Is the Japanese Capital Accumulation "Balanced"?

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If there is no way to improve social welfare by diverting investment from one sector to another, then capital accumulation is sectorally balanced. We derive a necessary condition of the sectorally-balanced growth, which can be called *no arbitrage condition in shadow prices (NACISP)*. Assuming perfect competition and constant returns, the test of *NACISP* is applied to the Japanese data. The result suggests sectorally-unbalanced growth in the Japanese economy between 1960 and 1985. Strong evidence of sectoral-unbalancedness is found in agriculture-forestry-fishery, mining, construction, manufacturing, and real estate industries. (*JEL* Classifications: E22, O41, O53)

I. Introduction

One of the most remarkable features of the twentieth-century economic history is the phenomenal economic growth observed in the north east Asia. In 1945, after the devastating war raged over the pacific ocean, Japan was just on the brink of starvation. Forty-eight years later, she is among the most prosperous countries in the world. Korea and Taiwan followed the lead of Japan, and now they are considered as most fast-growing economies. Such phenomenal success of the three

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countries has naturally attracted attention on the process of their economic growth.

There are, however, various signs and symptoms of "unbalanced" or "distorted" sectoral development despite the high economic growth in the three countries. Take Japan as an example. Housing conditions are not as good as other OECD countries (Ito 1993). There are sizable sectors (or sub-sectors) of seemingly low productivity such as retail and wholesale trades, compared with highly productive export sectors (Nishimura 1993). There is evidence that the productivity increase of transportation industries has not kept up with that of the U.S. counterpart (Nishimura 1993).

This paper focuses on Japan, and examines whether the Japanese economic development is "unbalanced" or not. One may argue that such seemingly distorted development may in fact be efficient one achieved by the market, which is the result of inter-temporal allocation of resources.[1] Thus, the first purpose of this paper is to clarify the idea of "balanced" growth, or more precisely, "sectorally-balanced" growth. Moreover, in order to put economic content on the discussion of the sectorally-balanced growth, we must devise the empirical method to "test" the balancedness of economic growth. The second purpose of this paper is to develop such a test, and to apply it to the Japanese economy after 1960.

The balancedness we adopt in this paper is based on the inter-temporal resource allocation.[2] If the economic development of the economy is consistent with the optimal inter-temporal resource allocation, we call the development balanced. Since there are many sectors in the economy, the balancedness we consider is the sectoral balancedness. If there is no way to improve social welfare by diverting investment from one sector to another, then the economic growth is sectorally balanced.

We derive a necessary condition of the sectorally-balanced growth, which is expressed in shadow prices of output and capital goods, and

[1]This line of argument is found in the recent debate over the "efficiency" of the Japanese distribution system. See Nishimura (1993) for details.

[2]The balancedness considered here is closely related to the argument of "dynamic inefficiecy." See Abel, Mankiw, Summers, and Zeckhauser (1989). The dynamic inefficiency argument is mostly concerned with the choice between consumption and capital formulation, and asks whether the economy over-invests (or equivalently under-consumes). In this paper, we are concerned mostly with sectoral over/under investment, and asks whether the economy can improve social welfare by diverting investment from one sector to another.

shadow rents of capital stocks. It should be noted that it is clearly not always optimal to make all sectors grow at the same rate. (Thus, literal "balanced" growth is not the balanced growth in our sense.) What is relevant here is the "shadow rate of return" on capital stocks. On the sectorally-balanced growth path, *ex ante* shadow rate of return must be the same across sectors, since otherwise the economy is better off by diverting investment from a low-rate industry to a high-rate industry. In this paper, we call this condition *no arbitrage condition in shadow prices (NACISP)*.

The next step is to estimate the shadow prices and rents from economic statistics. Here, we adopt the "dual approach" inferring shadow prices from market prices, instead of "primary approach" which estimates production technology directly and constructs shadow prices using estimated production function. The advantage of the dual approach over the primary one is easily understood by considering complexity of technological production frontier the Japanese economy faces. Using market information, we can circumvent difficult problems of gathering quantity data and estimating complex production function.

However, the dual approach is not without disadvantage. In order to infer the shadow prices from market prices, we have to make assumptions on market structure and production technology. In this paper, we assume that the Japanese market is competitive at least as the first approximation. Also, we assume that production technology exhibits constant returns to scale, and that there is no production externality. Under these assumptions, we will show that it is possible to identify shadow prices and rents from market information.

The organization of this paper is as follows. In section II, we develop analytical framework of the sectorally-balanced economic growth. Using the result of this section, we derive the no-arbitrage condition in shadow prices in section III. Section IV shows the way shadow prices and rents are inferred from market prices and returns. Section V reports the test of whether the Japanese economic growth is sectorally-balanced, under the assumption of the perfectly competitive economy. Using the disaggregate data of thirty industries, we show that there is a strong possibility that Japanese economic growth is not balanced. Section VI concludes this paper with the assessment of the result and the comments on future research.

II. Analytical Framework

We consider the economy with many identical infinitely-lived households ("dynasties"), in which there are N production sectors. Each sector produces sector-specific products by using sector-specific capital stocks and labor. The products are either consumed or used in capital formation in production sectors.

In this paper, we are mostly concerned with sectoral capital accumulation, that is, whether sectoral investment is "balanced" or not. To focus on the issue, we take the intra-temporal as well as inter-temporal allocation of labor as given. Thus, the optimal capital allocation analyzed in this paper is conditional on the actual allocation of labor force. We make this assumption for analytic sharpness, and do not intend to belittle the important issue of intra- and inter-temporal labor allocation, which is surely an important problem especially in developing countries. Our strategy is tactical, and must not be misunderstood.

A. A Representative-Consumer Model with N Sectors

Let k_t be the capital stock vector in period t, in which k_t^i is the capital stock of the i-th sector. We hereafter use subscript t to denote the t-th period, and superscript i to denote the i-th sector.

The production function is a function of labor inputs and capital stocks such that

$$y_t^i = F^i (l_t^i, k_t^i; x_t^i), \tag{1}$$

where y_t^i is the output of the i-th sector, and x_t^i is the technological shock affecting the i-th sector. Let y_t be the output vector consisting of y_t^i, and x_t be the technological-shock vector consisting of x_t^i. It is assumed that x_t is observed at t. However, future x_{t+s} $(s > 0)$ is not observed at t.

We assume the allocation of labor inputs as given, so that the production function has the form:

$$y_t^i = f^i (t, k_t^i; x_t^i) \equiv F^i (\overline{l}_t^i, k_t^i; x_t^i), \tag{2}$$

where f^i is assumed to be differentiable in k_t^i.

The output is either consumed or used in capital formation. Let c_t be the representative consumer's consumption vector in which c_t^i is the consumption of the products of the i-th sector. The representative consumer's inter-temporal utility is

$$E_0 \sum_{t=0}^{\infty} u_t(c_t) = E_0 \sum_{t=0}^{\infty} u_t(c_t^1, \ldots, c_t^N),$$

where E_0 is the expectation operator conditional on information available at $t = 0$, and u_t is the period-utility function. Period-utility function u_t is assumed to be differentiable with respect to c_t^i. u_t depends on time t, which allows time preference. This formulation is general enough to include not only the constant time preference but also time-varying one.

Let v_{t+1}^i be the gross investment-input vector of the i-th sector in period t which is used to form capital stock k_{t+1}^i in period $t + 1$, where $v_{t+1}^{i,j}$ is the products of the j-th sector used in forming the i-th sector's capital stock k_{t+1}^i. That is,

$$k_{t+1}^i = h^i(t, v_{t+1}^i) + (1 - \delta^i)\, k_t^i,$$

where h^i is the transformation function[3], and δ^i is the rate of depreciation of the i-th sector's capital stock.

Finally, the demand for and the supply of products must coincide, so that we have

$$c_t^i + \sum_{j=1}^{N} v_{t+1}^{j,i} = f^i(t, k_t^i; x_t^i).$$

B. Welfare Maximization

The socially optimal capital accumulation (dynamic sectoral efficiency) is then determined by the following inter-temporal maximization of the representative consumer's utility:

$$\underset{\{c_t^i, v_{t+1}^i\}}{\text{Max}}\; E_0 \sum_{t=0}^{\infty} u_t(c_t) = \underset{\{c_t^i, v_{t+1}^i\}}{\text{Max}}\; E_0 \sum_{t=0}^{\infty} u_t(c_t^1, \ldots, c_t^N)$$

subject to

$$c_t^i + \sum_{j=1}^{N} v_{t+1}^{j,i} = f^i(t, k_t^i; x_t^i),\quad k_{t+1}^i = h^i(t, v_{t+1}^i) + (1 - \delta^i) k_t^i,\quad \text{and}\quad k_0 = \bar{k}_0.$$

[3]The transformation function may depend on labor inputs. However, since we take allocation of labor as given, the transformation function can be expressed as a function of investment-inputs alone. Here t in h^i captures the effect of labor inputs in the same way as t does in f^i.

The last constraint is the initial condition.

In this paper, we assume (1) the existence and (2) the uniqueness of the optimal accumulation path[4], and that (3) Bellman's equation is a necessary condition of this inter-temporal utility maximization.[5] Let the value function W_t be such that

$$W_t(\bar{k}) \equiv W_t(\bar{k}_t^1,\ldots,\bar{k}_t^N) \equiv \underset{\{v_{t+s+1}^i\}}{\mathrm{Max}}\, E_t\left[\sum_{s=0}^{\infty} u_t\left(f^1(t+s,k_{t+s}^1,x_{t+s}^1)-\sum_{j=1}^{N} v_{t+s+1}^{j,1},\ldots,\right.\right.$$

$$\left.\left. f^N(t+s,k_{t+s}^N,x_{t+s}^N)-\sum_{j=1}^{N} v_{t+s+1}^{j,N}\right)\right]$$

$$\text{s.t. } k_{t+s+1}^i = h^i(t+s,v_{t+s+1}^i)+(1-\delta^i)k_{t+s}^i, \text{ and } k_t^i=\bar{k}_t^i.$$

Then, Bellman's equation is

$$W_t(k_t) \equiv W_t(k_t^1,\ldots,k_t^N)$$

$$\equiv \underset{v_{t+1}^i}{\mathrm{Max}}\left[\begin{array}{l} u_t\left(f^1(t,k_t^1,x_t^1)-\sum_{j=1}^{N} v_{t+1}^{j,1},\ldots,f^N(t,k_t^N,x_t^N)-\sum_{j=1}^{N} v_{t+1}^{j,N}\right) \\ +E_tW_{t+1}(h^1(t,v_{t+1}^1)+(1-\delta^1)k_t^1,\ldots,h^N(t,v_{t+1}^N)+(1-\delta^N)k_t^N) \end{array}\right]$$

I assume W_t is differentiable in k_t.[6]

From the Bellman's equation, two fundamental necessary conditions for the optimum are derived. First, the first-order condition of the right-hand side of Bellman's equation yields

$$\frac{\partial u_t(c_t)}{\partial c_t^j} = E_t\frac{\partial W_{t+1}(k_{t+1})}{\partial k_{t+1}^i}\frac{\partial h^i(t,v_{t+1}^i)}{\partial v_{t+1}^{i,j}} \quad \text{for all } (i,j)$$

or equivalently,

$$u_t'(c_t) = E_t\frac{\partial W_{t+1}(k_{t+1})}{\partial k_{t+1}^i}h^{i\prime}(t,v_{t+1}^i), \tag{3}$$

where u_t' denotes the derivative of u_t with respect to the vector c_t, and $h^{i\prime}$ is defined analogously. This condition determines the optimum sec-

[4]For conditions ensuring the existence and uniqueness, see, for example, Lucas and Stokey (1990).

[5]Under weak conditions, Bellman's equation is actually necessary. See Lucas and Stokey (1990).

[6]See Benveniste and Scheinkman (1979) for sufficient conditons of the differentiability.

toral investment-input vector v^i_{t+1} for given c_t and k_{t+1}.

Second, differentiating Bellman's equation and using the above envelope relation, we have

$$\frac{\partial W_t(k_t)}{\partial k^i_t} = \frac{\partial u_t(c_t)}{\partial c^i_t} f^i_k(t, k^i_t, x^i_t) + E_t \frac{\partial W_{t+1}(k_{t+1})}{\partial k^i_{t+1}}(1-\delta^i) \quad \text{for all } i. \tag{4}$$

This equation governs the optimal accumulation, and can be called the stochastic Euler equation.

III. No-Arbitrage Condition in Shadow Prices

A. Representation of the Stochastic Euler Equation by Shadow Prices

Let us define the shadow price q^i_t of the i-th sector's capital k^i_t and its shadow rent r^i_t, and let us characterize the stochastic Euler equation by them. In the following discussion, we take the first-sector product as a *numeraire* product.

Consider the "cost minimization" problem such that

$$\Gamma^i\{t, p_t, k^i_{t+1} - (1-\delta^i)k^i_t\} \equiv \underset{v^i_{t+1}}{\text{Min}} \; p_t v^i_{t+1} \quad \text{s.t.} \quad k^i_{t+1} = h^i(t, v^i_{t+1}) + (1-\delta^i)k^i_t,$$

where p_t is taken as given. Here the "shadow output price vector" p_t is defined as

$$p_t \equiv (1, p^2_t, \ldots, p^N_t) \equiv \left(1, \frac{\dfrac{\partial u_t(c_t)}{\partial c^2_t}}{\dfrac{\partial u_t(c_t)}{\partial c^1_t}}, \ldots, \frac{\dfrac{\partial u_t(c_t)}{\partial c^N_t}}{\dfrac{\partial u_t(c_t)}{\partial c^1_t}} \right)$$

$$\text{or equivalently, } \frac{\partial u_t(c_t)}{\partial c^1_t} p_t = u'_t(c_t).$$

Then, the shadow price of the i-th sector's capital is defined as

$$q^i_t = \frac{\partial \Gamma^i\{t, p_t, k^i_{t+1} - (1-\delta^i)k^i_t\}}{\partial k^i_{t+1}}.$$

From the envelope relation, we have

$$p_t = q^i_t h^{i'}(t, v^i_{t+1}) \text{ or requivalently, } u'_t(c_t) = \frac{\partial u_t(c_t)}{\partial c^1_t} q^i_t h^{i'}(t, v^i_{t+1}). \tag{5}$$

Next, the shadow rent of the i-th sector's capital is defined analogously. Consider the following "profit maximization" problem with the "rent' r_t^i on k_t^i:

$$\underset{k_t^i}{\text{Max}}\ p_t^i y_t^i - r_t^i k_t^i \qquad \text{s.t.}\ \ y_t^i = f^i(t, k_t^i; x_t^i),$$

where p_t^i is taken as given. Then, the first-order condition is

$$r_t^i = p_t^i f_k^i(t,\ k_t^i;\ x_t^i), \tag{6}$$

which defines the shadow rent of the i-th sector's capital r_t^i.

From (3) and (5), we have

$$\frac{\partial u_t(c_t)}{\partial c_t^1} q_t^i = E_t \frac{\partial W_{t+1}(k_{t+1})}{\partial k_{t+1}^i}. \tag{7}$$

Moreover, from (6) and the definition of p_t, we have

$$\frac{\partial u_t(c_t)}{\partial c_t^1} r_t^i = \frac{\partial u_t(c_t)}{\partial c_t^i} f_k^i(t, k_t^i; x_t^i). \tag{8}$$

Consequently, the stochastic Euler equation (4) can be expressed as[7]

$$\frac{\partial u_t(c_t)}{\partial c_t^1} q_t^i = E_t\left[\frac{\partial u_{t+1}(c_{t+1})}{\partial c_{t+1}^1}\{r_{t+1}^i + q_{t+1}^i(1-\delta^i)\}\right] \tag{9}$$

B. No Arbitrage Condition in Shadow Prices (NACISP)

Let us define the "shadow rate of net return" on the i-th sector's capital, Φ_t^i, such that

$$\Phi_{t+1}^i = \frac{r_{t+1}^i + \{(1-\delta^i)q_{t+1}^i - q_t^i\}}{q_t^i}$$

In addition, let us simplify notation in the following way:

$$u_t'(1) \equiv \frac{\partial u_t(c_t)}{\partial c_t^1}.$$

Then, taking that q_t^i is non-stochatic at period t, we have from the

[7]Taking one-period lead of (4), we have

$$\frac{\partial W_{t+1}(k_{t+1})}{\partial k_{t+1}^i} = \frac{\partial u_{t+1}(c_{t+1})}{\partial c_{t+1}^i} f_k^i(t+1, k_{t+1}^i, x_{t+1}^i) + E_{t+1}\frac{\partial W_{t+2}(k_{t+2})}{\partial k_{t+2}^i}(1-\delta^i).$$

Taking E_t on both sides, and using the relations (7) and (8), we obtain this equation.

stochastic Euler equation (9),

$$u_t'(1) = E_t\,[u_{t+1}'(1)\,\{\Phi_{t+1}^i + 1\}] = E_t\,[u_{t+1}'(1)\,\{\Phi_{t+1}^j + 1\}] \quad \text{for all } i \text{ and } j. \qquad (10)$$

We hereafter call (10) the *no arbitrage condition in shadow prices (NACISP).* This condition implies that the expected shadow rate of net return must be the same for all capital stocks. This equation will be the basis of the empirical analysis presented in section V.

Example

As an example, let us consider the familiar case of

$$u_t(c_t) \equiv \left(\frac{1}{1+\rho}\right)^t c_t.$$

Then the relation (10) implies

$$(1+\rho) = E_t\,\{\Phi_{t+1}^i + 1\} \text{ or equivalently, } \rho = E_t\left\{\frac{r_{t+1}^i + (1-\delta^i)q_{t+1}^i - q_t^i}{q_t^i}\right\},$$

which is the familiar no-arbitrage condition, though it is expressed in shadow prices. Equation (10) is the general case of this simple no-arbitrage condition.

C. Test of NACISP: the Weak-Form Efficiency Test

Let us consider testable implication of the no arbitrage condition in shadow prices. In general, we have, from the property of the conditional expectation

$$u_{t+1}'(1)\{\Phi_{t+1}^i + 1\} - u_t'(1) = \varepsilon_t^i u_{t+1}'(1) \text{ or equivalently, } \Phi_{t+1}^i + 1 - \frac{u_t'(1)}{u_{t+1}'(1)} = \varepsilon_t^i,$$

where ε_t^i is the percentage expectation error in terms of the numeraire good in period $t + 1$, which is orthogonal to information available at period t.

Consequently, the pair-wise "excess returns in shadow prices" such that

$$\Phi_{t+1}^i - \Phi_{t+1}^j = \varepsilon_t^i - \varepsilon_t^j \qquad (11)$$

must be serially uncorrelated. Equation (11) can be used to test whether the *no-arbitrage condition in shadow prices* is satisfied or not.

The test based on (11) is known as weak-form efficiency test in the literature of finance. If the financial market is informationally efficient in the sense that there is no way to gain profits by using information available in the market, then there must not be serial correlation in the pair-wise excess rate of returns on assets. This is because, if there were such correlation, it would be possible to gain positive (expected) profits by taking advantage of the correlation. Since such "informational efficiency" is a necessary condition for the optimal capital accumulation, it is no wonder that we have this weak-form efficiency as a necessary condition for the optimum.

Equation (11) also shows that the necessary direction of adjustment to improve social welfare if (11) is not satisfied with equality. If there is a positive serial correlation in $\Phi^i_{t+1} - \Phi^j_{t+1}$, then the i-th sector *ceteris paribus* under-invests relative to the j-th sector, so that the i-th sector's rate of return on capital is persistently higher than that of the j-th sector. Thus, diverting investment from the j-th sector to the i-th increases the social welfare.

IV. The Market Economy

A. *Identifying Shadow Prices: The Competitive-Market-Economy Assumption with Constant-Returns-to-Scale Technology without Externality*

Equation (11) in the previous section is a testable hypothesis if the "excess returns in shadow prices" are observable. Then, the next task is to identify them in the market or to infer from the market. Here, we must make additional assumptions on market structure and technology. We assume that (1) products are not rationed, (2) markets are perfectly competitive, and (3) there is no externality in production.

There are three types of shadow prices in this equation. First, we must have information about p^i_t, which is the marginal utility of the i-th product in terms of the numeraire product, i.e.,

$$P^i_t = \frac{\dfrac{\partial u_t(c_t)}{\partial c^i_t}}{\dfrac{\partial u_t(c_t)}{\partial c^1_t}}. \tag{12}$$

This P^i_t is easily inferred from market prices. Let P^i_t be the market price of the i-th product.[8] Since it is natural to assume that the repre-

[8]This price is the actual price buyers pay, including indirect taxes.

sentative consumer is a price taker, the consumer maximizes the following period-utility for given level of expenditure I.

$$\operatorname*{Max}_{c_t^i} \ u_t(c_t^1,\ldots,c_t^N) \ \text{ s.t. } \sum_{i=1}^{N} P_t^i c_t^i = I.$$

Therefore, we have

$$p_t^i = \frac{P_t^i}{P_t^1}, \tag{13}$$

so long as no product is rationed.[9]

Second, the shadow price of capital q_t^i is the marginal cost of producing capital. Since (i) the firm minimizes the cost of capital formation in such a way that

$$\operatorname*{Min}_{v_{t+1}^i} \ P_t v_{t+1}^i \ \text{ s.t. } \ k_{t+1}^i = h^i(t, v_{t+1}^i) + (1-\delta^i)k_t^i, \tag{14}$$

and (ii) the firm always has an option to buy the capital from the market of capital stocks, the market replacement value (i.e., the price) Q_t^i of the i-th sector capital stock satisfies $P_t = Q_t^i \, h^{i\,\prime}(t, \, v_{t+1}^i)$. Therefore, we have from (5)

$$q_t^i = \frac{Q_t^i}{P_t^1}. \tag{15}$$

Finally, the shadow rent r_t^i is the marginal productivity of the i-th sector, multiplied by the shadow price of the i-th sector product. Under the assumption of perfect competition and no externality in production, the optimal plan requires that the firm should maximize the following after-tax profits for given capital stocks

$$\operatorname*{Max}_{k_t^i, l_t^i} \ (1-\tau_t)\{(1-\sigma_t^i)P_t^i F^i(k_t^i, l_t^i; x_t^i) - W_t^i l_t^i\}, \tag{16}$$

where the original function form (1) of the production function is used, τ_t is the corporate income tax in period t, σ_t^i it is the excise tax applied to the i-th sector products in period t, W_t^i is the wage rate. From the first-order condition of optimality, we have

$$F_l^i = \frac{W_t^i}{(1-\sigma_t^i)P_t^i}, \tag{17}$$

[9]Note that this relation holds even if prices are controlled by the government.

where F_l^i is the derivative of F^i with respect to labor input l.

As for production technology, we make a standard neoclassical assumption in which production technology exhibits constant returns to scale and that there is no externality in production.[10] Thus, function F^i is linear homogeneous, so that we have $F^i = F_k^i\, k_t^i + F_l^i\, l_t^i$. Therefore, we obtain from the definition of f^i

$$r_t^i = p_t^i f_k^i(t, k_t^i, x_t^i) = \frac{P_t^i}{P_t^1} F_k^i(l_t^i, k_t^i, x_t^i) = \frac{1}{P_t^1} \frac{(1-\sigma_t^i)P_t^i F^i - W_t^i l_t^i}{(1-\sigma_t^i)k_t^i}, \quad (18)$$

which can be inferred from the product-market prices, P_t^i, the observed returns on capital $(1 - \sigma_t^i)\, P_t^i\, F^i - W_t^i\, l_t^i$, and the quantity of capital stocks, k_t^i.

Thus, under the assumptions of perfect competition, constant returns to scale, and no production externality, we can infer shadow prices and shadow rents from observed market prices, returns on capital, and the quantity of capital stocks.

Let us now express (11) in observed prices and returns to capital. The shadow rate of net return Φ_t^i can be re-written as

$$\Phi_{t+1}^i = \frac{r_{t+1}^i \{(1-\delta^i)q_{t+1}^i - q_t^i\}}{q_t^i}$$

$$= \frac{\frac{P_t^1}{P_{t+1}^1} \frac{(1-\sigma_{t+1}^i)P_{t+1}^i F^i - W_{t+1}^i l_{t+1}^i}{(1-\sigma_{t+1}^i)k_{t+1}^i} + \{(1-\delta^i)\frac{P_t^1}{P_{t+1}^1} Q_{t+1}^i - Q_t^i\}}{Q_t^i}.$$

Consequently, we can test whether $\Phi_{t+1}^i - \Phi_{t+1}^j$ is serially correlated or not, which the weak-form efficiency test of the no-arbirage condition in shadow prices, by using information about market prices P_t^i, and Q_t^i, market returns on capital (including corporate income taxes) $(1 - \sigma_{t+1}^i)$ $P_{t+1}^i\, F^i - W_{t+1}^i\, L_{t+1}^i$, the rate of depreciation δ^i, and the capital stock k_t^i.

B. Sources of Unbalanced Capital Accumulations

We are concerned with whether the actual Japanese economy has been deviated from the optimal sectoral capital accumulation path, or "balanced" capital accumulation path. It is well-known that if there is no externality in production, no distrotionary taxes, no irrationality in

[10]Thus, we implicitly assume away increasing returns and production externality, which are emphasized in the recent literature of imperfect competition and endogenous growth. We will discuss them later in section VI.

investment, and no financial distortion,[11] then the competitive economy with the representative consumer can achieve the optimal sectoral accumulation,[12] and the no-arbitrage condition in shadow prices is satisfied (see Appendix A). This "neoclassical case" can be considered as the reference point. Thus, if the no-arbitrage condition in shadow prices (NACISP) is rejected by the data, this implies at least one of the maintained assumptions of perfect competition, no production externality, no distortionary taxation, and no irrationality in investment behavior, does not hold.

However, in order to identify the shadow prices and rents, we have already assumed that perfect competition and no production externality. Thus, we have implicitly assumed that the sources of unbalanced capital accumulation, if they exist, are tax distortion, irrational investment behavior, or financial distortion.

Distortionary financial markets may cause substantial distortion in capital accumulation. If financial markets are not perfect, then there are firms which might be liquidity-constrained. Such constraint generally causes inefficient capital accumulation. Moreover, if funds are available only for a subset of firms, resulting investment may also be inefficient. Then, even if product markets are perfectly competitive, capital accumulation is not efficient nor sectorally balanced.

V. Sectoral Balancedness in the Japanese Capital Accumulation: 1960-1985

In this section, we will examine whether the no-arbitrage condition in shadow prices (NACISP) is satisfied in the post-war Japanese capital accumulation between 1960 and 1985. This quarter of the twentieth century 1960-85 has witnessed a dramatic change in the Japanese economy. The starting year, 1960, is chosen since rapid economic growth in the 1960s is at the heart of the Japanese economic "miracle" (Ito 1992, p. 61).[13] Chronic trade deficits plagued in the early years after the Second World War were by and large disappeared around 1960. Hayato Ikeda became prime minister in July 1960, and his

[11]We are indebted to Professor Kyung-Soo Kim, who convinced us that this factor is likely to play an important role in the Japanese economy under consideration, namely, between 1960 and 1985.

[12]See, for example, Blanchard and Fischer (1989; Chapter 2).

[13]The choice of 1960 is partly due to the data availability. Kuroda (1993)'s estimates of sectoral capital stocks and capital goods prices starts in 1960.

ambitious "income-doubling plan," which aimed to double real national income in ten years, was adopted in December as the basic economic plan of the government. From then, economic growth until 1974 was just remarkable, in which the average growth rate was close to 10% and real national income was doubled in seven years, not in ten years as originally planned.

The two oil crises in the 1973 and 1978 transformed the Japanese economy from the rapidly growing one to the steadily growing one. The average growth rate between 1974 and 1985 was between 4% and 5%, which was still decent but paled before the past history of rapid growth. The choice of the ending year, 1985, is partly dictated by the data availability (see below) and partly due to the fact that the driving force of the Japanese economy after 1985 is different from that before 1985. Most notably, the surge of asset prices and their following collapse lead the long expansion and subsequent sharp decline after 1985, while such dramatic movement in asset prices were not observed between 1960 and 1985. However, since the data is only partially available for the recent period, we decided not to include this period in order to concentrate our analysis on rapid growth era and subsequent steady growth one.

The primary data we use is the sectoral data of the quantity and the price of capital stocks and returns on capital stocks, compiled by Professor Masahiro Kuroda of Keio University (Kuroda 1993).[14] The time span is between 1960 and 1985, and thirty industries (plus one government service sector) are identified (see Table 1). The industry classification is based on the Input-Output Table, compiled by the Ministry of International Trade and Industry. The brief account of the way Kuroda's (1993) data is compiled is presented in Appendix B.

Table 2 shows the annual growth rate of capital stocks by industry. This table shows a remarkable slowdown in investment around 1973, as well as the sectoral shift taken place at that time. During the rapid

[14]Kuroda (1993) goes further than simply compiles the data. He estimates the private after-tax returns on capital stocks, meticulously taking into consideration various forms of taxes that firms have to pay but that are often ignored in the formal analysis, such as business property taxes, prefecture inhabitant taxes, municipal inhabitant taxes, Motor Vehicle Tonnage Tax, and Automobile Acquisition Tax, to name a few. He also imputes the private shadow price of services from various types of capital stocks. These data reveal private incentive to invest, so that they contain important information for the analysis of possible source of bias in capital accumulation. This is, however, beyond the scope of the present paper.

TABLE 1
INDUSTRY CLASSIFICATION

No.	Sector Name	Abbreviation
1.	Agriculture-Forestry-Fishery	Agric.
2.	Mining	Mining
3.	Construction	Construct.
4.	Food and Kindred Products	Food
5.	Textile Mill Products	Textile
6.	Apparel and Other Fabricated Textile	Fab. Text.
7.	Lumber and Wood Products (except Furniture)	Lumber
8.	Furniture and Fixture	Furniture
9.	Paper and Allied Products	Paper
10.	Printing, Publishing, and Allied Products	Printing
11.	Chemical and Allied Products	Chemical
12.	Petroleum Refinery and Related Products	Petroleum
13.	Rubber and Glass Products	Rubber
14.	Leather Products	Leather
15.	Stone Clay Products	Stone clay
16.	Iron and Steel	Iron steel
17.	Nonferrous Metal Products	Nonferrous
18.	Fabricated Metal Products	Fab. Metal
19.	Machinery	Machinery
20.	Electric Machinery	Elec. Mach.
21.	Motor Vehicles and Equipment	Mot. Veh.
22.	Transportation Equipment except Motor Vehicles	Trsp. Equip.
23.	Precision Instruments	Prec. Inst.
24.	Miscellaneous Manufacturing	Misc. Mfg.
25.	Transportation and Communication	Trsp. Comm.
26.	Electric Utility and Gas Supply	Utilities
27.	Wholesale and Retail Trade	Trade
28.	Finance and Insurance	Finance
29.	Real Estate	Estate
30.	Service	Service
31.	Government Service	Gov. Service

Source: Kuroda (1993) Table 0.

growth era between 1960 and 1972, most manufacturing industries show two-digit growth rates, while their growth rates exhibit dramatic slowdown after 1972. Take Iron and Steel. The annual growth rate of capital stocks in the Iron-and-Steel industry is above 14% in the rapid growth era, while it goes down to less than one third in the steady growth era. Some industries experience more severe slowdown, as exemplified by the Leather Products industry (down to almost one

TABLE 2

ANNUAL GROWTH RATE OF CAPITAL STOCKS BY INDUSTRY (%)

No.	Sector Name	60-72	72-85
1.	Agriculture-Forestry-Fishery	4.495	5.278
2.	Mining	6.282	0.748
3.	Construction	14.633	6.137
4.	Food and Kindred Products	12.617	5.243
5.	Textile Mill Products	6.275	3.305
6.	Apparel and Other Fabricated Textile	10.936	2.736
7.	Lumber and Wood Products (except Furniture)	5.217	3.356
8.	Furniture and Fixture	9.901	5.093
9.	Paper and Allied Products	11.822	5.613
10.	Printing, Publishing, and Allied Products	9.982	7.037
11.	Chemical and Allied Products	12.692	4.804
12.	Petroleum Refinery and Related Products	15.063	5.228
13.	Rubber and Glass Products	17.073	6.273
14.	Leather Products	12.251	1.575
15.	Stone Clay Products	14.045	5.718
16.	Iron and Steel	14.061	3.311
17.	Nonferrous Metal Products	10.853	7.262
18.	Fabricated Metal Products	19.722	8.289
19.	Machinery	17.455	5.927
20.	Electric Machinery	14.671	9.812
21.	Motor Vehicles and Equipment	16.973	8.069
22.	Transportation Equipment except Motor Vehicles	13.792	3.258
23.	Precision Instruments	16.929	10.052
24.	Miscellaneous Manufacturing	16.372	8.627
25.	Transportation and Communication	6.357	3.064
26.	Electric Utility and Gas Supply	6.473	10.996
27.	Wholesale and Retail Trade	12.211	5.482
28.	Finance and Insurance	10.327	3.875
29.	Real Estate	4.841	4.399
30.	Service	11.863	6.714

Source: Kuroda (1993) Table 14.

tenth).

By contrast, the Precision-Instrument industry fares much better than other industries, keeping two-digit growth rates even in the steady growth era. In addition, the Electric-Utility-and-Gas-Supply industry steps up its investment from 6% to 11%. The Agriculture-Forestry-Fishery industry also shows the steady pace of capital accumulation.

Since the capital-stock growth in the rapid growth era is dramatic, and that the ensuing slowdown is drastic both in the overall trend and in the sectoral shift, there might be inefficient adjustment in transition periods. Moreover, the Japanese tax system imposes various complicated taxes on firms, which might result in inefficient capital accumulation. We will examine whether the necessary condition of the sectorally-balanced capital accumulation, that is, the no arbitrage condition in shadow prices, is satisfied by the Japanese sectoral capital stock and price data between 1960 and 1985.

Table 3 reports the result. Here we adopt the product of Agriculture-Forestry-Fishery industry as numeraire. We use the value-added deflator of this industry as its price series, which is taken from the System of National Accounts. We also make two additional simplifying assumptions. First, we ignore the effect of excise tax. This assumption is generally not serious, since its effect is relatively small except possibly for motor vehicles.[15] Second, we use the economic depreciation rate for machinery reported in Kuroda (1993) as the representative of depreciation rates of depreciable assets in general.[16] In this table, in order to save space, we only show the result based on the following six reference industries. They are the agriculture-forestry-fishery, textile, iron-and-steel, machinery, precision-instrument, and wholesale-and-retail-trade industries.

This table shows that the Japanese capital accumulation is generally not sectorally balanced. This is particularly the case among agriculture-forestry-fishery, mining, construction, manufacturing, and real estate.

Extremely high persistence of positive excess shadow rate of returns of the real-estate industry seems to confirm the popular view that the Japanese capital accumulation is biased toward the industrial base,

[15]During the period under consideration, there was no general commodity tax. Commodity taxes were levied on luxury goods, such as fur coat, and most non-luxury items are exempt from them, except liquor and automobile. However, the luxury goods are heavily taxed, and the commodity-tax revenue is non-negligible in the central government tax revenue (accounting for roughly four percent).

The commodity-tax system changed dramatically in 1989, when the *de facto* value-added tax called consumption tax was introduced and most commodity taxes were abolished.

[16]To measure economic depreciation rate is in general very difficult. Kuroda (1993) in fact attempted to measure it, but his estimate is still tentative. Thus, we are obliged to have recourse to the second-best solution, in which we use the relatively-reliable depreciation rate in the machinery industry as a representative depreciation rate.

TABLE 3

TEST OF NO-ARBITRAGE CONDITION IN SHADOW PRICES IN THE JAPANESE ECONOMY: 1960-1985

β Coefficient and Its t-Value of the regression: $\Phi^i_{t+1} - \Phi^{ref.ind.}_{t+1} = \beta(\Phi^i_t - \Phi^{ref.ind.}_t) + \alpha$

Industry	Reference Industry											
	Agric.	*t*-value	Textile	*t*-value	Iron Steel	*t*-value	Mauhinery	*t*-value	Prec. Inst.	*t*-value	Trade	*t*-value
Agric.	n.a.		0.306	1.483	0.439*	2.4356*	0.567*	4.8817*	0.674*	6.8206*	0.258	1.6027
Mining	0.795*	7.0606*	0.647*	4.174*	0.526*	3.946*	0.677*	8.0201*	0.74*	12.234*	0.611*	5.941*
Construct.	0.69*	5.052*	0.647*	4.4495*	0.559*	3.1007*	0.781*	6.4955*	0.814*	7.722*	0.686*	4.3342*
Food	0.403	2.448	0.551*	3.6531*	0.681*	4.4954*	0.279	1.2705	0.357	1.8413	0.47	2.4802
Textile	0.306	1.483	n.a.		0.279	1.4912	0.439*	3.3373*	0.67*	6.0549*	-0.2	-1.2816
Fab. Text.	0.807*	5.6551*	0.624*	3.6311*	0.264	1.4102	0.669*	6.2414*	0.803*	9.174*	0.546*	3.7144*
Lumber	0.411	2.1036	0.003	0.0134	0.163	0.8295	0.499*	3.6817*	0.681*	6.7632*	0.311	1.9346
Furniture	0.676*	4.2538*	0.443	2.2551	0.721*	4.9511*	0.351	2.3273	0.352*	3.0305*	0.575*	3.7207*
Paper	0.421	2.2806	-0.22	-1.1372	0.339	1.7101	0.59*	5.2631*	0.737*	7.155*	-0.2	-1.1161
Printing	0.779*	5.8636*	0.634*	3.6898*	0.743*	5.0445*	0.339	2.3435	0.35	2.6289	0.48	2.6036
Chemical	0.219	1.066	0.081	0.3761	0.402	2.115	0.409*	2.9173*	0.68*	6.03*	-0.29	-1.7292
Petroleum	0.32	1.5775	0.455	2.3148	0.702*	4.3645*	0.199	0.9764	-0.11	-0.6135	0.304	1.44
Rubber	0.646*	6.0066*	0.715*	8.0521*	0.872*	10.275*	0.471	2.4684	0.61*	3.8278*	0.69*	4.7443*
Leather	0.742*	4.9694*	0.72*	4.8075*	0.275	1.3812	0.453*	5.5616*	0.843*	10.063*	0.703*	5.1725*
Stone Clay	0.47	2.6114	0.434	2.2529	0.677*	4.2657*	0.453*	3.3626*	0.641*	5.5687*	0.004	0.0217
Iron Steel	0.437	2.4356	0.279	1.4912	n.a.		0.727*	6.1725*	0.837*	9.4335*	0.453	2.452
Nonferrous	0.3	1.5093	0.024	0.1181	0.154	0.7651	0.581*	4.2629*	0.764*	7.4214*	0.176	0.7717
Fab. Metal	0.772*	7.5983*	0.758*	6.9313*	0.865*	8.1879*	0.55*	3.3879*	0.507*	3.528*	0.72*	4.8063*
Mahinery	0.567*	4.8817*	0.439*	3.3373*	0.727*	6.1725*	n.a.		0.746*	5.3125*	0.413	2.3952

TABLE 3
CONTINUED

Industry	Reference Industry											
	Agric.	t-value	Textile	t-value	Iron Steel	t-value	Machinery	t-value	Prec. Inst.	t-value	Trade	t-value
Elec. Mach.	0.6*	3.8334*	0.314	1.6391	0.724*	4.862*	0.294	2.1092	0.594	0.594	0.022	0.1054
Mot. Veh.	0.572	3.2761	0.451	2.2963	0.693*	4.5501*	0.546*	4.8457*	0.561*	5.076*	0.354	1.9753
Trsp. Equip.	0.182	0.9112	0.121	0.5835	0.555*	3.1173*	0.543*	4.2615*	0.566*	4.1875*	–0.04	–0.2033
Prec. Inst.	0.674*	6.8206*	0.67*	6.0549*	0.837*	9.4335*	0.746*	5.3125*	n.a.		0.836*	9.8289*
Misc. Mfg.	0.851*	7.5469*	0.746*	5.0793*	0.808*	6.2921*	0.45	2.8066	0.019	0.159	0.719*	4.9296*
Trsp. Comm.	0.562*	3.0652*	0.361	1.8058	0.306	1.6184	0.573	5.1804	0.724*	6.8846*	0.148	0.8341
Utilities	0.233	1.127	0.031	0.1417	0.168	0.9204	0.498*	4.1663*	0.651*	5.5507*	–0.07	–0.4283
Trade	0.258	1.6027	–0.2	–1.2816	0.453	2.452	0.413	0.8359	0.836*	9.8289*	n.a.	
Finance	0.407	2.0739	–0.04	–0.2021	0.023	0.1078	0.447	2.675	0.649*	4.5361*	0.058	0.2721
Estate	0.81*	7.6165*	0.722*	5.6129*	0.685*	6.1968*	0.753*	8.7075*	0.823*	13.636*	0.754*	8.1705*
Service	0.688*	6.2591*	0.642*	5.2446*	0.81*	7.4237*	0.402	2.0631	0.532*	3.0386*	0.696*	4.9097*

Notes: 1. * indicates significance at 1% level.
2. "n.a."=not applicable.
Source: See text.

and thus leaves residents of Japan in poor living conditions compared with the other OECD countries. Various institutional barriers affecting real estate transactions and tax distortions are often cited as major culprit of the bias.[17]

The biased accumulation is also found in agriculture-forestry-fishery. The agriculture-forestry-fishery industry showed relatively high returns on capital in the 1960s, but a sharp decline followed in the subsequent years. Large serial correlation in the excess shadow returns on capital shows that adjustment to changing economic conditions in the 1970s and 80s is far less satisfactory. This also supports the view that agricultural policy of the Japanese government is not effective in making adjustment smooth. A similar and stronger persistent serial correlation is found in mining, another declining and heavily subsidized industry.

Although not often discussed in the literature, the performance of the Japanese construction industry is also rather disappointing. This industry persistently shows positive excess shadow rate of returns, which implies under-investment. This industry is well-known for its complicated system of sub- and sub-sub contracting and the maze of implicit as well as explicit regulations and administrative guidance, which surely affect the industry's ability to adjust itself to changing economic and social conditions.

Nobody denies the post-war success of the Japanese economy is led by the high rate of capital accumulation in manufacturing. However, even in the manufacturing sector, there are signs of skewed accumulation, though they are not as conspicuous as other sectors. For example, the machinery and precision instrument industries show significant serial-correlation coefficients for most reference industries we consider, which alludes to inefficient capital accumulation.

VI. Concluding Remarks

In this paper, we have defined the "sectorally-balanced economic growth", and derived the no-arbitrage condition in shadow prices (NACISP) as a necessary condition for the sectorally-balanced growth. We also have developed the method to test NACISP using market prices

[17]See Ito (1993) for a concise survey of the "land problem" in Japan. A more detailed analysis of the Japanese real estate market is found in Nishimura and Sasaki (1994), where the agricultural land, residential land, and commercial land are jointly analyzed.

and-returns on capital. The test has been applied to the Japanese sectoral capital stock data between 1960 and 1985. It has shown that the Japanese sectoral capital accumulation is in general not balanced in the sense that diverting investment from one sector to another improves social welfare.

However, there are caveats. First, the fundamental assumptions in our empirical study, namely, perfect competition and constant returns to scale without externality, are not without objections. There is now a sizable literature to emphasize imperfect competition as a building block of economic analysis (see Nishimura 1992, Chapter 1). Imperfect competition makes market relative prices divergent from shadow relative prices, except for the unlikely case of the universal mark-up ratio.

Second, recent empirical studies about the technological progress cast serious doubts on the standard neoclassical assumption of constant-returns-to-scale technology with no externality. Hall (1991) emphasizes the importance of increasing returns to scale in understanding the behavior of the Solow residual which is vehicle of the neoclassical theory of technological progress. Moreover, endogenous growth theory points out that externality in production is one of the key elements in growth. Increasing returns and production externality distort the way we construct the shadow rent from market returns on capital.

Third, to consider thirty industries and to assume homogeneity within them may be too naive. Thirty industry classifications may be too coarse for policy purpose. Moreover, it is well-known that there are many small and medium-size firms in Japan. They command roughly four tenths of total production of the manufacturing corporate sector. Thus, it may be appropriate to disaggregate further, industry-wise and size-wise.

Appendix A

In this appendix, we examine the competitive market economy without externality, distortionary tax, and no irrationality. In this case, the market economy can achieve the optimal sectoral accumulation under suitable weak assumptions. We show in this appendix that the economy satisfies the no-arbitrage condition in shadow prices, (11).

We assume that there are three kinds of economic agents. First, there is a representative consumer having the inter-temporal utility (2). The representative consumer owns capital stocks, lends them to output-producing firms, buys output from them, and consumes the products. The consumer also saves in the form of buying capital goods from capital-goods producing firms. The consumer owns stocks of the firms, and receives dividends from them.

The representative output-producing firm in each sector rents capital stocks, produces output to sell it to the consumer and the capital-goods-producing firms. The capital-goods-producing firms buy output from output-producing firms, produce capital goods, and sell them to the consumer.

Let us take the representative consumer's utility of period 0 as a numeraire. This assumption is a bit unusual, but it reduces notational complexity. Moreover, to convert the "utility" price into the standard "commodity" price in terms of, say, the product of the first sector in period 0, is straightforward. (Note that this definition of P_t^i is different from that in the text, where P_t^i is the commodity price. This difference must be kept in mind.) Let P_t^i be the (utility) price of the i-th sector's product at period t, Q_t^i be the (utility) price of the i-th sector's capital goods at period t, and R_t^i be the (utility) rent of the i-th sector's capital stock.

The representative consumer solves the following maximization problem in the market economy:

$$W_t(\bar{k}_t) \equiv \underset{\{c_t\}}{\text{Max}}\ E_0 \sum_{t=0}^{\infty} u_t(c_t)$$

where $\sum_{i=1}^{N} P_t^i c_t^i + \sum_{i=1}^{N} Q_t^i \{k_{t+1}^i - (1-\delta^i)k_t^i\} = \sum_{i=1}^{N} (R_t^i k_t^i + \pi_t^{Pi} + \pi_t^{Ki}).$

As in the welfare maximization, we assume the existence, and the uniqueness of the optimal path, and that Bellman's equation is a necessary condition. The representative consumer's Bellman's equation is

$$W_t(k_t) \equiv \underset{\{c_t, k_{t+1}\}}{\text{Max}}\left[u_t(c_t) + E_t W_{t+1}(k_{t+1})\right]$$

$$\text{s.t.}\ \ P_t c_t + Q_t k_{t+1} = \sum_{i=1}^{N} (\{R_t^i + (1-\delta^i)Q_t^i\}k_t^i + \pi_t^{Pi} + \pi_t^{Ki}),$$

where P_t and Q_t are the vectors whose components are P_t^i and Q_t^i, respectively. Then, the necessary conditions of the optimum of the right-hand-side of Bellman's Equation are

$$u_t'(c_t) = \lambda_t P_t;\ \ E_t W_{t+1}'(k_{t+1}) = \lambda_t Q_t \ \ \text{and}$$
$$P_t c_t + Q_t k_{t+1} = \sum_{i=1}^{N} (\{R_t^i + (1-\delta^i)Q_t^i\}k_t^i + \pi_t^{Pi} + \pi_t^{Ki}). \tag{A1}$$

Equations (A1) determine the optimum consumption c_t and optimum capital accumulation k_{t+1} as functions of existing capital stocks k_t. Differentiating the inter-temporal budget constraint with respect to k_t and taking account of the fact that c_t and k_{t+1} are the function of k_t, we have

$$P_t \frac{\partial c_t}{\partial k_t^i} + Q_t \frac{\partial k_{t+1}}{\partial k_t^i} = R_t^i + (1 - \delta^i) Q_t^i .$$

Differentiating Bellman's Equation and taking account of the above envelope relation yield

$$\frac{\partial W_t(k_t)}{\partial k_t^i} = \lambda_t \{P_t \frac{\partial c_t(k_t)}{\partial k_t^i} + Q_t \frac{\partial k_{t+1}(k_t)}{\partial k_t^i}\} = \lambda_t \{R_t^i + (1 - \delta^i) Q_t^i\} \qquad \text{(A2)}$$

From (A1), we have

$$\begin{aligned} \lambda_t &= \frac{\partial u_t(c_t)}{\partial c_t^i} \frac{1}{P_t^i} = \frac{\partial u_t(c_t)}{\partial c_t^j} \frac{1}{P_t^j} = E_t \frac{\partial W_{t+1}(k_{t+1})}{\partial k_{t+1}^i} \frac{1}{Q_t^i} \\ &= E_t \frac{\partial W_{t+1}(k_{t+1})}{\partial k_{t+1}^j} \frac{1}{Q_t^j} \qquad \text{for all } i \text{ and } j. \end{aligned} \qquad \text{(A3)}$$

Rearranging terms in (A2) and (A3), we obtain the following market-economy stochastic Euler equation:

$$\frac{\partial W_t(k_t)}{\partial k_t^i} = \frac{\partial u_t(c_t)}{\partial c_t^i} \frac{1}{P_t^i} R_t^i + \frac{\partial E_t W_{t+1}(k_{t+1})}{\partial k_{t+1}^i} (1 - \delta^i), \qquad \text{(A4)}$$

and the market-economy investment equation:

$$\begin{aligned} &\frac{\partial u_t(c_t)}{\partial c_t^i} = E_t \frac{\partial W_{t+1}(k_{t+1})}{\partial k_{t+1}^j} \frac{P_t^i}{Q_t^j} \\ &\text{or equivalently, } u_t'(c_t) = E_t \frac{\partial W_{t+1}(k_{t+1})}{\partial k_{t+1}^j} \frac{P_t}{Q_t^j} . \end{aligned} \qquad \text{(A5)}$$

Next, consider firms. On the one hand, the representative i-th sector output-producing firm's expected profit maximization is, where i_t is the market rate of interest and z_t^i is its demand for capital (service).

$$\underset{\{z_t^i\}}{\text{Max}} \; E_0 \sum_{t=0}^{\infty} (\prod_{s=1}^{t} \frac{1}{1 + i_s}) \pi^{P_i} ,$$

where $\pi^{P_i} = P_t^i y_t^i - R_t^i z_t^i$ and $y_t^i = f^i(t, z_t^i, x_t^i)$.

The first-order condition of the optimum is

$$P^i_t f^i_k(t, z^i_t, x^i_t) - R^i_t = 0 \tag{A6}$$

On the other hand, the representative i-th sector capital-goods-producing firm's profit maximization is

$$\underset{\{v^i_{t+1}\}}{\text{Max}}\ E_0 \sum_{t=0}^{\infty}\left(\prod_{s=1}^{t}\frac{1}{1+i_s}\right)\pi^{Ki},$$

where $\pi^{Ki} = Q^i_t d^i_{t+1} - P_t v^i_{t+1}$ and $d^i_{t+1} = h^i(t, v^i_{t+1})$.

The first-order condition of the optimum is then

$$Q^i_t h^{i\prime}(t, v^i_{t+1}) - P_t = 0 \quad \text{or equivalently,}\ h^{i\prime}(t, v^i_{t+1}) = \frac{P_t}{Q^i_t}. \tag{A7}$$

Finally, market equilibrium conditions are as follows.

$$\text{The } i\text{-th output market: } \left(C^i_t + \sum_{j=1}^{N} v^j_{t+1}(i)\right) = y^i_t \tag{A8}$$

$$\text{The } i\text{-th capital-goods market: } d^i_{t+1} = k^i_{t+1} - (1-\delta^i)\,k^i_t \tag{A9}$$

$$\text{The rental market of capital goods: } z^i_t = k^i_t \tag{A10}$$

We assume the existence and uniqueness of the market equilibrium.

It is straightforward to show that the optimum conditions (1) and (4) are satisfied in the market economy. Equations (A8), (A9) and (A10) guarantee the feasibility. From (A6) and (A4), we have (4). From (A7) and (A5), we have (3). Therefore, the market economy achieves the dynamically optimal sectoral accumulation, or in orhter words, balanced growth.

Appendex B

In this appendix, we briefly explain the way Kuroda's (1993) estimates of sectoral capital stocks and their prices are obtained. The following step-by-step procedure is employed.

Step 1. Disaggregate capital stocks by owners and kinds of assests. The following categories are used.

(1) Depreciable assets

(1.A) Corporate Sector/Private Enterprise

1. Residential building, 2. Non-residential building, 3. Other structure, 4. Machinery, 5. Water transport vessels, 6. Land and air

transport vessels, 7. Tool and fixture

(1.B) Non-corporate Sector (Private Enterprise)

8. Residential building, 9. Non-residential depreciable assets

(1.C) Corporate Sector/Government Enterprise

10. Residential building

(2) Non-depreciable assets

(2.A) Corporate Sector/Private Enterprise

11. Land, 12. Inventory

(2.B) Non-corporate Sector (Private Enterprise)

13. Land, 14. Inventory

Step 2. To get the benchmark stock data of assets for each category.

The benchmark data are the Economic Planning Agency (EPA)'s National Wealth Survey in 1955 and 1970. The method in the National Wealth Survey to get the gross asset value is to multiply the historic book value inclusive of depreciation by the rate of change in the price between the acquisition year and the survey year. The net asset value is then obtained by multiplying the gross value by the remaining-value ratio which is the proportion of years elapsed since acquisition to life time.

Step 3. To get constant-price investment series for each category of depreciable assests.

(1) Total investment. Private Enterprises' (both corporate and non-corporate) total constant investment series are based on the EPA's Gross Capital Stock of Private Firms (CSPF). However, industry classification of manufacturing in CSPF is coarse, so the manufacturing investment data is further disaggregated using deflated gross investment series in the Census of Manufacturing, Reported by Industry, with deflators which are the weighted average of appropriate commodity deflators. The weight is the value share of the commodity in the industry's capital formation vector reported in the Capital Formation Matrix of Input-Output Table, 1975.

(2) Disaggregation into each asset category. Total investment is then divided into different asset categories by relying on the shares of each asset in the EPA's Report on the Corporate Industry Investment Survey (RCIS) until 1974 when the survey was curtailed. Since then balance-sheet information of all firms whose stocks are traded three national stock markets (Tokyo, Osaka and Nagoya) is used assuming that disaggregation of the total is the same as in this subgroup. (Agriculture-

forestry-fishery, mining, and finance-insurance are exceptions. The disaggregation is achieved in the three industries under the assumption that 1974 RCIS proportions continue to hold after 1975)

(3) Government enterprises' series are obtained from the published balance sheet.

Step 4. To compute time series of the stock of depreciable assets of each category by industry via perpetual inventory method.

Here, the economic rate of replacement is estimated from the data, rather than using the approximation (the rate of replacement = 2/(the average economic life)). The method is based on the computation of zero of the polynomial, based on starting 1955 benchmark assets, ending 1970 benchmark assets, and investment series between 1955 and 1970.

It should be noted here that there is important convention in this kind of estimation. All residential buildings are regarded to be owned by real estate industry. This procedure is consistent with the convention adopted by the System of National Account and the Input-Output Table, where the imputed rent on residential building is included in the value-added of real estate industry.

Step 5. To estimate the quantity and the value of total capital stocks.

The quantity of the total capital stock of an industry is the unweighted sum over all categories of assets in the industry. The value of the total capital stock is obtained by first multiplying the stock of assets of each category by the corresponding deflator, and then summing them up. The price of the total capital stock is obtained implicitly by dividing the value by the quantity.

Step 6. To estimate the non-depreciable assets.

(1) Land. The benchmark is 1955 National Wealth Survey. It contains corporate as well as non-corporate land holdings in terms of area by industry. The increment to the holdings is estimated by using the Real Estate Survey of the Ministry of Home Affairs and the Census of Manufacturing, Report on Industrial Land and Water Use. The deflator of land is taken from the Japan Real Estate Research Institute Land Price indices.

(2) Inventory. The benchmark is 1970 National Wealth Survey, augmented by information contained in the Census of Manufacturers, Report on Industry. Inventory stocks are classified into finished goods

and merchandise, semi-processed goods, and other inventories. The inventory-investment series are obtained from the Census of Manufacturers, Report on Industry, for corporate manufacturing enterprise, and the Annual Statistics of Corporate Enterprise, for corporate non-manufacturing enterprise. For non-corporate sector, the nominal aggregate estimate in SNA is distributed using the distribution ratio in 1970 National Wealth Survey. The deflator of inventory is assumed to be the same as the deflator of the industry's products.

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Comment

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The issue of dynamic efficiency has concerned macroeconomists for both theoretical and empirical aspects. There are two directions for dealing with this issue: Whether optimal saving-investment can be achieved by market economy (pioneered by Diamond (1965) and how we can determine whether actual economics are dynamically efficient (Abel 1989).

Professor Nishimura and his co-author Dr. Kuninori took the second direction. Specifically, they examined whethor the Japanese economic development is "sectorally" balanced. Rather than investigating the choice between consumption and investment and ask whether the Japanese economy over-invests Professor Nishimura and Dr. Kuninori explored the balancedness of the Japanese industrial sectors. For this they solved the intertemporal optimization problem with costs of installation of investment goods. Three shadow prices are considered: Shadow output price, shadow capital price which is the marginal cost of producing capital, and shadow rent representing the marginal productivity of capital. From the set of the first order conditions the authors derived no arbitrage condition which is a necessary condition shown in equation (11) for the optimal capital accumulation. The no arbitrage condition in shadow prices may be interpreted as follows: Suppose the ownership of capital in various industries were alienable. Then if the stock market is informationally efficient, there's no way to gain systematic profits through trading equities and, as a result, the pairwise excess rate of returns on assets must not be serially correlated. Therefore, testing the no arbitrage condition in shadow prices would be equivalent to testing stock market efficiency. Here, if there is a systematic difference in excess returns in shadow prices between and two industries, then diverting investment from industry with lower rate of return on capital to industry with higher rate of return will increase the social welfare.

Assuming perfectly competitive markets and neoclassical production

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function Professor Nishimura and Dr. Kuninori identified shadow prices by observing the Japanese market eocnomy. Based on the data from 1960-85 they shared the common sense view; The Japanese sectoral capital stock does not satisfy the no arbitrage condition in shadow prices.

I found the paper interesting and substantial. This paper, I think, makes an important contribution to the literature of assessment of the dynamic efficiency especially in the area of economic development. An economy with export-led outward oriented growth is not necessarlly dynamically effcient even though it could face the terms of trade determined by world market.

The common-sence view of the Japanese economy is that the export sectors such as knowledge intensive industry and manufacturing industry are extremely efficient. On the other hand, domestic sectors such as construction industry and distribution industry are extremely inefficient. Looking at Table 3 amoing six reference industries the precision instrument industry has 24 industries which significantly violates the no arbitrage condition in shadow prices. This is the largest number. The machinery industry and the iron steel industry share the second laregest number which is 18. Professor Nishimura and his coauthor confirmed the common sense.

I would very much like to identify more factors contributing to the sectorally unbalancedness of the Japanese economy. They pointed out the possibility of imperfect competition. Imperfect competition brings up the problem of misidentification of the shadow prices. The externality in production may be another possibility. Also they briefly mentioned the potential problem of assuming homogeneity within industries under consideration. However, all of these possibilities are the logical outcome.

In addition to tax distortion and/or irrational investment behavior pointed out in the text, my guess is, the Japances financial system could be another important source of the unbalanced growth. The authors considered years between 1960 and 1985 prior to the rapid liberalization and internationalization of the Japanese financial system (although Hoshi et. (1990) identified 1983 as the first year in which the effects of deregulation were fully felt). In addition to the investment opportunitics explained by the theory of q informational asymmetries could make firms face liquidity constraint. This lending view of monetary policy transmission which has received rising attention in recent years is especially convincing for the Japanese economy.

At least during 1960-72 Japanese firms were heavily dependent on bank lending. The Japanese financial system such as the main bank system could play a significant role. (see Hoshi et.) Firms or an industry as a whole with close bank relationship would not be liquidity constrained. However, firms without close bank relationship would be severely liquidity constrained as well as investment opportunity.

Cross-share holding has prevented a large proportion of stocks from being traded in the market. Secondary market for bonds were not well developed until 1980s. In summary, the financial markets were not competitive during the period under consideration, which would distort the cost of capital among firms and possibly among industries.

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