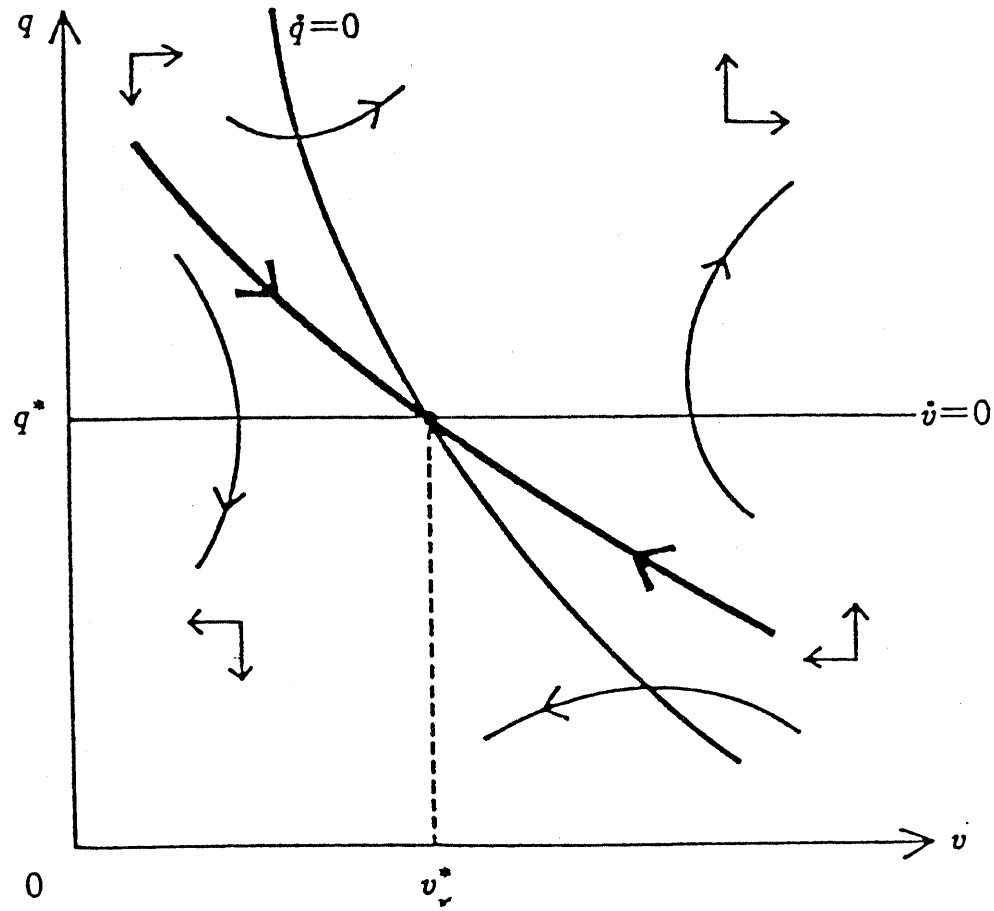


Figure 2. Growth Rate, Profit Rate and Capital Coeffiecnt

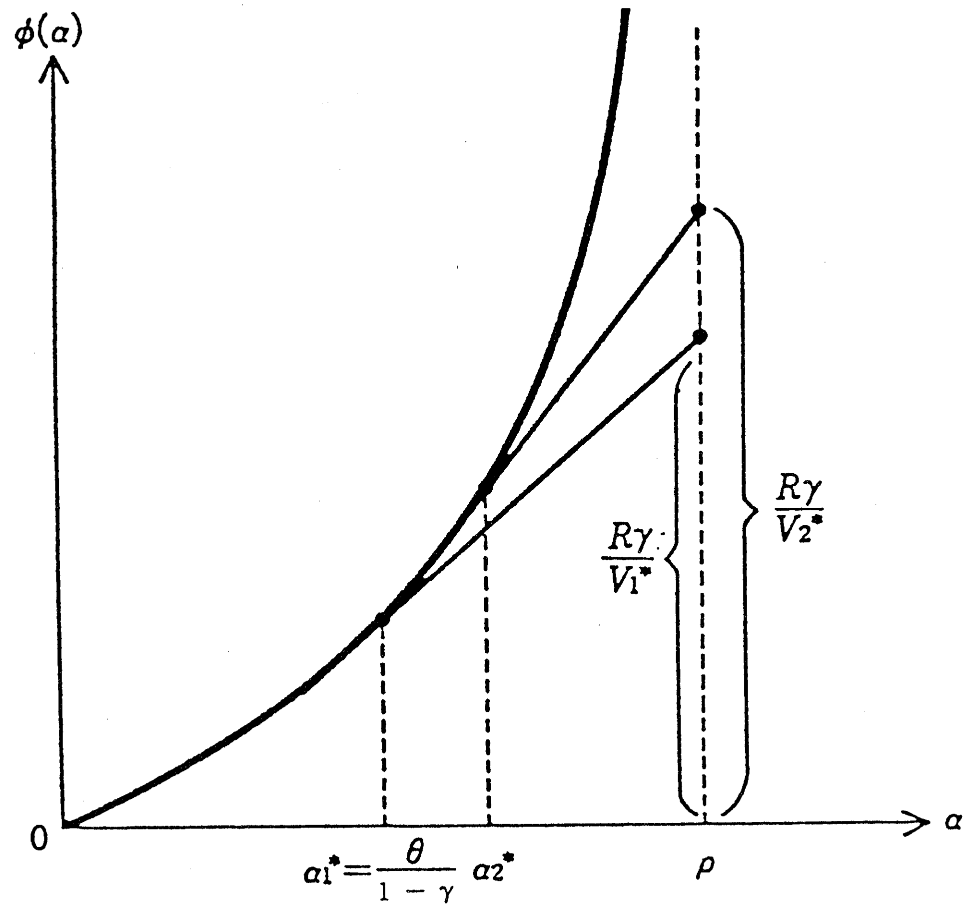


Figure 3. Real GNP 1928-40 (1928=100)

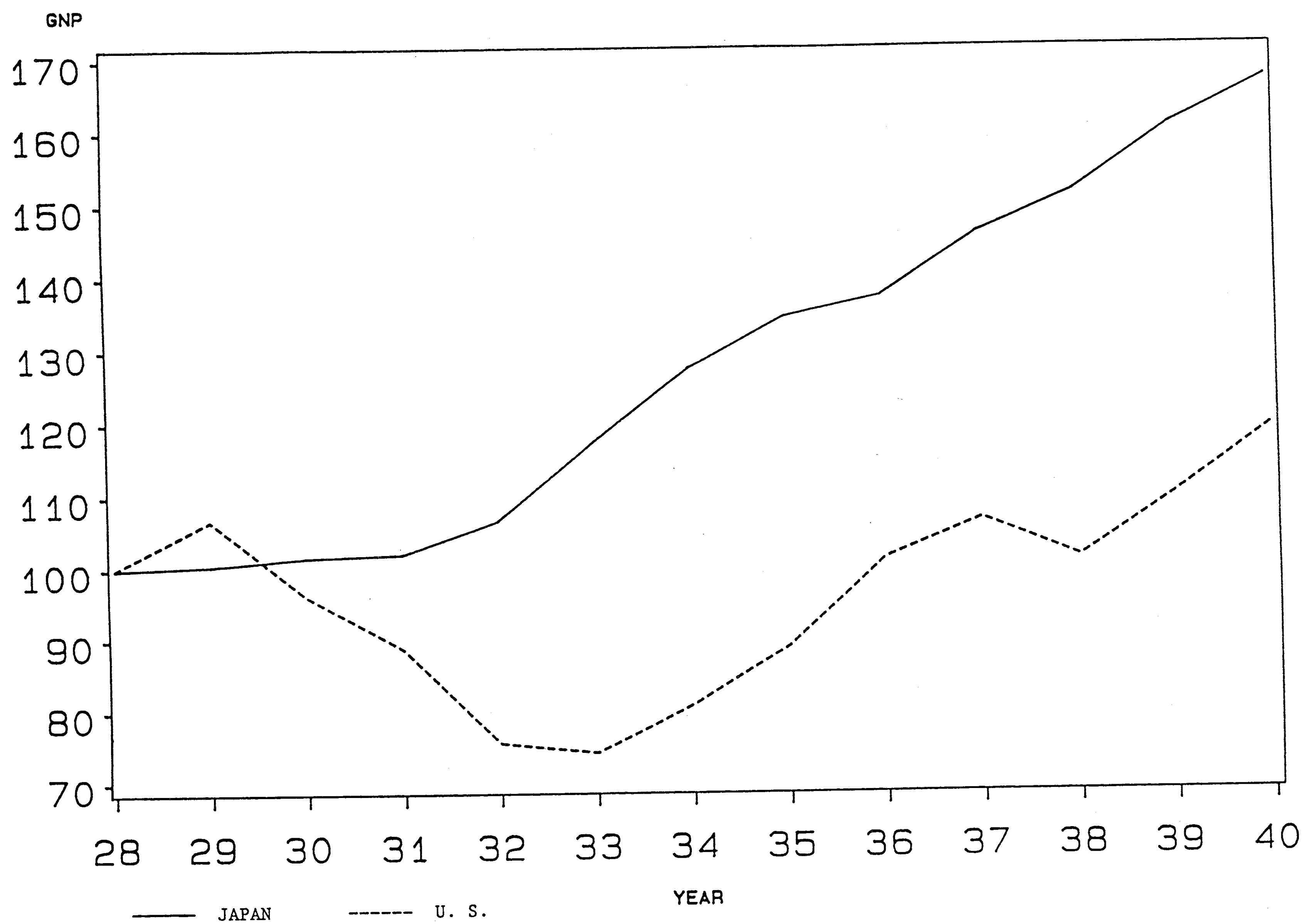


Figure 4. Growth Rate of Real GNP and Internal Migration in Japan

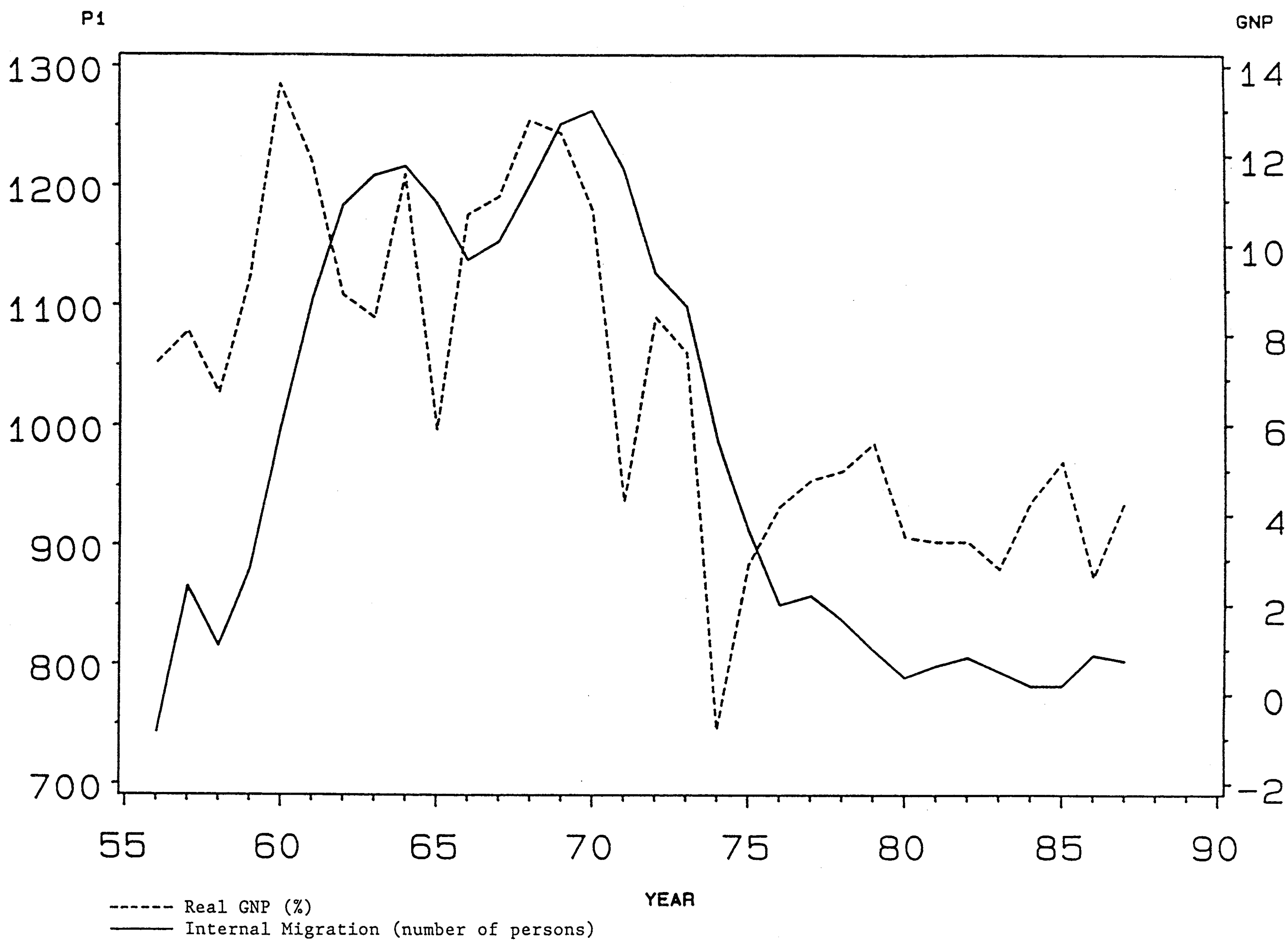
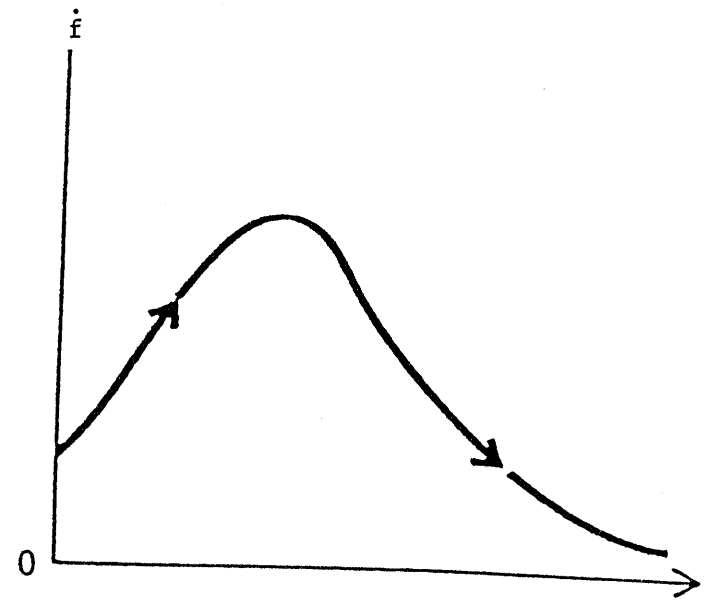
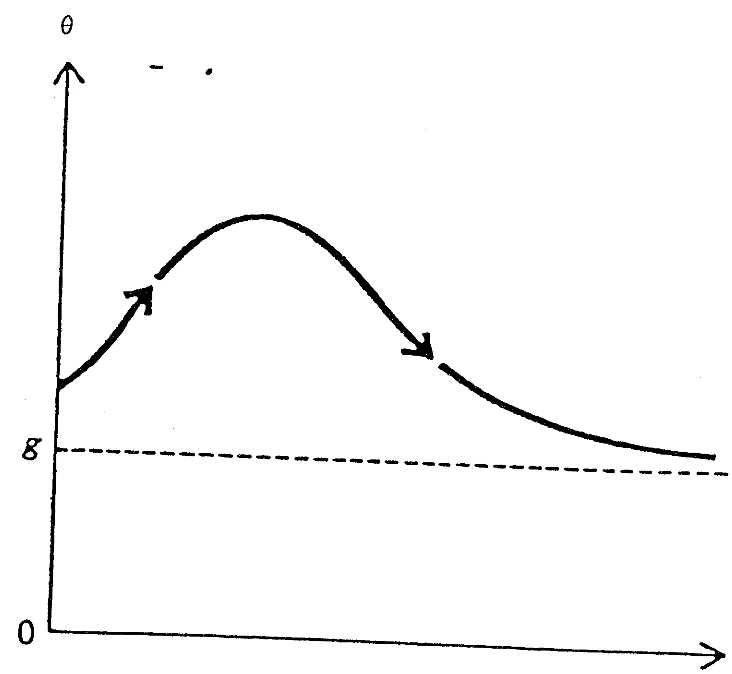


Figure 5. Growth and Internal Migration



(a) Change in Percentage of population of Urban Area



(b) Growth Rate

Figure 6. Growth Rate and Capital/Output Ratio in Japan: 1965.I - 89.I

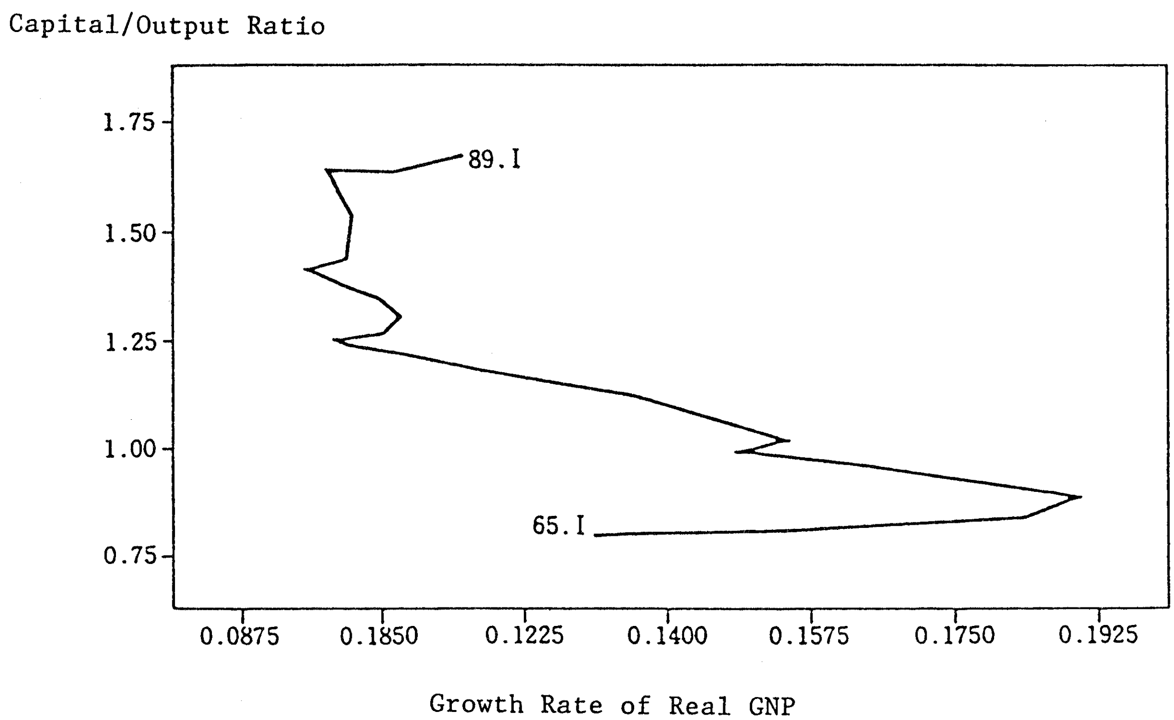
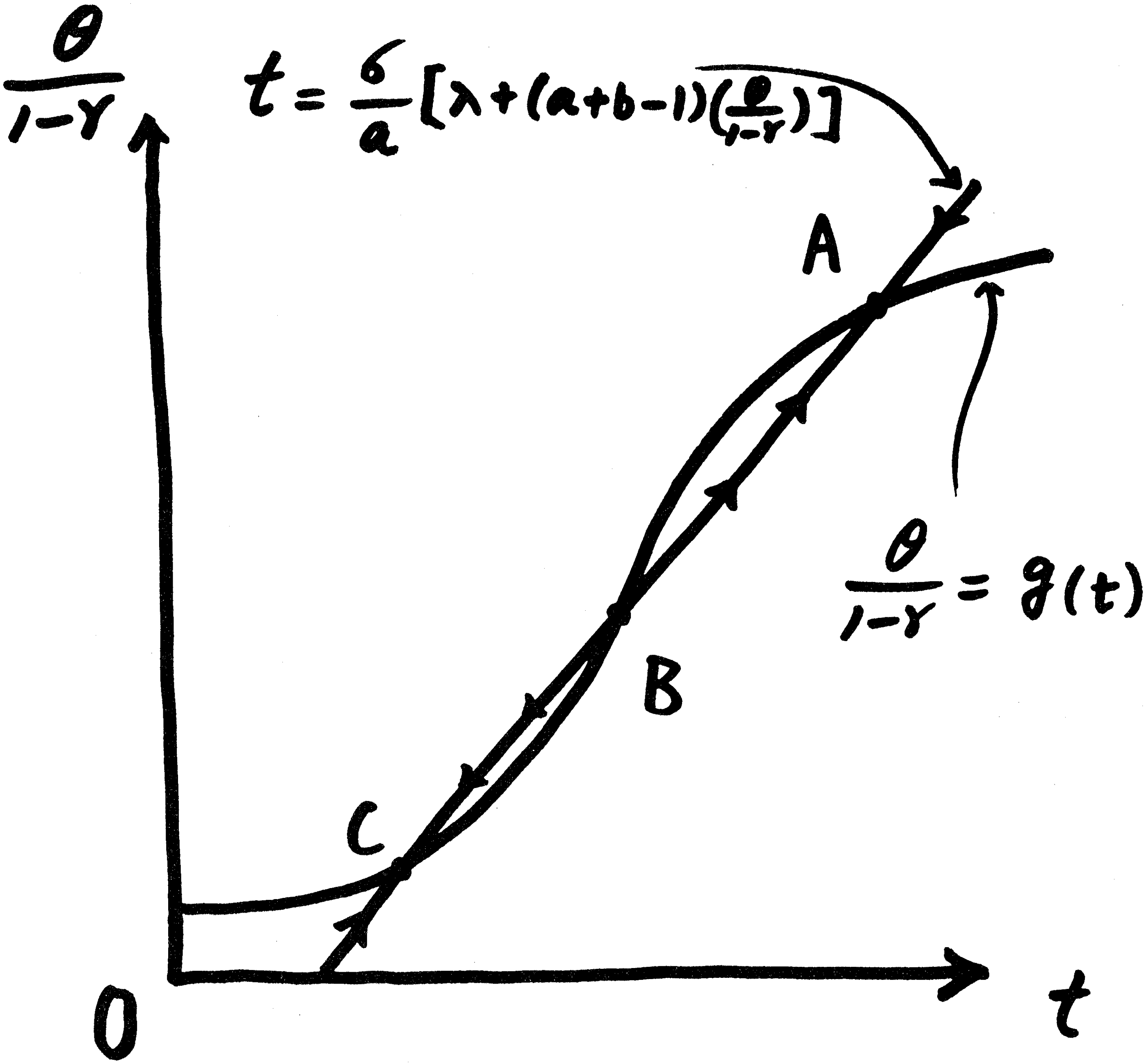


Figure 7. TFP and Growth Rate



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