# Theoretical Capital Stock and Its Returns by Sector Compared with Statistics: Japan versus the US, 1960–2005[1)]

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**Abstract**

Statistics has its limitation by nature. This paper will propose a consistent framework or a subsystem to the current SNA from the viewpoint of the data required by policy-makers. It is most important for policy-makers to obtain common consistency of the data lying between national accounts and the Cobb-Douglas production function. For this purpose, the measurement of theoretical capital stock, returns, and wages, each by sector, is indispensable. These data are measured under an endogenous growth model, by replacing the current *GDP* base by the *NDI* base. The framework starts with several basic data given by the SNA so that policy-makers can evaluate the results of policies after one year, by comparing several data given at the beginning of the year with those at the end of the year. All parameters and variables except for the above given data are endogenously measured using a set of recursive non-linear equations, without using econometrics or synthesized linear equations. The framework and its results by country are shown by Kamiryo Endogenous World Table (KEWT 1.07) 1960–2005 by sector, yet this paper focuses two country comparison of theoretical capital measured in KEWT with actual capital in statistics such as Economic and Social Research Institute, Government of Japan, and Bureau of Economic Analysis, the US. To verify the consistency of capital and returns among parameters and variables, the author uses two tests; the matching test by year and the smoothening test in the long-run. The essence of the two tests is shown using the above Japan and the US data. Another paper that uses the 58 country data-sets of KEWT 2.08, 1990–2007, by sector (see http://www.riee.tv, Jan 2009) satisfies aggregate equilibrium wholly as a system by testing the necessary and sufficient conditions, where *NDI* and the net investment by sector become theoretical. KEWT 1.07 used for this paper does not thoroughly theoretical; yet this paper logically clarifies the process to measure capital stock.

## 1. Introduction

A system of national accounts (the SNA) is a unique one by country in the world today, although the government sector, by nature, is not well settled in terms of budget deficit. Capi-

1) For the author's research of capital measurement, the author is thankful to the researchers of OECD, World Bank, IMF, BEA, PWT, Canada Statistics and Canada Finance, and Indian Institute of Finance. In particular, the author is much obliged to Dr. Schreyer Paul, Drs. Heston Alan and Ye Wang, Dr. Steve Landefeld, Drs. Francois Bourguignon, Serven Luise, and Laliberte Lucie, Dr. Carole Brookings, and Shigeru Endo, Dr. Andrew Sharpe, and Dr. Aman Agarwal.

tal in the SNA is externally estimated independently of other data. The author respects the character of the SNA as statistics published for the people by country. However, it is true that the SNA does not consistently present the data necessary for the decision-making to economic, fiscal, and financial policies. The relationship between the current data used for policies and results one year after are in a fog. I indicate that the above vagueness is traced back to the fact that the data of national accounts and the data used for the Cobb-Douglas production function are inconsistent each other.

To solve the above problem, the author proposes a framework, in parallel to the SNA, to express hidden theoretical data by year for decision-makers of a country. The author does not use econometrics originated by Klein, L. R. (1950a, b, 1964). The author solves endogenously non-linear equations set shown by 'differences' by year, instead of solving synthesized linear equations. The actual data used for the framework are limited to several current/initial data by year based on *NDI*, instead of *GDP*: population, consumption, saving, investment, the balance of payments, and budget surplus/deficit, where actual $NDI = C + S$ equals theoretical $NDI = W + \Pi$. Other parameters and all the variables are theoretically measured using the author's endogenous growth model and without inserting random disturbances, although some errors in differences still exist by year. The framework, as a weak point, indicates that theoretical values cannot be compared with actual values, which differs from econometrics that compares the actual ex-post results in the SNA with the corresponding forecasted ex-ante results. However, in the process to measure theoretical capital and returns by sector, the author established two tests to examine and verify the consistency of the whole framework in the long-run. The empirical comparison using Japan and the US national accounts data will explain the implication of these tests and the consistency.

Kamiryo Endogenous World Table data-sets (KEWT 1.07, 1960–2005) shows consistently the results of the above framework by country and by sector, where once the annual values were fixed, no correction is required later for forty to fifty years.[2] The above framework first measures theoretical wages and returns by sector and second at the same time measures theoretical

2) I do no deny the possibility of later corrections in theoretical data (including capital stock) by year if actual data remain within twenty to twenty-five years (as in China 1980–2005). With learning by doing, the possibility of later corrections will be enough negligible when actual data are available for the last thirty to forty years. This is because, as the author shows in Appendix, non-linear equations are all theoretical without depending on econometrics. Furthermore, when aggregate equilibrium as in KEWT 2.07 is introduced into the data-sets, the above possibility will be much more thin.

capital stock by sector, where the rule of aggregate/sum holds: the total economy = the government sector + the private sector. The above framework is first maintained by introducing the wage function of consumption/utility at the macro level. Arrow's (1951) "Social Choice and Individual Values" is avoided by preferring this function to an aggregated individual utility at the micro level. *GDP* in the SNA includes some compromise of data arrangement in that the relationship between 'actual wages' and 'actual consumption' involved in *NDI* is vague. The author stares at this fact. The author connects actual consumption with theoretical wages, converting the *GDP* base in the SNA to the *NDI* base of the author's.[3)]

The above device, as a result, integrates the data of the SNA with the data accurately used in the Cobb-Douglas production function. This is beyond the range of the SNA. For this integration, the author needs at least two additional endogenous parameters, *beta* and *delta*. These two parameters lead to a perfect Cobb-Douglas production function under diminishing returns to capital by year and at the current situation of the transitional path. Without *delta*, the current Cobb-Douglas production function cannot explain the relationship between diminishing returns to capital at the current situation and constant returns to capital at convergence. Without *beta*, the current Cobb-Douglas production function must accept an exogenous rate of technological progress, as first shown by Solow (1956). Without this integration, theoretical wages and returns by sector cannot be measured; accordingly theoretical capital stock by sector is in a fog, particularly at the market basis.

The author indicates that capital stock aggregated by assets using the perpetual inventory method (PIM) at the micro level is a compromise in the SNA since there has been no way to estimate capital other than the use of the PIM (or the user cost of capital applicable to the manufacturing/corporate sector, based on the stock market). The author indicates that PWT 6.1 for 1950–2000 or PWT 6.2 for 1950–2004 has not published the capital-labor ratio (the stopping implies that capital stock after 1995 is not available any more in the future). The author really respects the brave decision-making at PWT to stop publishing the capital-labor ratio. PWT's 'by some reasons' definitely comes from an inevitable limit of econometrics for maintaining a system consistency at the macro level in the long-run.

First in Section 2, the author will show how to express the wage function of

3) Maddison Angus (1987, p. 659, p. 690) compares the relative share of capital/ labor with capital stock by country, much longer than the author's forty six years in KEWT 1.07. Apart from endogenous or not, his estimation is based on *GDP*. The author asserts that the *NDI* base is directly fitted for the improvement of per capita consumption towards stable growth and stop-inequality.

consumption/utility (hereafter, omitting utility) at the macro level and second, the author will show how to measure theoretical capital at the macro level. The author must prove, after measuring capital, a consistency among each data, using the *NDI* base. Otherwise, the consistency among data in the long-run and accordingly, the consistency between the data of the SNA and the data of the Cobb-Douglas production function cannot be trustworthy. For these proofs, in Section 3, the author will explain two powerful tests, the matching test by year and the smoothening test in the long-run, comparing the Japan and the US data in Kamiryo Endogenous World Table (KEWT 1.07, 1960–2005) with the corresponding data in Economic and Social Research Institute, Cabinet Office, Government of Japan (ESRI, hereafter) and those in the Bureau of Economic Analysis, Department of Commerce, the US (BEA, hereafter).

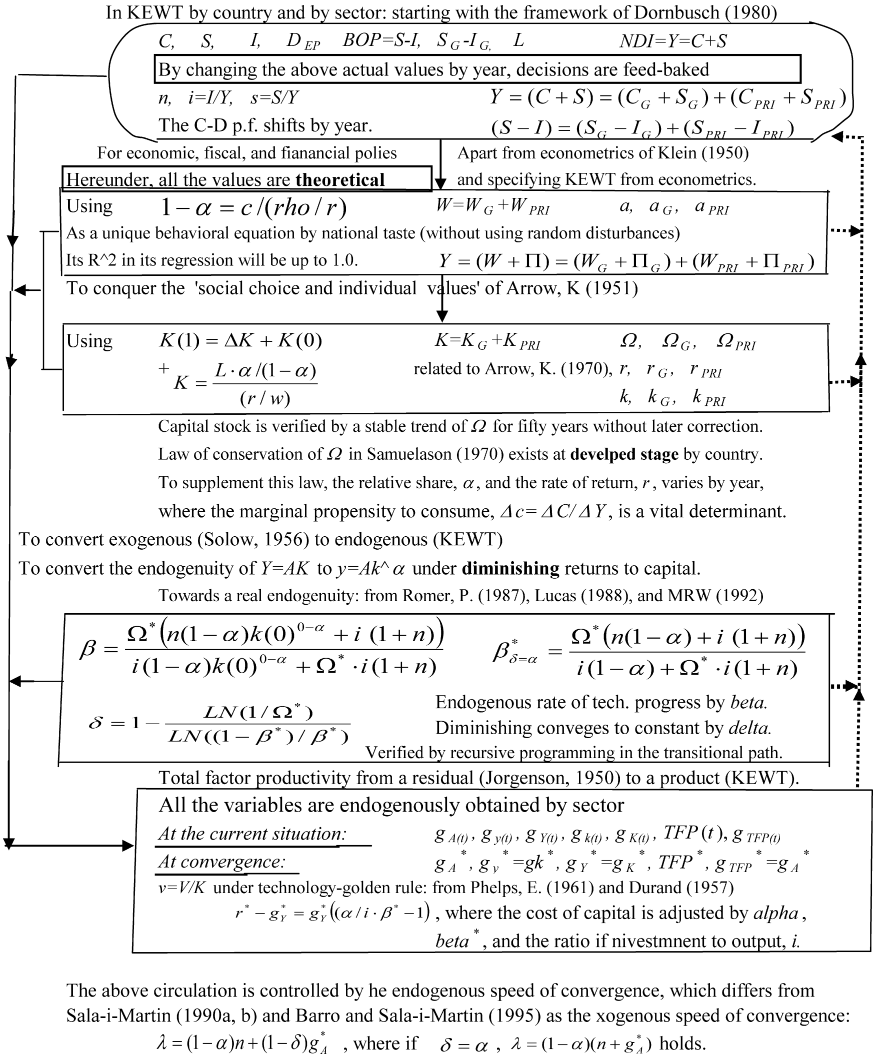
## 2. A whole framework of data and model

### 2.1 *Consistency between data and model*

The author's framework has two characteristics: consistency between data and model and the rule of aggregate between the government and private sectors.

The author will summarize the consistency between data and model in this section. The author's endogenous growth model holds under constant returns to scale prevailing in the Cobb-Douglas production function, by introducing three specified parameters, *beta* and *delta*, and *lambda*, to control the speed to convergence, into this production function. These parameters are each measured as a non-linear equation (see Appendix). The author's model (hereafter, the model) does not obtain each value of essential parameters by using regression analyses. (1) The model does not depend on econometrics but on a recursive non-linear-equations set. (2) The model and theoretical data are processed together. Thus, data and model do not contradict so that basic data from national accounts are consistent with the data used for the Cobb-Douglas production function. This framework holds when the data based on *GDP* is replaced by the data based on *NDI*, where output equals income. The framework is wholly illustrated by **Figure 1**.

This paper focuses the measurement of theoretical capital stock and returns by sector, simultaneously with theoretical wages by sector. Given data are consumption, saving, (accordingly *NDI*), and gross & net investment, each by sector, and also, population, the balance of payments *BOP* (or the current external balance if net primary income from abroad is unknown), and budget deficit, each by country. The effect of economic, fiscal, and financial




Note: At the developed sage, the capital-output ratio copes with a upper limit, where more qualitative investment is required for sustainable growth. Worldwide human-oriented education and environmental improvement are deeply involved in this qualitative investment. Even in the case of the developing stage, if the capital-output ratio is oppressed by environmental and infrastructural investment, a higher growth rate will be more guaranteed in the long run,

**Figure 1 A whole flowchart of KEWT: with the feedback to decision-making, comparing with the literature**

policies is evaluated by the change of these given data after one year. The data theoretically measured are wages, returns, and capital, each by sector, consistently at the macro level and without depending on the data aggregated at the micro level.

All the parameters and variables are shown ex-ante and at the same time ex-post, by time/year in the transitional path[4] (starting at the current situation and looking for at convergence), where the relative share of capital, *alpha*, remains unchanged under a fixed Cobb-Douglas production function. When national accounts are statistically published by year, the Cobb-Douglas production function changes by year and all the parameters and variables change by year. This paper focuses theoretical wages, returns, and capital, by sector and under these circumstances.

The first characteristic of the model is expressed by its endogenously measured parameters and variables. 'Endogenously measured' implies that quantity and quality of flows are rigorously separated in the model. For this explanation, one needs to choose a combination among four single cases: Case 1: in the transitional path at a year under a fixed Cobb-Douglas production function, Case 2: actual changes by year where the Cobb-Douglas production function changes by year, Case 3: the growth rates of flows by year, and Case 4: stocks by year. For stocks, both capital & labor and the level of technology or total factor productivity (*TFP*) are each a mixture of quantity and quality. Capital at the macro level does not specify the contents of capital by a sort of assets.[5] Now, an endogenous device was introduced into net investment[6] as the increase/decrease in capital as a flow[7]: this is *beta* as the ratio of quantitative investment to total investment. Net investment is divided into quantitative and qualitative. The growth rate of capital is quantitative by using *beta* and the rate of technological progress is qualitative

4) The ex-ante of this paper differs from the ex-ante based on econometrics that uses regression analysis. For example, Oulton Nicholas (2007, 310) compares ex-post with ex-ante capital services by industry. In the author's framework, an ex-ante value is equal to an ex-post value under several given parameters. Assume that several given parameters at the end of a year differ from those at the beginning of the year, due to goog/bad policies during the year. Then, the ex-ante value is not equal to the ex-post value.

5) Capital stock estimated by OECD for manufacturing sector excludes lands and dwellings. In the case of China, the owners of lands belong to the general (central and local) government. Capital stock aggregated using the micro level, as shown in statistics, classifies fixed assets and divides each asset into corresponding sector. Theoretical capital at the macro level, however, aims at the whole consistency among macro data including capital so that the model does not specify the differences of fixed assets.

6) Net investment differs from the net investment defined as gross investment less its depreciation. Net investment in the model is one after deducting total depreciation both to the previous capital stock and new gross investment and also any decrease of capital (including market value change) during one year.

7) Furthermore, this idea is applicable to flow items such as consumption, saving, wages, and returns, although for simplicity, this paper only treats net investment, where $1 = 1 - \beta + \beta$ .

by using 1 − *beta*. The theoretical growth rate of capital is less than the actual growth rate of capital (if *beta* < 1), whose difference is absorbed into the theoretical rate of technological progress. In this respect, note that the model of real assets does not express the change in the price level.[8)]

As a result, the level of technology or *TFP* is not a residual as commonly shown in the literature but is the product of two values: the ratio of qualitative investment to quantitative investment with the exponent of '1 − *delta*' and the capital-labor ratio with the exponent of '1 − *alpha*.'[9)] Note that at convergence, *delta* equals *alpha*, where *delta* is the parameter that neutralizes diminishing returns to capital. Therefore, capital is not purely quantitative and *TFP* is not purely qualitative.

Then, as a decisive clue of the first characteristic of data and model, the author will reveal the relationship between *beta* and the capital-output ratio (for the corresponding equation, see Appendix).[10)] This relationship justifies the measurement of theoretical capital stock in the long-run. At convergence, the hyperbolic curve of *beta* approaches 1.0 when the capital-output ratio at the horizontal axis approaches an infinite value, and both values are zero at the origin, which constitute a singular point. This implies that the capital-output ratio, $\Omega = K/Y$, has the most effective range to technological progress between $\Omega = 1.0$ and $\Omega = 1.5$, where stable developing countries stays at a condition that the ratio of net investment to output maintains a certain moderate level. If the ratio of net investment to output is too high as in China, the capital-output ratio approaches an upper limit of 2.5 quickly, where technology does not highly improve as before, as proved by the current Korea, Taiwan, and developed countries.

### 2.2 *Relationship between the government and private sectors*

The author will clarify the relationship between the government and private sectors in this section, with the rule of aggregate. This relationship is the second characteristic of data and model. The rule shows that total amount = the government amount + the private amount:

8) As long as the model is based on real assets, the price level *p* is 1.0 both by year and in the transitional path at one year: $p \cdot Y = r \cdot K + w \cdot L$. When real assets are connected with financial assets, a theoretical inflation rate is devised, comparing with the increase/decrease rate of consumers' price level, *CPI*.

9) $TFP(t) = B_{TFP(1-\delta,1-\alpha)}(t)^{1-\delta(t)} \cdot k(t)^{1-\alpha}$ holds in the model and is used in the transitional path by year. At convergence, this equation reduces to $TFP^{*} = B^{*1-\delta} \cdot k^{*1-\delta}$, where *delta* = *alpha*.

10) McQuinn Kieran and Karl Whelan (2007) adopted the capital-output ratio to a powerful output per worker function, but under exogenous technology (see Kamiryo (2000) under a similar but recursive approach).

$Total = G + PRI$. This rule is well maintained with 'capital at the end of a year equals the sum of net investment plus capital at the beginning the year' by sector. Two obstacles exist against the rule of aggregate: (1) What is the relationship between huge deficit and its returns in the government sector? This is unsolved under an assumption that government returns are zero.[11) ](2) What is the relationship between deficit and returns under the market basis? If theoretical returns, plus or minus, are measured, the market basis does not matter. Nevertheless, if the private sector absorbs minus returns of the government sector by assumption, the returns of the total economy remains unchanged yet, the returns of the government sector remain still unsolved. How does the market basis work for the government sector under these circumstances?

The model proposes that a solution to the above discrepancies starts with how to measure wages and returns by sector at the same time. The model further advocates that when theoretical wages and returns by sector are measured,[12)] then at the same time capital stock will be measured theoretically. The rule of aggregate prevails not only under the cost basis but also under the market basis. How is a minus rate of returns in the government sector, $r_G = \Pi_G / K_G$, reflected on capital of the government sector? Under any basis, a minus rate of return directly influences capital stock, as shown in ESRI capital stock statistics in Japan. Even under the cost basis as a surrogate to the market basis, both capital stock and output = income are adjusted at the same time. The author defines the rate of market risk as the difference between the rate of accounting/cost depreciation and the rate of theoretical depreciation that includes reduction of capital in the model. The matching test by year will be moderate when the rate of theoretical depreciation is properly used. The rate of market risk will roughly be at least 10 to 20% of the rate of accounting depreciation, responding to the market level of the economic stage. The introduction of market risk into the theoretical rate of depreciation decreases capital stock by

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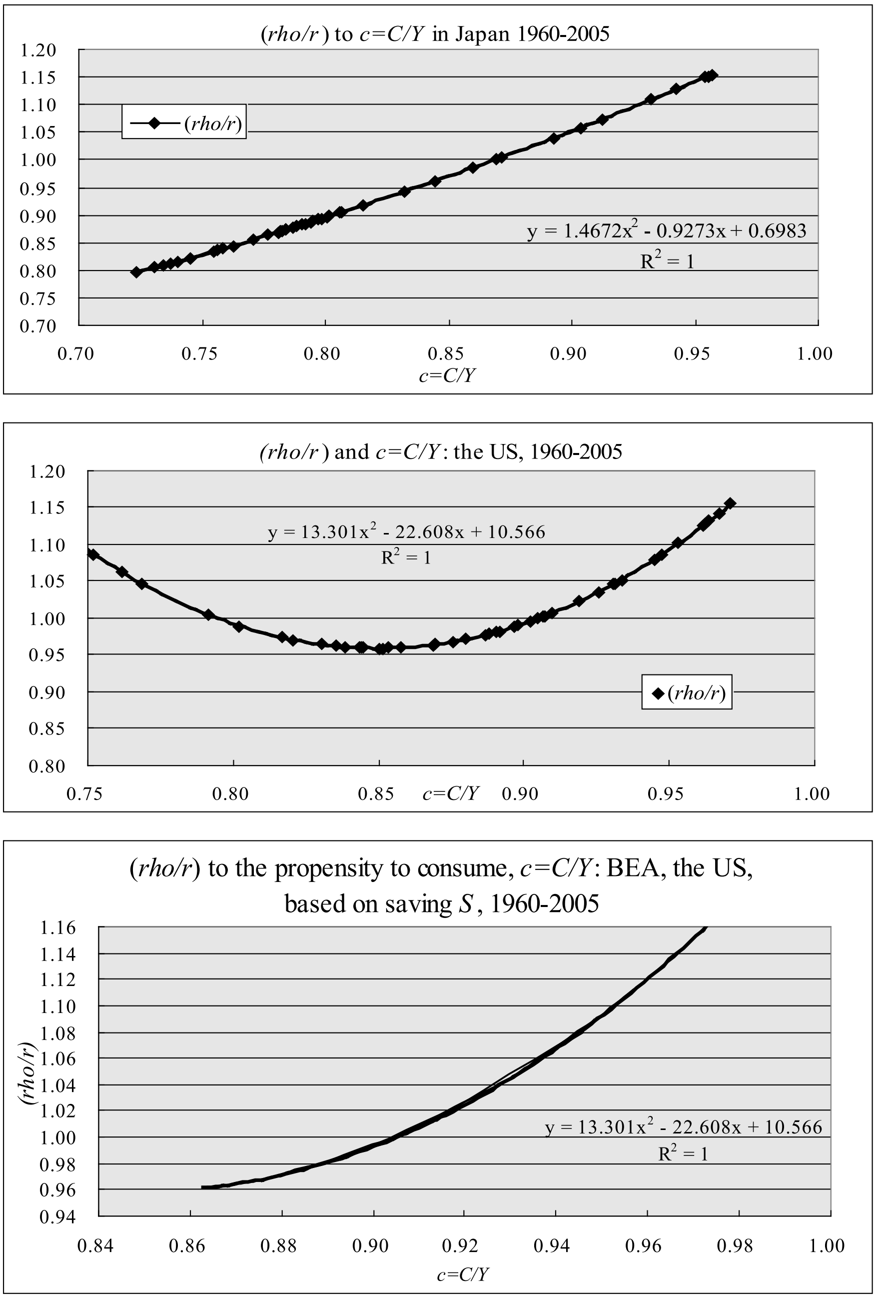
11) As far as the author has investigated, there is no literature that shows a minus rate of return in the government sector. The literature must assume that government saving is zero. The literature has been based on *GDP*; actual wages and returns were modified so that these are used in the private sector (typically, see Hamilton James and Marjorie Flavin (1986)).

12) The actual *NDI* equals theoretical *NDI* which is the sum of actual consumption and saving: $W + \Pi = Y = C + S$. The wage function of consumption, $1 - \alpha = c / (rho / r)$, will determine theoretical wages and returns of the total economy. To determine theoretical wages and returns of the government sector, the consumption/utility coefficient, (*rho/r*), is set 1.0 due to the neutrality of consumption: $W_G = C_G$ and $\Pi_G = S_G$. Empirical work is shown in later section, comparing $(rho / r)(C / Y)$ of Japan with that of the US. This is a preparatory step to the measurement of capital by sector (see **Figure 2**).




Data source: Kamiryo Endogenous World Table (KEWT) 1.07

**Figure 2　Comparison of the relationship between the consumption coefficient and the propensity to consume: Japan and the US**

that risk and makes it steadier to find an upper limit of capital-output ratio by country in the long-run.

A minus rate of return of the government sector results in a minus government growth rate of output at convergence and decreases the output of government and accordingly, the output of the total economy. This clarifies how huge deficit damages an economy as a whole. Deficit and government output is, by accounting identity, related to the equation that taxes equal government output: $T_{AX} = C_G + S_G$ (see Eq. 3 in Appendix).

The model reveals the relationship at convergence between the rate of return, $r^*$, and the growth rate of output, $g_Y^*$, by extending the golden rule of Phelps, Edmond (1961, 1965) from an exogenous to endogenous case:[13] If the relative share of capital equals the product of the ratio of investment to output and the ratio of quantitative investment to total investment at convergence, $\alpha = i \cdot \beta^*$, then the rate of return, $r^*$, equals the corresponding growth rate of output $g_Y^*$, at convergence. In this case, the theoretical cost of capital at convergence, $r^* - g_Y^*$, becomes zero and the Petersburg paradox occurs (for the paradox since the 1800s, see Durand, David, 1957). And furthermore, if $\alpha > i \cdot \beta^*$, the cost of capital is plus and if $\alpha < i \cdot \beta^*$, the cost of capital is minus. Assume that $\beta_G^* > 1$ with a high ratio of investment to output, $i_G$, in the government sector. Then, both the rate of return and the cost of capital are minus, as typically shown in Japan.[14] When the Cobb-Douglas production function holds by year as in KEWT, the marginal productivity of capital equals the rate of return in the transitional path (at the current situation and at convergence). The user cost of capital in Jorgenson Dale (1963) and Jorgenson and et al (1967), to the author's understanding, differently approaches the above rate of return under exogenous circumstances but without revealing the growth rate of output at convergence (for the author's cost of capital, see Appendix). Besides, one cannot estimate the user cost of capital by sector when the corporate/private sector absorbs minus returns of the government sector.

Therefore, the capital-output ratio, $\Omega = K / Y$, reflects the above circumstances more severely than capital stock itself. The numerator of $K$ is lowered under the cost basis by the

13) The exogenous golden rule does not clarify the relationship between the rate of return and the growth rate of output each at convergence. The technology-golden rule, as shown in Appendix, clarifies the above relationship, which is derived using an endogenous rate of technological progress (see Appendix).

14) The cost of capital of the government sector, $r_G^* - g_G^*$, is plus if $|r_G^*| < |g_G^*|$ under huge deficit since both the rate of return and the growth rate of output, each at convergence, are minus. However, this does not guarantee sustainability of huge national debt (see Kamiryo, *IAEC*, Warsaw, 2008).

adjusted rate of depreciation in the long-run. The denominator of *Y* decreases, which coincides with the actual *NDI* of the government sector. Besides, the capital-output ratio has its upper limit under competition of the global economy. And if the difference of capital stock of the government sector between KEWT and ESRI still exists, this difference will be, to some extent, eliminated by adjusting the theoretical rate of depreciation for the government sector. Note that capital stock under the market basis varies by year and is not always consistent with theoretical capital stock in the long-run.

Lastly, the author clarifies the relationship between assets-deflation of stock-base and inflation of flow-base due to the rise of consumer price index (*CPI*). The literature does not prove the existence of assets-deflation that comes from huge deficit. This fact is related to the measure of the user cost of capital in the corporate sector as the author touched above. A minus rate of return reduces government capital or minus returns reduces government capital by that amount, which spreads 'assets-deflation' into the total economy partly depending on the share of government output. Inflation originally occurs from the relationship between the real and financial assets, depending on the magnitude of money supply M2 or the equivalents. Even under such inflation, the assets-deflation and assets-inflation also occurs by the level of surplus/deficit in an economy.

## 3. Capital stock, theoretical versus statistics, Japan and the US, 1960–2005

### 3.1 *Method to determine theoretical wages and returns by sector*

This section will show theoretical wages and returns by sector, starting with the wage function of consumption in Japan and the US. Measure of theoretical wages and returns is required as a preliminary bridgehead, before measuring theoretical capital stock. Theoretical returns must be consistent with theoretical capital. If capital were measured inappropriately, theoretical returns must be readjusted. Recall that the actual *NDI* equals the sum of theoretical wages and returns by year. If theoretical wages and returns by sector are well determined, capital stock by sector works consistently in a whole economy. Kamiryo (2005a) presented the basic method to determine wages and returns, by comparing thirty countries, setting three clubs by the range of the propensity to consume, $c = C / Y$; Club SS, Club S, and Club C. Japan had been the saving-oriented country for more than thirty years but recently Japan has gradually lost households saving and now entered into the consumption-oriented club, Club C. The US has been a typical country of Club C.

The wage function of consumption, $1-\alpha = c/(rho/r)$, is illustrated by setting the ratio of consumption discount rate to the saving discount rate, (*rho* / *r*), on the Y axis and the propensity to consume, *c* = *C* / *Y*, on the X axis (see **Figure 1**). The relationship between (*rho* / *r*) and *c* = *C* / *Y* by country constitutes only one external function in the model. The function, $(rho/r)(c)$ , is obtained exceptionally using regression analysis by country. The function, however, is able to raise the variance $R^2$ in its regression analysis so that its $R^2$ approaches 1.0. This is because the relationship between three savings (households saving, undistributed profit as corporate saving, and dividend saving) and, wages is close to an accounting identity (as proved in Kamiryo, 2005a), assuming that the wages are theoretical (not actual).

The wage function of consumption differs by country according to national taste. National taste is an expression of the utility at the macro level. The model presumes and proves that data at the macro level differ from the corresponding data aggregated from the micro level. By this reason, the utility at the macro level differs from collective (using vector) utility aggregated from individuals at the micro level. Utility is inevitably endowed with individual preference. How is it possible to justify a conversion from the immovable individual utility at the micro level to a new utility at the macro level? The author watches social welfares as the present value of consumption and wages and, for justification, applies an 'instantaneous' idea of utility of Cass, David (1964, 4–5) to consumption by year, where *C* = *U*(*C*) holds by year (see Appendix). Thus, the author calls the above (*rho* / *r*) the consumption/utility coefficient.

In the case of Japan KEWT (as a base), the function, $(rho/r)(c)$, is $(rho/r) = 1.4672c^2 - 0.9273c + 0.6983$, which is shown in the upper figure of Figure 1. In the case of the US KEWT (as a base), the function is $(rho/r) = 13{,}301c^2 - 22.608c + 10.566$, which is shown in the middle of Figure 1. The author applies the same function to the case of BEA, the US, which is shown in the bottom of Figure 1. Conclusively speaking, these suggest that national taste by country does not change in the long-run; the range of the propensity to consume changes by year and in the long-run. It seems that national taste differs due to the difference of system/methodology such as KEWT and BEA. The fact, however, is that the variance of $R^2$ rises to 1.0 in both cases of KEWT and BEA, even under the same wage function of consumption in several countries. As a result, the background to measure capital stock is now appropriately ready. The author inspects the difference of national taste by country in a separate paper after increasing the number of countries in KEWT up to fifty eight at KEWT 2.08, 1990–2006.

3.2 *Method to derive capital stock by sector and its results compared with statistical methods*

Theoretical capital stock (hereafter, capital) by sector is measured at the macro level, so that capital is wholly consistent with other macro values in the author's endogenous growth model. To finalize theoretical capital, the author proposes in this section the matching test by year and the smoothening test in the ling-run. Theoretical capital differs from the two approaches such as (1) capital aggregated by assets using the perpetual inventory method (PIM) and (2) capital and its returns derived using the user cost of capital in the market of financial assets. The above PIM approach presumes that capital is independently taken yet, capital and other data cannot maintain true consistency in that the data of national accounts are independent of the data used for the Cobb-Douglas production function at the macro level. The above user cost approach estimates capital and returns at the same time yet, this approach cannot be applied to capital and returns of the government sector since it presumes that government returns are zero regardless of whether deficit is huge or not.

The data-sets in KEWT 1.07, however, do not satisfy the necessary and sufficient conditions of aggregate equilibrium. All the values in KEWT 2.08 (*JES* 12 (Feb), 2009) is in equilibrium by year, where national disposable income (*NDI*) is derived using actual *GDP* by manipulating *NDI* and (*NDI* / *GDP*), with theoretical ratio of Taxes to *NDI* at the government sector. Without manipulating theoretical taxes at the government sector, aggregate equilibrium does not reach the range of an optimum level. This paper manipulates the level of capital stock by using KEWT 1.07, yet the author applied two simplified tests of aggregate equilibrium to the manipulation of capital. KEWT 1.07 assumes that the values of the simplified tests remain unchanged by the level of capital stock over years. This is because the change in capital (i.e., net investment) by year remains unchanged by year. And, this is further justified by the fact that the level of capital over years is only determined by resetting a selected year's capital (e.g., capital in 1960 or capital 2005) in manipulation.

**The matching test:**

Theoretical capital and returns by sector are measured by taking two steps: (1) preliminarily, by deriving theoretical wages and returns by sector, after externally determining the wage function of consumption as shown in the previous section, and (2) by finalizing theoretical capital and theoretical returns, after testing by sector the theoretical relationship between ratio of the rate of return and the wage rate lying between capital and returns. The latter test is essential for theoretical capital and is called the matching test. The matching test by year obeys the accounting identity. The matching test compares two capitals: (1) the capital that is theoretically derived using the capital-labor ratio, $k = K / L$, the relative share of capital, *alpha*, and the ratio of the rate of return to the wage rate, $(r / w)$ and (2) the capital that is the theoretical sum of the previous capital and the increase in capital during this year (as net investment). The test finishes if the value of $K(t) = k \cdot L = L(\alpha / (1-\alpha)) / (r / w)$ equals the value of $K(t) = \Delta K + K(t-1)$ by year.

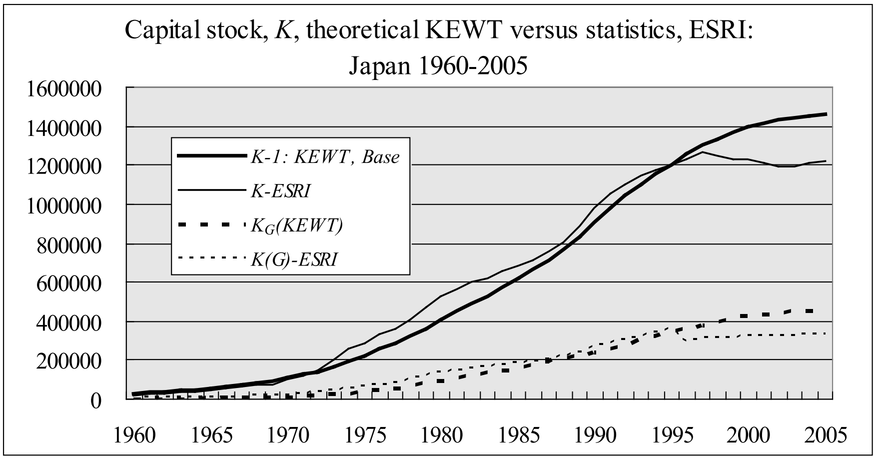
Underlying theory is that the ex-post equilibrium[15] by year holds by adjusting the relationship between $(r/w)$ and $\alpha / (1 - \alpha)$ under a necessary condition that the Cobb-Douglas production function holds using basic national accounts data.[16] The matching test preliminarily proves that $(r/w)$, the capital-output ratio, $k = K / L$, and the capital-labor ratio, $\Omega = K / Y$, each changes by year under the theoretical wage rate and *NDI*, where actual *NDI* equals theoretical *NDI*. Note that the matching test guarantees a consistent relationship between the rate of return and the wage rate by year as above yet, this test is also related to the following smoothening test in that the relationship between the rate of return and the wage rate must be consistent in the long-run.

**The smoothening test:**

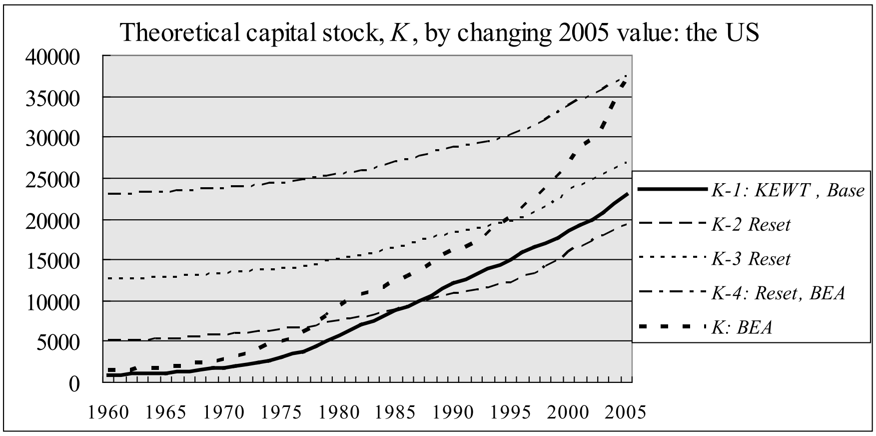
Then, another test, the capital-smoothening test, is processed in the long-run. This test examines theoretical capital and its returns over years, by inspecting each trend of the capital-output ratio using several cases, by resetting the current year's (2005) capital. This test finally selects the most smoothening case in the long-run (see **Figures 3** and **4**, and for detail, see **Tables A2** and **A3** in Appendix). If the trend of capital-output ratio during 46 years, 1960–2005, is abnormal, this case is abandoned. For example, if the US capital-output ratio shows 48.79 at 1960 and 3.47 at 2005 using the framework of KEWT, this case is abnormal since the capital-output ratio does not usually decrease by year but gradually and slowly increases by year. Why did this case happen? This case happened when the current capital 37251 at 2005 is much higher than the theoretical capital 26782 at 2005. Note that the author took the value of 37251 from the capital estimated by BEA, the US. How did BEA estimate

15) KEWT 1.07 used in this paper has ex-post equilibrium while KEWT 2.08 has aggregate equilibrium. The difference between two equilibriums comes from the treatment of *NDI* and net investment. KEWT 1.07 cannot measure theoretical *NDI* and theoretical net investment by year and by sector. KEWT 1.07 assumes that actual *NDI* equals theoretical *NDI* using actual *NDI*.

16) In an exogenous case of Uzawa Hirofumi (1964), the relative share of capital converges to a certain point by adjusting the inverse number of $(r / w)$ and the capital-labor ratio $k$. His idea has the same root as the above test that comes from an accounting identity of $k = (\alpha / (1-\alpha)) / (r / w)$.




Note: Japan is a typical case of less difference of data between KEWT and ESRI.

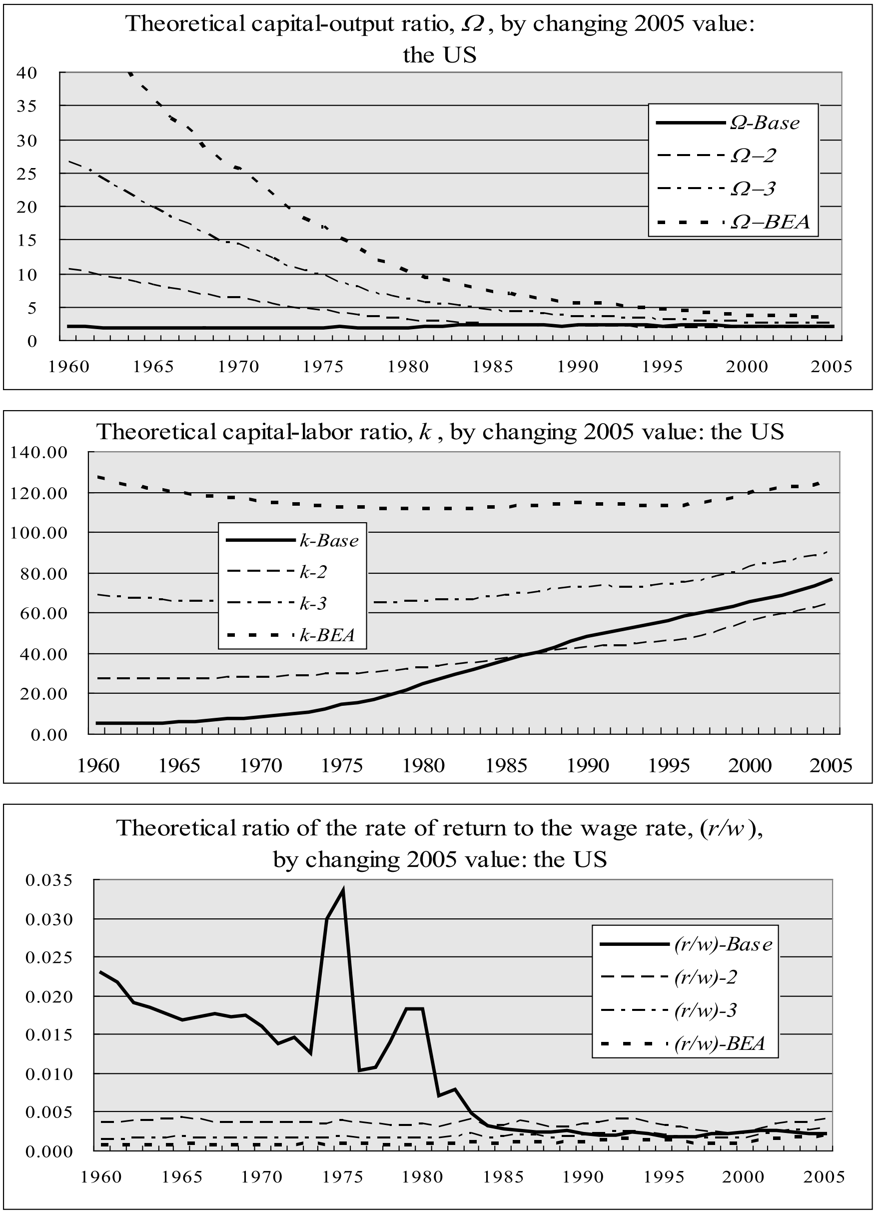



Note: The US is a typical case of much difference of data between KEWT and BEA.
Data source: Kamiryo Endogenous World Table (KEWT) 1.07

**Figure 3 Capital stock, theoretical KEWT versus statistics (ESRI and BEA): Japan and the US**

the capital at 2005? BEA revised the method for estimating capital in 1997 more relying on accounting approach (as discussed by Triplett, Jack E.(1996)) and since then, revaluation of capital was excluded, as interpreted by Jorgenson Dale (1999) and summarized by Nomura Koji (2005, 47–49).[17] The author supposes that it is difficult for BEA to adjust the transition of

17) The author, on the other hand, measures aggregate capital directly and consistently in the macro level. The author then compares aggregate capital with its valuation value, by using the rate of return divided by the cost of capital at convergence: the valuation ratio is an aggregate leverage. The author is thankful to Dr. Nomura Koji for his time-sharing discussions with the author.




Data source: Kamiryo Endogenous World Table (KEWT) 1.07

**Figure 4 Comparison of the capital-output ratio to test the consistency of the framework**

capital by year from the viewpoint of continuation of statistics. This problem is beyond of the issue lying between the cost basis and the market basis. This problem rather comes from a difficult problem lying between the macro level and the micro level.

The smoothening test overwhelmingly indicates that the higher the capital at 2005 compared with the theoretical capital, the contradiction will spread more rapidly to earlier years. This symptom is shown by the capital at 1960 derived through KEWT framework that uses BEA capital 37251 at 2005: capital 22969 at 1960 indicates a value much higher than the theoretical capital at 1960, 948. Accordingly, the capital-output ratio at 1960 (corresponding with capital 22969) is 48.79, with an increase of 48.79 – 3.47 = 45.32 during 46 years (in Table 2). The capital-output ratio, if BEA capital 37251 at 2005 is replaced by 26782, turns from 2.50 at 2005 to 26.55 at 1960 (in Table 3), which is still too high.

Let the author reset capital 19282 at 2005. Then capital at 1960 becomes 5000, yet the capital-output ratio at 1960 is 10.62 although the capital at 2005 is 1.80. This reset case is still abnormal. Finally, the author resets capital 22912 at 2005. Then, capital at 1960 becomes 948 and its capital-output ratio is 2.11 (see Figure 4). The trend of the capital-output ratio is now smoothly theoretical: 2.11 at 1960 and 2.06 at 2005. The author prefers this reset case as the capital-output ratio suitable for a base of the US KEWT to other alternative reset cases. The final capital of KEWT by year results in that the rate of technological progress and accordingly, the growth rate of output/income at convergence are a little higher than those of other reset cases, due to the lowest smoothness of the capital-output ratio (variable results will be illustrated below in the next section).

Therefore, there are several reset cases between the capital by BEA and the capital by KEWT (final: as a base). The intermediate reset cases are called ‘reset cases inserted into KEWT framework’ or simply reset cases. The difference between actual BEA capital by year and theoretical capital by year (inserted into the framework of KEWT) comes from the difference of capital taken at 2005. What is the difference between these two current capitals? The BEA capital has been principally based on the PIM with some devices/adjustments/revaluations, where the increase in capital is rigidly accounting-oriented. The reset theoretical capital is based on the author’s above method at the macro level, using the increase in capital more flexibly than the increase in capital of the BEA. Thus, the above matching test works well for the reset capital and this strongly suggests that each theoretical trend of the rate of return and the wage rate are consistent with each in the real world. If the rate of return has increased for the last 46 years and/or if the wage rate has decreased for the last 46 years, these are against the actual trend in the real world and must be abandoned in the above reset cases (see Tables A1, A2, and A3 in Appendix).

Note that the increase in capital is not gross but net, where total depreciation (both to the previous capital and the current increase in capital, and including removal/revaluation of capital) is deduced from the current capital before depreciation. The matching test to theoretical capital works by inserting the equation of $K(t) = \Delta K + K(t-1)$ into the current capital, $K(t)$, where the increase in capital used for reset differs from actual one in statistics. The author sets the depreciation rate by sector higher than the accounting rate of depreciation, by taking the risks for retirement, selling of fixed assets, and market revaluation; at least 10 to 20 percent higher in the private and government sectors. The taking-risk helps to make the test more flexible.

In short, the US presents a typical case of the difference between actual capital estimation and theoretical capital measurement. This is partly because the US has reached the advanced/developed stage most early in the world. Already, in 1960, the US was at the best in the economic stage. This implies that there has had no room to increase the capital-output ratio since 1960. Capital is a mixture of qualitative and quantitative capital yet, capital is more qualitative oriented at the developed stage by nature (recall the function of the qualitative investment to total investment to the capital-output ratio at Appendix and Figure 8). Technology and capital are endogenously related so that the capital-output ratio has its upper limit by country in the global competitive economy (see *PRSCE* 49 (Feb), 2009). And, when the capital-output ratio is determined, the capital-labor ratio is also determined. The relationship between the capital-output ratio and the capital-labor ratio is differently clarified using reset cases (see Figure 4).

Lastly, in the case of Japan, the difference between the capital of KEWT and the capital by ESRI is incidentally negligible except for the last ten years. Therefore, Japan case study to reset is not attractive, compared with the cases of the US capital reset. Nevertheless, Japanese cases reveal another problem (see Figure 2). When the increase in capital $\Delta K$ is connected with $K(t) = \Delta K + K(t-1)$ aggregated from the micro level, the matching test does not work well.[18] For example, as an extreme case, the relationship between $(r / w)$ and $(\alpha / (1 - \alpha))$

18) ESRI, GOJ, estimates capital (fixed assets) by the market basis so that the trend of capital stock has decreased after 2000. In the case of the cost basis, the matching test seems to breakdown: typically, the adjustment of $(r / w)$ by year may not work well and as a result, the value of $(r / w)$ seems suddenly to become extreme beyond allowance. However, the matching test, after having the cost basis flexible by adjusting the depreciation rate, absorbs the difference between the market and cost bases on average in the long run. The author uses 20–30%a higher rate of depreciation than that of the cost basis. The author finally solved the above problems in KEWT 2.07, by replacing actual *NDI* with theoretical *NDI*, to directly obtain theoretical net investment by year, where the above two tests were much more smoothened. This is because capital is measured under aggregate equilibrium and satisfies necessary and sufficient conditions of aggregate equilibrium.

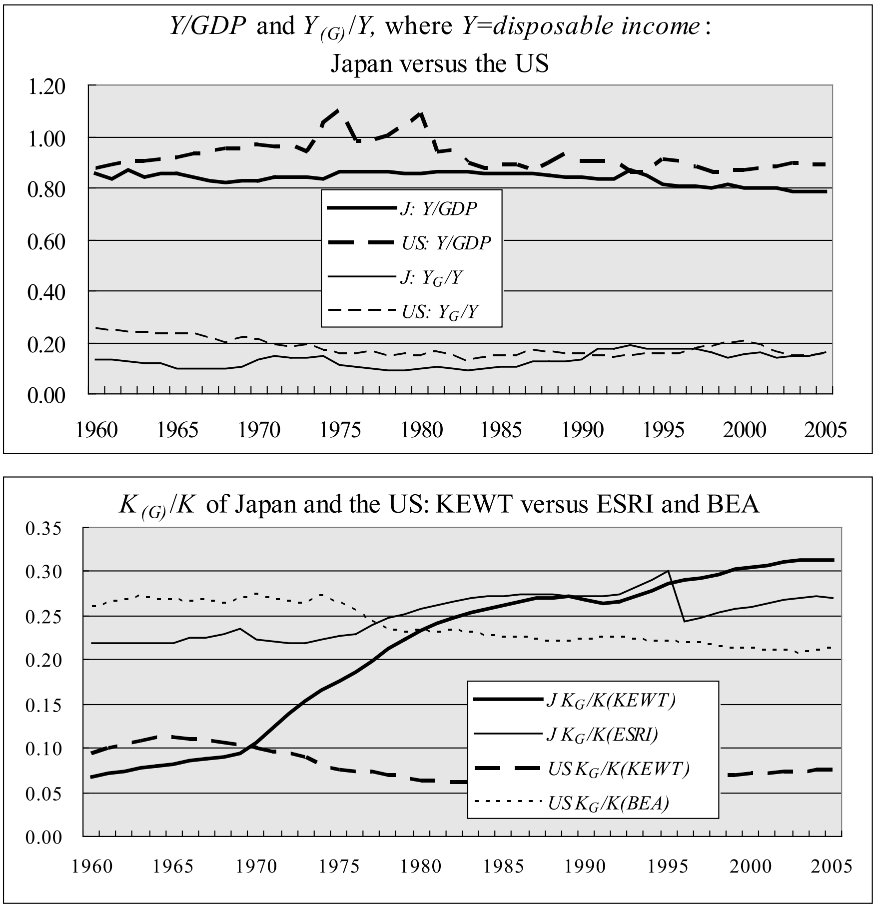
will disperse due to a lack of the consistency between accounting data and the data of the Cobb-Douglas production function even under the *NDI* base. In short, accounting capital may be a case but does not guarantee sound cooperation between the macro and micro levels. If the consistency between the data of national accounts and the data of the Cobb-Douglas production function is required, capital must be theoretical with its returns, to some extent apart from accounting capital.

3.3 *Results of endogenous parameters and variables: Japan versus the US*

This section will first examine the shares of output and capital of Japan and the US as a preliminary discussion and, second present main results of parameters and variables by sector. These values are all theoretical (hereunder, omitting the word of 'theoretical'), after clearing the tests of 'matching by year' and 'smoothening in the long-run.' If capital is appropriately determined by country with the above tests, all the endogenous parameters and variables are also trustworthy by country. In statistics, saving by sector is actually given yet the literature has not revealed returns by sector hitherto. Statistics differs from theory whose centre is represented, by the equation of $W+\Pi=Y=C+S$ after the matching test, where theoretical wages and returns are measured by sector based on actual *NDI*, *Y*.

**Government shares of output and capital:**

**Figure 5** shows government shares of output and capital, comparing those of KEWT with RSEI, Japan, and BEA, the US. There is no difference of government share of output between the author's and actual statistics since actual *NDI* equals theoretical *NDI*. However, there is much difference of the government share of capital between theoretical KEWT and actual ESRI and BEA. Why did this happen? The difference symbolizes the difference of capital between the theoretical basis of KEWT at the macro level and the cost basis aggregated from the PIM (with revaluation) or the market basis related to the user cost of capital. The difference of capital of the government sector in the US shows a typical case. In particular, the government share of capital to the total economy is 20% or more on average in the case of BEA 1960–2005, while that in the case of KEWT 1960–2005 is less than 10%. This implies that government capital by BEA is too high, compared with government capital by KEWT. As shown in Figure 2 above, capital of the total economy by BEA is much higher than that by KEWT, if taking data from BEA is correct. Accordingly, it is natural that government capital by BEA will be high. Is this justified in statistics?




Data source: Kamiryo Endogenous World Table (KEWT) 1.07

**Figure 5 Disposable income/*GDP* and government shares of output and capital: KEWT versus ESRI, Japan, and BEA, the US**

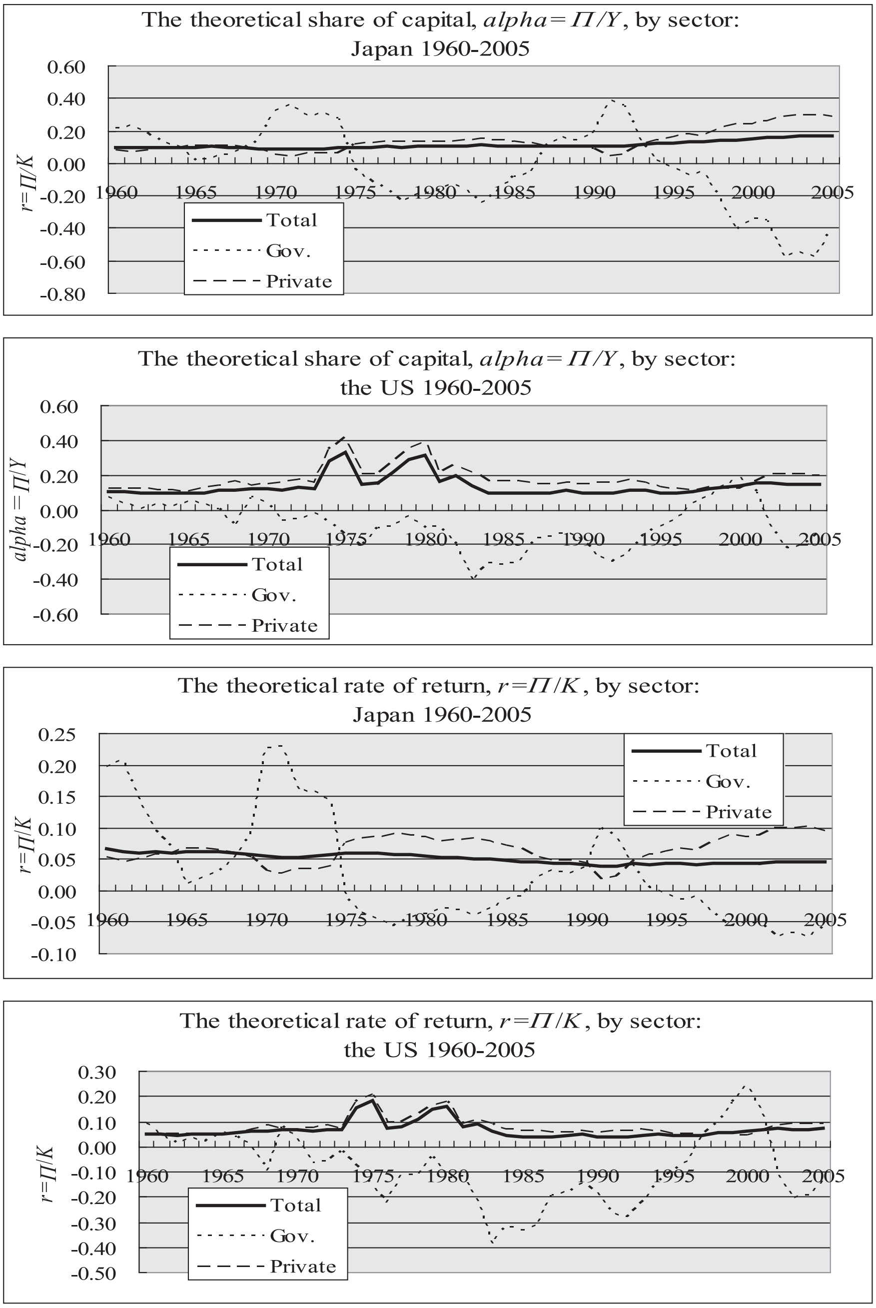
The bottom of Figure 4 indicates that the government share of capital by BEA has been between 20 and 25% while that by KEWT has been below 10%, each for the last 46 years. Watch the upper of Figure 4: the government share of output by BEA is less than 20%, which is equal to that by KEWT (since actual *NDI* equals theoretical *NDI*). Therefore, the shares of output and capital roughly correspond with each other. For this review, let the author watch the shares of output and capital in Japan, comparing those by KEWT with those by ESRI: The shares of output by KEWT and ESRI are similar to those of the US. Nevertheless, in Japan, the government share of capital by KEWT has risen from 7% to 31% for the last 46 years. This is justified by the huge accumulation of deficits in Japan since capital is accumulated while output is not. Then, how is the deficit accumulation of the US justified with a constant level of 20–25% in the government share of capital for the last 46 years?

The author's interpretation is the following: The upper limit of the capital-output ratio in the US is roughly 2.2 according to KEWT. This is a little lower than 2.5 in other developed countries yet, will be justified by the two that (1) the potential power of technological progress is strong and accordingly and (2) the government share of output is lower than other 'large government' countries. When the capital-output ratio is lower, the rate of technological progress and accordingly, the growth rate of per capita output will be more highly maintained. The above interpretation will be supported by reviewing the history of the Japanese economy. In Japan, to reduce the excess of the balance of payments, the government, central and local, had maintained five to ten times higher investment to output than other developed countries, accumulating national debt to finance public investment by year. As a result, 5 to 10% minus rate of return in the government sector has continued. This implies that government capital reduces by that rate and that government capital at the market basis by ESRI has remained roughly unchanged after 1995 (see $J\ K_{(G)}/K$ (*ESRI*) in Figure 4). The difference of the government share of capital between Japan and the US, each KEWT, has continued to enlarge after 1970. If the author adjusts the upper limit of the capital-output ratio by resetting the theoretical capital-output ratio, the above difference of two government capital shares will shrink to some extent. In this respect, the measurement of capital stock by sector is still slightly relative in KEWT 1.07, in particular regarding capital stock of the government sector.[19] Yet, the results by BEA will suggest a limit of capital estimation aggregated using the PIM.

**Endogenous parameters and variables:**

Next, the author will discuss endogenous parameters and variables. First, **Figure 6** shows the relative share of capital (a parameter) and the rate of return (a variable), each 'by sector' in Japan and the US: for the government sector, e.g., $\alpha_G = \Pi_G / Y_G$ and $r_G = \Pi_G / K_G$. 'By sector' implies that each denominator is the value of the government sector or the private sector. For example, in the case of returns, the additive rule expressed by $\frac{\Pi}{Y} = \frac{\Pi_G}{Y} + \frac{\Pi_{PRI}}{Y}$ does not work. This additive rule works when $\Pi_G / Y_G$ is replaced by $\frac{\Pi_G}{Y} = \frac{\Pi_G}{Y_G} \cdot \frac{Y_G}{Y}$ and $\Pi_{PRI} / Y_{PRI}$ is replaced

19) This is because the government sector is extremely sensitive to equilibrium although the output share of government sector is usually less than 20%. This problem was solved in KEWT 2.07, as the author already explained it. The author is thankful to the discussion with BEA people when more information about the government sector was given from BEA in Oct 2006.




Data source: Kamiryo Endogenous World Table (KEWT) 1.07

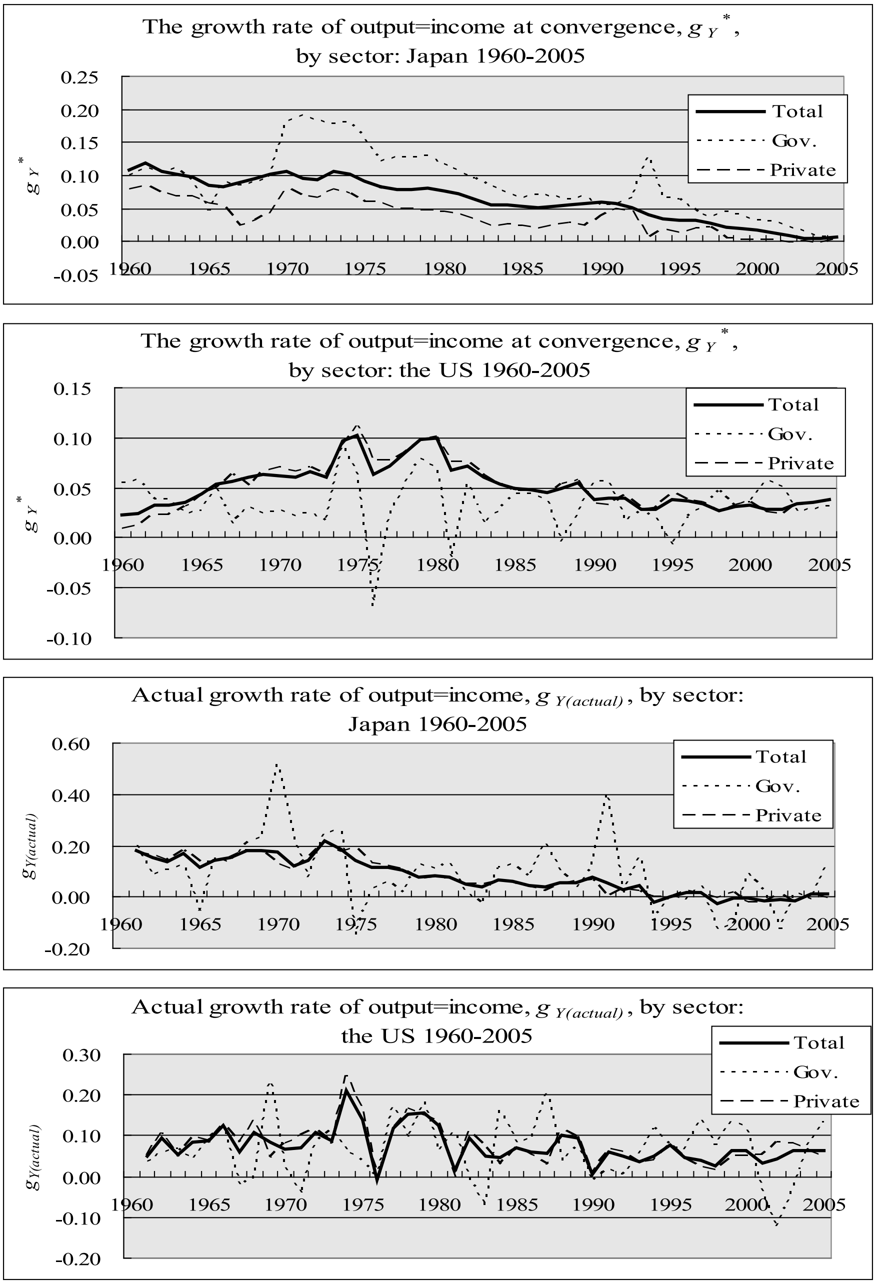
**Figure 6 Theoretical relative share of capital and rate of return by sector: Japan versus the US**

by $\frac{\Pi_{PRI}}{Y} = \frac{\Pi_{PRI}}{Y_{PRI}} \cdot \frac{Y_{PRI}}{Y}$, each using $Y_G / Y$ and $Y_{PRI} / Y$. The 'by sector' data under no additive rule is most basic in that capital and returns by sector will be vividly shown if government share of output or capital, $Y_G / Y$ or $K_G / K$, is appropriate. Note that when the additive rule works, the ratios of the private sector do not much differ from those of the total economy.

Back to Figure 5, the relative share of capital of the government sector fluctuates much more than that of the total economy in both Japan and the US. This fluctuation reflects huge deficit; in particular, after 1995 in Japan. The statistics of both ESRI and BEA cannot reveal this common fact. Similarly, the rate of return of the government sector fluctuates much more than that of the total economy in both Japan and the US. What does this mean by these results? These suggest that the government and private sectors are dependent and even if the results of the government sector are not good the private sector must be responsible for the results of the government sector. Both results are ultimately determined by politics and reflect mutual results of democracy-based quality and preference by country and people. The author indicates that the private sector does not prosper without good circumstances of the government sector.

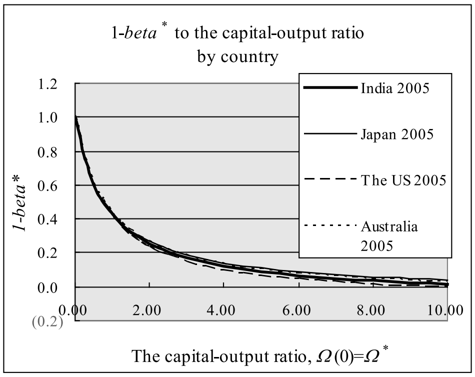
Turning to endogenous growth rates, **Figure 7** shows the growth rate of output (= income) by sector, comparing theoretical (at convergence) with actual, in Japan and the US. The actual growth rate of output is the same as that in statistics since both uses actual *NDI*. The current actual growth rate of output reaches that at convergence, where each growth rate by time is theoretical in the transitional path. In this respect, the upper two figures in Figure 7 basically show similar results to the bottom two figures. However, the actual growth rates of output are more fluctuating for the last 46 years. This is because the post-equilibrium compels an economy to balance by year. The government sector rather accepts a rapid shift by year and that under a low government share of output to the total economy. An underlying reason comes from the fact that the private sector is under global competition and the movements must be within a certain range of activities while the government sector has no severe restriction to fiscal policy (except for the EU rule). And even a sudden change in the actual growth rate reflects a technology shock, which must be a main absorber. This is justified by related equations in Appendix. Besides, the smoothening test at the developed stage works for a constant capital-output ratio in the long-run.

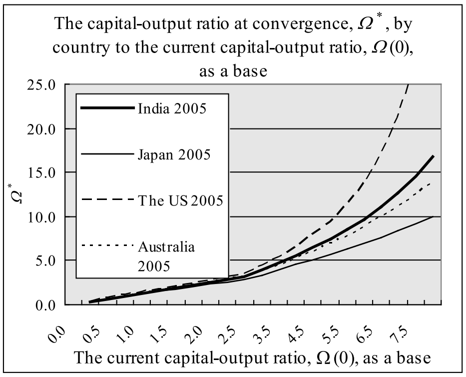
Background of the smoothening test is straightforwardly expressed by the 1 – *beta*' function of the capital-output ratio (see the LHS of **Figure 8**): the lower the capital-output ratio the higher qualitative investment through population/human capital, education, and R & D for




Data source: Kamiryo Endogenous World Table (KEWT) 1.07

**Figure 7 The growth rate of output-income by sector, at convergence versus actual: Japan and the US**



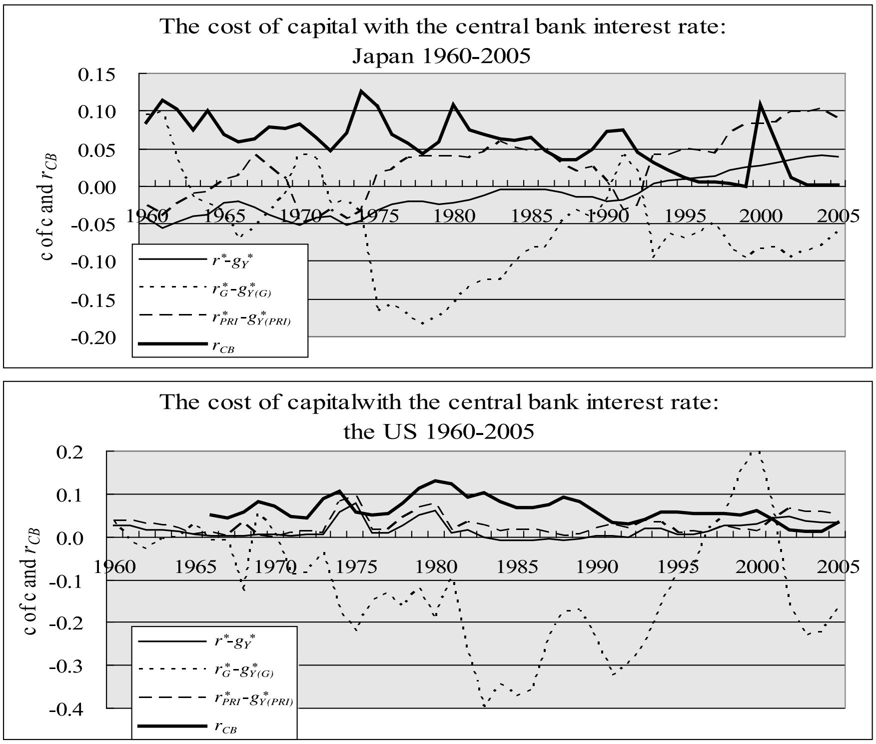

Data source: Kamiryo Endogenous World Table (KEWT) 1.07

Note: On the LHS, the roughly-equal relationship is shown among countries similarly at the developing stage such as Russia, China, Korea, India, Brazil, and Mexico, due to the characteristic more decisive than other relationships between parameters. On the RHS, the assumption of $\Omega(0) = \Omega^*$ is eliminated, where if the current capital-output ratio is low (0.5 to2.5), the assumption of $\Omega(0) = \Omega^*$ is true.

**Figure 8 The qualitative investment to investment function of the capital-output ratio as the backbone of the smoothening test**

global environmental stability. This indicates that capital increases and population not. This implies that for sustainable growth, the capital-output ratio is a decisive key for economic, fiscal, and financial policies and that qualitative investment towards growth is continuously requested, without reluctantly increasing capital and the capital-output ratio. The smoothening test and following results of variables will guarantee not only consistent measurement of capital but also the base of long-run growth towards tender earth reservation. The assumption of $\Omega(0) = \Omega^*$ is trustworthy when the capital-output ratio falls between 0.5 and 2.5 (see figure on the RHS of Figure 8 and for this assumption, see related equations in Appendix).

**Figure 9** shows the cost of capital ‘by sector’ in Japan and the US. The cost of capital is theoretical, defined as the difference between the rate of return and the growth rate of output each at convergence. The cost of capital originally differs from the user cost of capital shown in the literature and based on the market basis for the corporate/manufacturing sector. Again, the cost of capital fluctuates tremendously in Japan and the US. The cost of capital is derived from real assets and thus trustworthy. Besides, the cost of capital and the rate of return at convergence in the real assets must be compared with the market rate or the central bank interest rate, $r_{CB}$, in the financial assets. The author indicates that financial policy by country, from the viewpoint of the neutrality in financial assets, should have a rule similarly to the EU 3% rule to




Data source: Kamiryo Endogenous World Table (KEWT) 1.07

**Figure 9 The cost of capital at convergence by sector, compared with the central bank interest rate, $r_{CB}$: Japan and the US**

deficit. The rule will result in no bubble by setting the ratio of the rate of return, $r^*$, to the market rate, $r_{CB}$, at a certain level, say, within two or three times, watching the Marshall's $k$ at less than 2.

Interesting to say, the cost of capital of the private sector is plus and stable, compared with that of the government sector. The government sector has much wider range of policies and serves for the private sector but most wastefully. The government cost of capital will be a good indicator to check that inefficient substance of the government sector. And, if people realize government substance and choose the policies to serve people even if services are inefficient, it will contribute to the sustainability of an economy to some extent. The results, at the same time, suggest how the private sector acts for itself at the cost of the government sector. The rate of technological progress of the government sector, $1 - beta_G$, must be compared more rigidly with that of the private sector, $1 - beta_{PRI}$ (see Tables A8 and A9 in Appendix). The US 'small' government is an alternative by people, when people neglect the safety to public investment.

## 4. Concluding remarks

This paper presented theoretical capital stock of Japan and the US, measured in KEWT (Kamiryo Endogenous World Table 1.07) 1960–2005 by sector, and compared with capital stock of ESRI, Government of Japan and BEA, the US. Strikingly, the difference of capital between the US KEWT, and BEA, the US, has spread by year for the last 46 years. Capital of the US KEWT was 946 in 1960 and 22912 in 2005 while capital of BEA, the US, was 1482 in 1960 and 37251 in 2005. The difference was so extreme compared with Japan's cases that the author examined the US capital by resetting the current capital in 2005 several times between 22912 and 37251 (see Figures 3 and compare Table A2 with Table A3). Conclusively, the differences of capital between KEWT' and the US become enlarged since theoretical capital remains unchanged according to the endogenous growth model over years. And this is well expressed by the corresponding differences of the capital-output ratio, whose denominator, *NDI*, is the same.

Two tests were requested: the matching test by year and the smoothening test in the long-run, where both tests are tightly related in the long-run. The matching test directly proves that all the data are consistent by year in the model. The smoothening test directly justifies capital measurement in the long-run, examining the smoothness of the change in the capital-output ratio for 46 years. In the final case of the US KEWT, its capital-output ratio has remained at a stable level, 2.0 to 2.2, under the developed stage for the last 46 years. The stable level is a little below a usual upper limit of the capital-output ratio among countries of 2.5. The measurement of capital is examined wholly in the model; in particular, by the trends of the theoretical rate of return and the theoretical wage rate in the long-run.[20)]

20) Assume that the US upper limit of the capital-output ratio is 2.5 to 2.7: this level is not acceptable since it makes the current rate of technological progress lower than the actual rate that prevails in the US. Furthermore, an appropriate level of the capital-output ratio is confirmed by inspecting the theoretical ratio of the rate of return to the wage rate, $(r / w)$. Assume that the current capital in 2005 is 37251 (as in BEA) instead of 22912 (as in KEWT 1.07). Then, the capital-output ratio is 3.47 in 2005 and 48.79 in 1960, each theoretically, instead of 2.06 in 2005 and 2.11 in 1960 as in KEWT 1.07. One will doubt such a high level of 48.79 in 1960. This is justified by the result that $(r / w)$ is 0.0021 in 2005 and 0.0008 in 1960 (see Table A2). This abnormal case unbelievablely indicates that the rate of return increases and the wage rate decreases for 46 years. On the other hand, the corresponding $(r / w)$ at KEWT 1.07 is 0.0023 in 2005 and 0.0230 in 1960. This final case reasonably indicates that the rate of return decreases and the wage rate increases moderately for 46 years. Note that KEWT 2.07 could get optimum-oriented results much more directly and accurately by using the theoretical *NDI* and theoretical net investment 'by sector,' and without paying attention to the trend of $(r / w)$ in the long run.

The difference of capital in 2005 between the US KEWT and BEA is 14339 = 37251 – 22912. This is not surprising as the difference of capital in theory and statistics. It is true that the transition of capital in statistics reveals fatal contradiction among each value by year at the macro level. Theoretical capital and returns, on the other hand, are consistent with all other data at the macro level. Theoretical capital at the macro level melts away all the discrepancies in capital estimation at the micro level that comes from the differences of costs, market values, depreciation, removal, and depletion. The theoretical backbone of the smoothening test is shown by Figure 8: the qualitative investment function to the capital-output ratio by country in 2005.

When capital and returns of the total economy is theoretically measured, those by sector are appropriately measured, starting with the government sector. The facts hidden in the government sector will be revealed by deleting an assumption that government returns are zero as in the SNA and by using such a framework/subsystem as KEWT as approves an equal-relationship between saving and rents in the government sector. A consensus among people is that government should be smaller by various reasons. This consensus is numerically proved by the data of KEWT by sector, comparing the government sector with the private sector or the total economy, in particular, among others, by the rate of technological progress by sector, using the ratio of qualitative investment to total investment. It is true that the private sector shifts ineffective investment to the government sector. People must be alert at the numerical differences of ineffectiveness between the government sector and the private sector. If people have to depend more on the private sector under competition, the total economy will become more robust, but in the short-run, decreasing the loss of a large government. The welfare of people must be maintained in the long-run. Data-sets as a subsystem and the endogenous model will response to this story at the macro level, conquering the difficulties brought from the micro level. The SNA and the subsystem will cooperate with each other when the SNA as an accounting remains the character of statistics.

The model uses a recursive set of non-linear equations, which completely differs from econometrics that solves a set of synthetic linear equations under several assumptions. In particular, theoretical capital is directly connected with technological progress, which in turn is connected with the capital-output ratio through the ratio of qualitative to total net investment. This justifies the existence of the upper limit of the capital-output ratio in the long-run under global competition. Note, the author does not deny the usefulness of regression analysis in econometrics though KEWT does not depend on it except for one unique behavioural equation to national taste.  The author will, in the future, challenge for reviewing hypotheses in the literature starting from the factual data in KEWT and supported by regression analysis.

**Table A1 Capital stock in Japan: KEWT based on disposable income vs. ESRI based on *GDP***

| | **K: KEWT, Base** | (r/w)-Base | Ω-Base | k-Base | **K-ESRI** | (r/w)-ESRI | Ω–ESRI | k-ESRI |
|---|---|---|---|---|---|---|---|---|
| 1960 | **30000** | 0.000329 | 2.1632 | 321 | ***20000*** | 0.000493 | 1.4421 | 214 |
| 1961 | 34522 | 0.000282 | 2.1114 | 366 | *24522* | 0.000396 | 1.4998 | 260 |
| 1962 | 39323 | 0.00025 | 2.0820 | 413 | *29323* | 0.000335 | 1.5526 | 308 |
| 1963 | 44613 | 0.000236 | 2.0748 | 464 | *34613* | 0.000304 | 1.6098 | 360 |
| 1964 | 50558 | 0.000206 | 2.0058 | 521 | *40558* | 0.000257 | 1.6091 | 418 |
| 1965 | 56277 | 0.000197 | 2.0056 | 573 | *46277* | 0.000239 | 1.6492 | 471 |
| 1966 | 62496 | 0.000183 | 1.9523 | 626 | *52496* | 0.000218 | 1.6399 | 526 |
| 1967 | 70473 | 0.000161 | 1.9102 | 699 | *60473* | 0.000188 | 1.6392 | 600 |
| 1968 | 80595 | 0.000133 | 1.8476 | 790 | *70595* | 0.000152 | 1.6184 | 692 |
| 1969 | 93320 | 0.000112 | 1.8094 | 905 | 78459 | 0.000133 | 1.5213 | 760 |
| 1970 | 109126 | 9.5E-05 | 1.8027 | 1046 | 98078 | 0.000106 | 1.6202 | 940 |
| 1971 | 125215 | 8.48E-05 | 1.8430 | 1185 | 116384 | 9.12E-05 | 1.7131 | 1101 |
| 1972 | 143270 | 7.64E-05 | 1.8456 | 1337 | 148581 | 7.36E-05 | 1.9140 | 1386 |
| 1973 | 168030 | 6.57E-05 | 1.7793 | 1546 | 207865 | 5.31E-05 | 2.2012 | 1912 |
| 1974 | 196127 | 5.97E-05 | 1.7472 | 1780 | 260514 | 4.49E-05 | 2.3208 | 2365 |
| 1975 | 224689 | 5.53E-05 | 1.7516 | 2014 | 287465 | 4.32E-05 | 2.2410 | 2577 |
| 1976 | 254572 | 5.01E-05 | 1.7750 | 2257 | 331137 | 3.85E-05 | 2.3089 | 2936 |
| 1977 | 286090 | 4.52E-05 | 1.7894 | 2513 | 364145 | 3.55E-05 | 2.2776 | 3198 |
| 1978 | 321145 | 4.03E-05 | 1.8217 | 2795 | 404350 | 3.2E-05 | 2.2937 | 3519 |
| 1979 | 361683 | 3.79E-05 | 1.9026 | 3121 | 470207 | 2.92E-05 | 2.4735 | 4058 |
| 1980 | 404789 | 3.45E-05 | 1.9664 | 3465 | 526588 | 2.66E-05 | 2.5581 | 4508 |
| 1981 | 448892 | 3.05E-05 | 2.0245 | 3815 | 564440 | 2.43E-05 | 2.5456 | 4797 |
| 1982 | 491908 | 2.93E-05 | 2.1140 | 4152 | 597117 | 2.42E-05 | 2.5661 | 5040 |
| 1983 | 531666 | 2.81E-05 | 2.1928 | 4456 | 621498 | 2.41E-05 | 2.5633 | 5209 |
| 1984 | 573593 | 2.55E-05 | 2.2214 | 4777 | 656650 | 2.22E-05 | 2.5431 | 5468 |
| 1985 | 617252 | 2.35E-05 | 2.2537 | 5108 | 687559 | 2.11E-05 | 2.5105 | 5690 |
| 1986 | 661624 | 2.18E-05 | 2.3131 | 5446 | 712720 | 2.02E-05 | 2.4918 | 5866 |
| 1987 | 711069 | 2.03E-05 | 2.3860 | 5824 | 756505 | 1.91E-05 | 2.5384 | 6196 |
| 1988 | 768702 | 1.85E-05 | 2.4376 | 6269 | 807310 | 1.76E-05 | 2.5600 | 6584 |
| 1989 | 831429 | 1.74E-05 | 2.4963 | 6753 | 891730 | 1.62E-05 | 2.6773 | 7243 |
| **1990** | 904107 | 1.57E-05 | 2.5243 | 7318 | 977669 | 1.46E-05 | 2.7297 | 7914 |
| 1991 | 977553 | 1.44E-05 | 2.5858 | 7889 | 1051737 | 1.34E-05 | 2.7821 | 8487 |
| 1992 | 1046074 | 1.39E-05 | 2.6973 | 8414 | 1103653 | 1.32E-05 | 2.8457 | 8878 |
| 1993 | 1103480 | 1.5E-05 | 2.7163 | 8849 | 1144429 | 1.45E-05 | 2.8171 | 9177 |
| 1994 | 1155418 | 1.5E-05 | 2.8984 | 9234 | 1173178 | 1.48E-05 | 2.9430 | 9376 |
| 1995 | 1204391 | 1.53E-05 | 3.0101 | 9599 | 1199933 | 1.53E-05 | 2.9990 | 9564 |
| 1996 | 1254989 | 1.52E-05 | 3.0885 | 9975 | 1230474 | 1.55E-05 | 3.0281 | 9780 |
| 1997 | 1302211 | 1.48E-05 | 3.1492 | 10324 | 1262687 | 1.53E-05 | 3.0536 | 10010 |
| 1998 | 1336124 | 1.56E-05 | 3.3119 | 10566 | 1248764 | 1.67E-05 | 3.0953 | 9875 |
| 1999 | 1367110 | 1.59E-05 | 3.3967 | 10785 | 1234178 | 1.76E-05 | 3.0664 | 9736 |
| 2000 | 1394977 | 1.61E-05 | 3.4718 | 10981 | 1231376 | 1.82E-05 | 3.0647 | 9694 |
| 2001 | 1418672 | 1.7E-05 | 3.5770 | 11145 | 1212344 | 1.99E-05 | 3.0568 | 9524 |
| 2002 | 1434903 | 1.75E-05 | 3.6508 | 11252 | 1192017 | 2.1E-05 | 3.0329 | 9348 |
| 2003 | 1444735 | 1.81E-05 | 3.7319 | 11310 | 1192939 | 2.19E-05 | 3.0814 | 9339 |
| 2004 | 1451873 | 1.82E-05 | 3.7145 | 11350 | 1215108 | 2.17E-05 | 3.1088 | 9499 |
| 2005 | 1462573 | 1.8E-05 | 3.6907 | 11419 | *1220000* | 2.16E-05 | 3.0786 | 9525 |

Data source: Kamiryo Endogenous World Table (KEWT) 1.07 and BEA, the US.

Note: There is not much difference between capital of KEWT and capital of ESRI, Japan. The RHS of this table shows the results where capital of ESRI is applied to the framework of KEWT.

**Table A2 Capital stock in the US: KEWT based on disposable income vs. BEA based on *GDP* (1)**

| | **K-1: KEWT, Base** | (r/w)-Base | Ω-Base | k-Base | **K-4: Reset, B** | (r/w)-BEA | Ω–BEA | k-BEA | **K: BEA** |
|---|---|---|---|---|---|---|---|---|---|
| 1960 | **948** | 0.0230 | 2.11 | 5.25 | **22969** | 0.0008 | 48.79 | 127.13 | **1482** |
| 1961 | 975 | 0.0218 | 2.07 | 5.31 | 23016 | 0.0008 | 47.22 | 125.30 | 1536 |
| 1962 | 1017 | 0.0191 | 1.97 | 5.45 | 23074 | 0.0009 | 43.88 | 123.70 | 1604 |
| 1963 | 1060 | 0.0185 | 1.95 | 5.60 | 23136 | 0.0009 | 41.60 | 122.25 | 1661 |
| 1964 | 1110 | 0.0176 | 1.89 | 5.78 | 23201 | 0.0009 | 38.77 | 120.91 | 1767 |
| 1965 | 1180 | 0.0169 | 1.84 | 6.07 | 23286 | 0.0010 | 35.89 | 119.85 | 1883 |
| 1966 | 1275 | 0.0173 | 1.77 | 6.49 | 23377 | 0.0009 | 33.12 | 118.93 | 2041 |
| 1967 | 1385 | 0.0177 | 1.81 | 6.97 | 23465 | 0.0009 | 31.43 | 118.09 | 2197 |
| 1968 | 1515 | 0.0174 | 1.79 | 7.55 | 23560 | 0.0009 | 28.82 | 117.38 | 2412 |
| 1969 | 1663 | 0.0175 | 1.81 | 8.21 | 23661 | 0.0009 | 26.77 | 116.74 | 2628 |
| 1970 | 1818 | 0.0160 | 1.85 | 8.87 | 23746 | 0.0009 | 25.68 | 115.81 | 2861 |
| 1971 | 1982 | 0.0138 | 1.89 | 9.54 | 23843 | 0.0009 | 23.83 | 114.82 | 3159 |
| 1972 | 2182 | 0.0146 | 1.87 | 10.39 | 23962 | 0.0009 | 21.74 | 114.16 | 3474 |
| 1973 | 2382 | 0.0125 | 1.88 | 11.24 | 24114 | 0.0009 | 19.45 | 113.80 | 3938 |
| 1974 | 2747 | 0.0298 | 1.79 | 12.84 | 24257 | 0.0009 | 18.18 | 113.43 | 4692 |
| 1975 | 3182 | 0.0336 | 1.82 | 14.73 | 24352 | 0.0010 | 16.93 | 112.76 | 5076 |
| 1976 | 3483 | 0.0105 | 2.01 | 15.98 | 24492 | 0.0010 | 15.25 | 112.33 | 5534 |
| 1977 | 3860 | 0.0107 | 1.99 | 17.53 | 24683 | 0.0009 | 13.77 | 112.07 | 6194 |
| 1978 | 4358 | 0.0141 | 1.94 | 19.58 | 24925 | 0.0009 | 12.33 | 111.98 | 7012 |
| 1979 | 5007 | 0.0183 | 1.93 | 22.25 | 25185 | 0.0009 | 11.24 | 111.91 | 8088 |
| 1980 | 5753 | 0.0183 | 1.97 | 25.26 | 25406 | 0.0010 | 10.46 | 111.57 | 9217 |
| 1981 | 6317 | 0.0072 | 2.13 | 27.47 | 25688 | 0.0009 | 9.42 | 111.70 | 10163 |
| 1982 | 6984 | 0.0080 | 2.16 | 30.08 | 25911 | 0.0011 | 9.10 | 111.59 | 10720 |
| 1983 | 7602 | 0.0048 | 2.24 | 32.44 | 26128 | 0.0013 | 8.52 | 111.51 | 11067 |
| 1984 | 8176 | 0.0032 | 2.30 | 34.59 | 26531 | 0.0010 | 7.66 | 112.25 | 11662 |
| 1985 | 8754 | 0.0028 | 2.30 | 36.71 | 26907 | 0.0011 | 7.27 | 112.84 | 12276 |
| 1986 | 9349 | 0.0026 | 2.32 | 38.85 | 27242 | 0.0013 | 7.02 | 113.20 | 13046 |
| 1987 | 9934 | 0.0025 | 2.33 | 40.91 | 27620 | 0.0012 | 6.65 | 113.75 | 13803 |
| 1988 | 10634 | 0.0024 | 2.26 | 43.40 | 28045 | 0.0011 | 6.20 | 114.46 | 14643 |
| 1989 | 11478 | 0.0027 | 2.23 | 46.41 | 28426 | 0.0011 | 5.92 | 114.92 | 15480 |
| **1990** | 12056 | 0.0021 | 2.33 | 48.20 | 28752 | 0.0013 | 5.68 | 114.95 | 16212 |
| 1991 | 12678 | 0.0020 | 2.32 | 50.01 | 29010 | 0.0014 | 5.54 | 114.44 | 16603 |
| 1992 | 13347 | 0.0020 | 2.32 | 51.96 | 29237 | 0.0015 | 5.34 | 113.81 | 17324 |
| 1993 | 13823 | 0.0023 | 2.32 | 53.11 | 29488 | 0.0016 | 5.14 | 113.30 | 18231 |
| 1994 | 14333 | 0.0023 | 2.29 | 54.41 | 29819 | 0.0015 | 4.90 | 113.19 | 19352 |
| 1995 | 15069 | 0.0018 | 2.23 | 56.53 | 30216 | 0.0014 | 4.71 | 113.36 | 20299 |
| 1996 | 15805 | 0.0018 | 2.24 | 58.61 | 30685 | 0.0013 | 4.51 | 113.79 | 21300 |
| 1997 | 16502 | 0.0019 | 2.24 | 60.47 | 31274 | 0.0011 | 4.31 | 114.59 | 22451 |
| 1998 | 17077 | 0.0023 | 2.26 | 61.85 | 32002 | 0.0010 | 4.15 | 115.90 | 23722 |
| 1999 | 17761 | 0.0023 | 2.21 | 63.59 | 32836 | 0.0010 | 4.01 | 117.57 | 25246 |
| 2000 | 18541 | 0.0024 | 2.17 | 65.65 | 33798 | 0.0011 | 3.87 | 119.67 | 26902 |
| 2001 | 19201 | 0.0027 | 2.17 | 67.24 | 34541 | 0.0014 | 3.87 | 120.97 | 28465 |
| 2002 | 19891 | 0.0027 | 2.15 | 68.92 | 35163 | 0.0017 | 3.84 | 121.84 | 29788 |
| 2003 | 20766 | 0.0024 | 2.11 | 71.12 | 35786 | 0.0018 | 3.74 | 122.55 | 31424 |
| 2004 | 21782 | 0.0023 | 2.08 | 73.84 | 36517 | 0.0019 | 3.59 | 123.79 | 34421 |
| 2005 | **22912** | 0.0023 | 2.06 | 76.83 | **37251** | 0.0021 | 3.47 | 124.92 | **37251** |

Data source: Kamiryo Endogenous World Table (KEWT) 1.07 and BEA, the US.
Note: The same theoretical increase in capital by year is applied to both K-1 and K-2.

**Table A3 Capital stock in the US: KEWT based on disposable income vs. BEA based on *GDP* (2)**

| | **K-2 Reset** | (r/w)-Reset2 | Ω–Reset2 | k-Reset2 | **K-3 Reset** | (r/w)-Reset3 | Ω-Reset3 | k-Reset3 |
|---|---|---|---|---|---|---|---|---|
| 1960 | **5000** | 0.0037 | 10.62 | 27.67 | **12500** | 0.0015 | 26.55 | 69.19 |
| 1961 | 5047 | 0.0037 | 10.36 | 27.48 | 12547 | 0.0015 | 25.74 | 68.31 |
| 1962 | 5105 | 0.0039 | 9.71 | 27.37 | 12605 | 0.0016 | 23.97 | 67.57 |
| 1963 | 5167 | 0.0039 | 9.29 | 27.30 | 12667 | 0.0016 | 22.77 | 66.93 |
| 1964 | 5232 | 0.0040 | 8.74 | 27.27 | 12732 | 0.0016 | 21.28 | 66.35 |
| 1965 | 5317 | 0.0042 | 8.20 | 27.37 | 12817 | 0.0017 | 19.76 | 65.97 |
| 1966 | 5408 | 0.0040 | 7.66 | 27.52 | 12908 | 0.0017 | 18.29 | 65.67 |
| 1967 | 5496 | 0.0037 | 7.36 | 27.66 | 12996 | 0.0016 | 17.41 | 65.40 |
| 1968 | 5591 | 0.0037 | 6.84 | 27.86 | 13091 | 0.0016 | 16.02 | 65.22 |
| 1969 | 5692 | 0.0036 | 6.44 | 28.09 | 13192 | 0.0016 | 14.93 | 65.09 |
| 1970 | 5777 | 0.0037 | 6.25 | 28.18 | 13277 | 0.0016 | 14.36 | 64.75 |
| 1971 | 5874 | 0.0037 | 5.87 | 28.29 | 13374 | 0.0016 | 13.37 | 64.40 |
| 1972 | 5993 | 0.0036 | 5.44 | 28.55 | 13493 | 0.0016 | 12.24 | 64.28 |
| 1973 | 6145 | 0.0036 | 4.96 | 29.00 | 13645 | 0.0016 | 11.00 | 64.39 |
| 1974 | 6288 | 0.0035 | 4.71 | 29.40 | 13788 | 0.0016 | 10.33 | 64.47 |
| 1975 | 6383 | 0.0040 | 4.44 | 29.56 | 13883 | 0.0018 | 9.65 | 64.28 |
| 1976 | 6523 | 0.0037 | 4.06 | 29.91 | 14023 | 0.0017 | 8.73 | 64.31 |
| 1977 | 6714 | 0.0035 | 3.74 | 30.48 | 14214 | 0.0016 | 7.93 | 64.54 |
| 1978 | 6956 | 0.0033 | 3.44 | 31.25 | 14456 | 0.0016 | 7.15 | 64.94 |
| 1979 | 7216 | 0.0032 | 3.22 | 32.07 | 14716 | 0.0016 | 6.57 | 65.39 |
| 1980 | 7437 | 0.0034 | 3.06 | 32.66 | 14937 | 0.0017 | 6.15 | 65.59 |
| 1981 | 7719 | 0.0031 | 2.83 | 33.56 | 15219 | 0.0016 | 5.58 | 66.18 |
| 1982 | 7942 | 0.0036 | 2.79 | 34.20 | 15442 | 0.0018 | 5.42 | 66.50 |
| 1983 | 8159 | 0.0041 | 2.66 | 34.82 | 15659 | 0.0022 | 5.11 | 66.83 |
| 1984 | 8562 | 0.0030 | 2.47 | 36.23 | 16062 | 0.0016 | 4.64 | 67.96 |
| 1985 | 8938 | 0.0033 | 2.41 | 37.48 | 16438 | 0.0018 | 4.44 | 68.93 |
| 1986 | 9273 | 0.0038 | 2.39 | 38.53 | 16773 | 0.0021 | 4.33 | 69.70 |
| 1987 | 9651 | 0.0035 | 2.33 | 39.75 | 17151 | 0.0020 | 4.13 | 70.64 |
| 1988 | 10076 | 0.0030 | 2.23 | 41.12 | 17576 | 0.0017 | 3.89 | 71.73 |
| 1989 | 10457 | 0.0031 | 2.18 | 42.28 | 17957 | 0.0018 | 3.74 | 72.60 |
| **1990** | 10783 | 0.0034 | 2.13 | 43.11 | 18283 | 0.0020 | 3.61 | 73.10 |
| 1991 | 11041 | 0.0036 | 2.11 | 43.56 | 18541 | 0.0022 | 3.54 | 73.14 |
| 1992 | 11268 | 0.0040 | 2.06 | 43.86 | 18768 | 0.0024 | 3.43 | 73.06 |
| 1993 | 11519 | 0.0041 | 2.01 | 44.26 | 19019 | 0.0025 | 3.32 | 73.08 |
| 1994 | 11850 | 0.0038 | 1.95 | 44.98 | 19350 | 0.0023 | 3.18 | 73.45 |
| 1995 | 12247 | 0.0033 | 1.91 | 45.95 | 19747 | 0.0021 | 3.08 | 74.08 |
| 1996 | 12716 | 0.0030 | 1.87 | 47.16 | 20216 | 0.0019 | 2.97 | 74.97 |
| 1997 | 13305 | 0.0026 | 1.83 | 48.75 | 20805 | 0.0017 | 2.87 | 76.23 |
| 1998 | 14033 | 0.0023 | 1.82 | 50.82 | 21533 | 0.0015 | 2.80 | 77.99 |
| 1999 | 14867 | 0.0023 | 1.82 | 53.23 | 22367 | 0.0015 | 2.73 | 80.08 |
| 2000 | 15829 | 0.0023 | 1.81 | 56.04 | 23329 | 0.0015 | 2.67 | 82.60 |
| 2001 | 16572 | 0.0028 | 1.86 | 58.04 | 24072 | 0.0019 | 2.69 | 84.30 |
| 2002 | 17194 | 0.0034 | 1.88 | 59.58 | 24694 | 0.0024 | 2.69 | 85.56 |
| 2003 | 17817 | 0.0037 | 1.86 | 61.02 | 25317 | 0.0026 | 2.65 | 86.70 |
| 2004 | 18548 | 0.0037 | 1.82 | 62.88 | 26048 | 0.0026 | 2.56 | 88.30 |
| 2005 | **19282** | 0.0040 | 1.80 | 64.66 | **26782** | 0.0029 | 2.50 | 89.81 |

Data source: Kamiryo Endogenous World Table (KEWT) 1.07 and BEA, the US.
Note: The same theoretical increase in capital by year as K-1 and K-2 is applied to K-3 and K-4. For resetting, it is vital to use the same increase in capital by year. In the framework of KEWT, whenever a current capital at 2005 is given, capital by year is counted back unitl 1960.

**Table A4 Returns and the relative share of capital by sector using Japan KEWT, Base: with *GDP* vs. disposable income**

| | Returns, *Π* | | | Relative share, *alpha* | | | *GDP* versus disposable income | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Gov. | Private | Total | Gov. | Private | *GDP* | Income, *Y* | *Y/GDP* |
| 1960 | 1325 | 391 | 934 | 0.0955 | 0.2158 | 0.0774 | 16207 | 13869 | 0.8557 |
| 1961 | 1529 | 513 | 1015 | 0.0935 | 0.2354 | 0.0717 | 19583 | 16350 | 0.8349 |
| 1962 | 1766 | 421 | 1345 | 0.0935 | 0.1782 | 0.0814 | 21660 | 18887 | 0.8720 |
| 1963 | 2124 | 331 | 1793 | 0.0988 | 0.1271 | 0.0949 | 25576 | 21502 | 0.8407 |
| 1964 | 2442 | 279 | 2162 | 0.0969 | 0.0952 | 0.0971 | 29531 | 25205 | 0.8535 |
| 1965 | 2846 | 57 | 2789 | 0.1014 | 0.0207 | 0.1102 | 32800 | 28060 | 0.8555 |
| 1966 | 3294 | 104 | 3190 | 0.1029 | 0.0328 | 0.1106 | 38085 | 32012 | 0.8405 |
| 1967 | 3737 | 180 | 3557 | 0.1013 | 0.0500 | 0.1068 | 44629 | 36892 | 0.8266 |
| 1968 | 4152 | 396 | 3756 | 0.0952 | 0.0914 | 0.0956 | 52922 | 43621 | 0.8242 |
| 1969 | 4731 | 766 | 3965 | 0.0917 | 0.1439 | 0.0857 | 62260 | 51574 | 0.8284 |
| 1970 | 5472 | 2631 | 2841 | 0.0904 | 0.3254 | 0.0542 | 73345 | 60535 | 0.8253 |
| 1971 | 6202 | 3510 | 2692 | 0.0913 | 0.3534 | 0.0464 | 80701 | 67939 | 0.8419 |
| 1972 | 7189 | 3181 | 4008 | 0.0926 | 0.2968 | 0.0599 | 92394 | 77628 | 0.8402 |
| 1973 | 8710 | 4074 | 4636 | 0.0922 | 0.3038 | 0.0572 | 112498 | 94434 | 0.8394 |
| 1974 | 10779 | 4649 | 6130 | 0.0960 | 0.2753 | 0.0643 | 134244 | 112250 | 0.8362 |
| 1975 | 12856 | (494) | 13349 | 0.1002 | (0.0343) | 0.1172 | 148327 | 128277 | 0.8648 |
| 1976 | 14575 | (1612) | 16187 | 0.1016 | (0.1089) | 0.1259 | 166573 | 143419 | 0.8610 |
| 1977 | 16312 | (2542) | 18854 | 0.1020 | (0.1619) | 0.1308 | 185622 | 159879 | 0.8613 |
| 1978 | 17853 | (3767) | 21620 | 0.1013 | (0.2356) | 0.1349 | 204404 | 176286 | 0.8624 |
| 1979 | 20114 | (3490) | 23604 | 0.1058 | (0.1939) | 0.1371 | 221547 | 190099 | 0.8581 |
| 1980 | 22010 | (3599) | 25609 | 0.1069 | (0.1802) | 0.1378 | 240176 | 205849 | 0.8571 |
| 1981 | 23112 | (2922) | 26034 | 0.1042 | (0.1289) | 0.1308 | 257363 | 221735 | 0.8616 |
| 1982 | 25260 | (3677) | 28937 | 0.1086 | (0.1591) | 0.1381 | 270601 | 232696 | 0.8599 |
| 1983 | 27019 | (5438) | 32457 | 0.1114 | (0.2411) | 0.1476 | 281767 | 242458 | 0.8605 |
| 1984 | 27991 | (4270) | 32261 | 0.1084 | (0.1696) | 0.1384 | 300543 | 258207 | 0.8591 |
| 1985 | 29302 | (2335) | 31637 | 0.1070 | (0.0824) | 0.1289 | 320419 | 273879 | 0.8548 |
| 1986 | 30355 | (1875) | 32230 | 0.1061 | (0.0614) | 0.1261 | 334609 | 286028 | 0.8548 |
| 1987 | 31518 | 3984 | 27534 | 0.1058 | 0.1078 | 0.1055 | 348425 | 298021 | 0.8553 |
| 1988 | 32755 | 6702 | 26053 | 0.1039 | 0.1639 | 0.0949 | 371429 | 315357 | 0.8490 |
| 1989 | 35008 | 6084 | 28924 | 0.1051 | 0.1436 | 0.0995 | 396197 | 333069 | 0.8407 |
| 1990 | 37003 | 8642 | 28361 | 0.1033 | 0.1821 | 0.0913 | 424537 | 358161 | 0.8437 |
| 1991 | 38569 | 25378 | 13191 | 0.1020 | 0.3810 | 0.0424 | 451297 | 378042 | 0.8377 |
| 1992 | 40705 | 23894 | 16811 | 0.1050 | 0.3558 | 0.0524 | 463145 | 387829 | 0.8374 |
| 1993 | 47574 | 10838 | 36736 | 0.1171 | 0.1392 | 0.1119 | 465972 | 406250 | 0.8718 |
| 1994 | 48536 | 1135 | 47402 | 0.1218 | 0.0161 | 0.1445 | 469240 | 398634 | 0.8495 |
| 1995 | 51151 | (1724) | 52876 | 0.1278 | (0.0243) | 0.1607 | 493272 | 400116 | 0.8111 |
| 1996 | 53428 | (5238) | 58666 | 0.1315 | (0.0746) | 0.1746 | 502609 | 406346 | 0.8085 |
| 1997 | 54820 | (3747) | 58567 | 0.1326 | (0.0511) | 0.1722 | 512249 | 413511 | 0.8072 |
| 1998 | 57021 | (14368) | 71389 | 0.1413 | (0.2237) | 0.2104 | 502973 | 403437 | 0.8021 |
| 1999 | 58815 | (23500) | 82316 | 0.1461 | (0.4098) | 0.2385 | 495227 | 402486 | 0.8127 |
| 2000 | 60348 | (21234) | 81582 | 0.1502 | (0.3382) | 0.2406 | 501068 | 401798 | 0.8019 |
| 2001 | 63198 | (22586) | 85784 | 0.1593 | (0.3538) | 0.2578 | 496777 | 396612 | 0.7984 |
| 2002 | 64509 | (32102) | 96611 | 0.1641 | (0.5743) | 0.2866 | 489618 | 393033 | 0.8027 |
| 2003 | 65696 | (31031) | 96727 | 0.1697 | (0.5451) | 0.2929 | 490544 | 387136 | 0.7892 |
| 2004 | 66916 | (32655) | 99570 | 0.1712 | (0.5777) | 0.2978 | 496058 | 390862 | 0.7879 |
| 2005 | 67525 | (26065) | 93590 | 0.1704 | (0.4077) | 0.2816 | 502457 | 396284 | 0.7887 |

Note: Returns of the governemnt sector equals government saving, where $(rho\ /\ r)_G = 1.0$ but $(r\ /\ w) \neq 1.0$.

Data source: KEWT 1.07.

**Table A5 Returns and the relative share of capital by sector using The US KEWT, Base**

| | Returns, *Π* | | | Relative share, *alpha* | | | *GDP* versus disposable income | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Gov. | Private | Total | Gov. | Private | *GDP* | Income, *Y* | *Y/GDP* |
| 1960 | 48 | 8 | 40 | 0.1078 | 0.0740 | 0.1191 | 512 | 449 | 0.8761 |
| 1961 | 49 | 5 | 44 | 0.1039 | 0.0404 | 0.1247 | 530 | 471 | 0.8880 |
| 1962 | 49 | 1 | 48 | 0.0943 | 0.0073 | 0.1216 | 570 | 516 | 0.9042 |
| 1963 | 51 | 4 | 47 | 0.0940 | 0.0304 | 0.1143 | 602 | 543 | 0.9026 |
| 1964 | 54 | 3 | 52 | 0.0924 | 0.0212 | 0.1141 | 644 | 589 | 0.9134 |
| 1965 | 60 | 7 | 52 | 0.0929 | 0.0493 | 0.1062 | 699 | 641 | 0.9169 |
| 1966 | 73 | 6 | 67 | 0.1007 | 0.0351 | 0.1206 | 770 | 721 | 0.9363 |
| 1967 | 84 | 1 | 83 | 0.1097 | 0.0061 | 0.1382 | 814 | 764 | 0.9387 |
| 1968 | 98 | (16) | 114 | 0.1158 | (0.0952) | 0.1664 | 889 | 847 | 0.9528 |
| 1969 | 115 | 14 | 102 | 0.1256 | 0.0672 | 0.1422 | 960 | 919 | 0.9574 |
| 1970 | 122 | 8 | 114 | 0.1244 | 0.0367 | 0.1478 | 1010 | 981 | 0.9713 |
| 1971 | 122 | (13) | 135 | 0.1165 | (0.0634) | 0.1584 | 1097 | 1051 | 0.9582 |
| 1972 | 154 | (12) | 166 | 0.1320 | (0.0570) | 0.1749 | 1207 | 1164 | 0.9650 |
| 1973 | 156 | (4) | 160 | 0.1235 | (0.0169) | 0.1564 | 1349 | 1266 | 0.9380 |
| 1974 | 425 | (18) | 443 | 0.2771 | (0.0689) | 0.3461 | 1458 | 1534 | 1.0520 |
| 1975 | 578 | (38) | 616 | 0.3309 | (0.1428) | 0.4153 | 1585 | 1747 | 1.1021 |
| 1976 | 249 | (57) | 306 | 0.1433 | (0.2162) | 0.2076 | 1767 | 1735 | 0.9819 |
| 1977 | 308 | (32) | 339 | 0.1584 | (0.1027) | 0.2077 | 1974 | 1943 | 0.9844 |
| 1978 | 486 | (34) | 519 | 0.2167 | (0.0995) | 0.2728 | 2233 | 2243 | 1.0044 |
| 1979 | 751 | (14) | 765 | 0.2898 | (0.0344) | 0.3491 | 2489 | 2591 | 1.0412 |
| 1980 | 921 | (44) | 965 | 0.3160 | (0.1038) | 0.3879 | 2684 | 2914 | 1.0857 |
| 1981 | 488 | (47) | 535 | 0.1649 | (0.0991) | 0.2153 | 3150 | 2962 | 0.9403 |
| 1982 | 625 | (92) | 718 | 0.1931 | (0.1962) | 0.2594 | 3405 | 3238 | 0.9508 |
| 1983 | 457 | (176) | 633 | 0.1345 | (0.4038) | 0.2139 | 3777 | 3397 | 0.8994 |
| 1984 | 354 | (156) | 510 | 0.0997 | (0.3066) | 0.1675 | 4039 | 3552 | 0.8794 |
| 1985 | 359 | (175) | 534 | 0.0944 | (0.3175) | 0.1641 | 4269 | 3807 | 0.8919 |
| 1986 | 375 | (180) | 554 | 0.0928 | (0.2986) | 0.1613 | 4540 | 4037 | 0.8891 |
| 1987 | 395 | (117) | 513 | 0.0927 | (0.1618) | 0.1447 | 4900 | 4265 | 0.8704 |
| 1988 | 452 | (115) | 567 | 0.0961 | (0.1528) | 0.1436 | 5251 | 4699 | 0.8948 |
| 1989 | 578 | (103) | 681 | 0.1125 | (0.1273) | 0.1574 | 5522 | 5140 | 0.9307 |
| 1990 | 484 | (141) | 624 | 0.0936 | (0.1754) | 0.1431 | 5723 | 5165 | 0.9024 |
| 1991 | 505 | (221) | 727 | 0.0924 | (0.2705) | 0.1562 | 6020 | 5469 | 0.9084 |
| 1992 | 532 | (242) | 774 | 0.0924 | (0.2946) | 0.1571 | 6343 | 5751 | 0.9066 |
| 1993 | 660 | (206) | 865 | 0.1107 | (0.2374) | 0.1699 | 6931 | 5961 | 0.8600 |
| 1994 | 707 | (136) | 843 | 0.1128 | (0.1402) | 0.1591 | 7246 | 6264 | 0.8645 |
| 1995 | 639 | (97) | 736 | 0.0945 | (0.0937) | 0.1287 | 7398 | 6757 | 0.9134 |
| 1996 | 681 | (62) | 743 | 0.0964 | (0.0555) | 0.1247 | 7817 | 7067 | 0.9041 |
| 1997 | 747 | 52 | 695 | 0.1015 | 0.0409 | 0.1142 | 8304 | 7359 | 0.8862 |
| 1998 | 941 | 111 | 830 | 0.1246 | 0.0811 | 0.1343 | 8747 | 7551 | 0.8633 |
| 1999 | 1024 | 221 | 803 | 0.1273 | 0.1418 | 0.1238 | 9268 | 8040 | 0.8675 |
| 2000 | 1150 | 329 | 821 | 0.1344 | 0.1886 | 0.1205 | 9817 | 8557 | 0.8717 |
| 2001 | 1353 | 170 | 1183 | 0.1529 | 0.1018 | 0.1649 | 10128 | 8849 | 0.8737 |
| 2002 | 1470 | (155) | 1624 | 0.1592 | (0.1056) | 0.2090 | 10470 | 9234 | 0.8819 |
| 2003 | 1432 | (316) | 1748 | 0.1458 | (0.2227) | 0.2081 | 10971 | 9821 | 0.8952 |
| 2004 | 1532 | (316) | 1848 | 0.1466 | (0.2070) | 0.2071 | 11734 | 10450 | 0.8906 |
| 2005 | 1648 | (230) | 1878 | 0.1483 | (0.1328) | 0.2002 | 12487 | 11112 | 0.8899 |

Note: Returns of the governemnt sector equals government saving, where $(rho / r)_G = 1.0$ but $(r / w) \neq 1.0$.

Data source: KEWT 1.07.

**Table A6 The capital-output ratio, the rate of return, and the ratio of net investment to output (= income) by sector: Japan KEWT, Base**

| | Capital-output ratio, $\Omega = K/Y$ | | | Rate of return, $r = \Pi/K$ | | | Net investment/$Y$; $i = I/Y$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Gov. | Private | Total | Gov. | Private | Total | Gov. | Private |
| 1960 | 1.4421 | 1.1036 | 1.4930 | 0.0662 | 0.1955 | 0.0519 | 0.2431 | 0.1860 | 0.1805 |
| 1961 | 1.4998 | 1.1250 | 1.5575 | 0.0623 | 0.2093 | 0.0460 | 0.2766 | 0.2074 | 0.2036 |
| 1962 | 1.5526 | 1.2406 | 1.5972 | 0.0602 | 0.1436 | 0.0510 | 0.2542 | 0.2031 | 0.1799 |
| 1963 | 1.6098 | 1.3287 | 1.6485 | 0.0614 | 0.0956 | 0.0576 | 0.2460 | 0.2031 | 0.1674 |
| 1964 | 1.6091 | 1.3812 | 1.6391 | 0.0602 | 0.0689 | 0.0592 | 0.2359 | 0.2025 | 0.1630 |
| 1965 | 1.6492 | 1.6847 | 1.6454 | 0.0615 | 0.0123 | 0.0670 | 0.2038 | 0.2082 | 0.1283 |
| 1966 | 1.6399 | 1.6884 | 1.6346 | 0.0628 | 0.0195 | 0.0676 | 0.1943 | 0.2229 | 0.1206 |
| 1967 | 1.6392 | 1.7364 | 1.6287 | 0.0618 | 0.0288 | 0.0656 | 0.2162 | 0.2512 | 0.0491 |
| 1968 | 1.6184 | 1.6934 | 1.6101 | 0.0588 | 0.0540 | 0.0594 | 0.2320 | 0.2538 | 0.0695 |
| 1969 | 1.6155 | 1.6354 | 1.6133 | 0.0568 | 0.0880 | 0.0531 | 0.2467 | 0.2583 | 0.0964 |
| 1970 | 1.6375 | 1.4416 | 1.6677 | 0.0552 | 0.2257 | 0.0325 | 0.2611 | 0.3648 | 0.2023 |
| 1971 | 1.6959 | 1.5453 | 1.7216 | 0.0538 | 0.2287 | 0.0270 | 0.2368 | 0.3716 | 0.1801 |
| 1972 | 1.7168 | 1.8647 | 1.6931 | 0.0539 | 0.1592 | 0.0354 | 0.2326 | 0.4327 | 0.1653 |
| 1973 | 1.6735 | 1.9303 | 1.6309 | 0.0551 | 0.1574 | 0.0351 | 0.2622 | 0.4399 | 0.1889 |
| 1974 | 1.6581 | 1.9144 | 1.6128 | 0.0579 | 0.1438 | 0.0399 | 0.2503 | 0.3817 | 0.1874 |
| 1975 | 1.6736 | 2.7440 | 1.5383 | 0.0599 | (0.0125) | 0.0762 | 0.2227 | 0.4982 | 0.1424 |
| 1976 | 1.7053 | 3.1955 | 1.5338 | 0.0596 | (0.0341) | 0.0821 | 0.2084 | 0.5272 | 0.1336 |
| 1977 | 1.7269 | 3.6102 | 1.5218 | 0.0591 | (0.0448) | 0.0859 | 0.1971 | 0.5970 | 0.1071 |
| 1978 | 1.7650 | 4.2632 | 1.5159 | 0.0574 | (0.0553) | 0.0890 | 0.1989 | 0.7174 | 0.1061 |
| 1979 | 1.8500 | 4.5000 | 1.5729 | 0.0572 | (0.0431) | 0.0872 | 0.2132 | 0.7128 | 0.1101 |
| 1980 | 1.9179 | 4.7199 | 1.6168 | 0.0558 | (0.0382) | 0.0852 | 0.2094 | 0.6647 | 0.1084 |
| 1981 | 1.9794 | 4.7724 | 1.6614 | 0.0527 | (0.0270) | 0.0787 | 0.1989 | 0.6135 | 0.0980 |
| 1982 | 2.0710 | 5.2799 | 1.7170 | 0.0524 | (0.0301) | 0.0804 | 0.1849 | 0.6015 | 0.0836 |
| 1983 | 2.1516 | 6.0053 | 1.7562 | 0.0518 | (0.0401) | 0.0840 | 0.1640 | 0.5943 | 0.0587 |
| 1984 | 2.1827 | 5.8974 | 1.7813 | 0.0497 | (0.0288) | 0.0777 | 0.1624 | 0.5171 | 0.0613 |
| 1985 | 2.2172 | 5.7057 | 1.8144 | 0.0483 | (0.0144) | 0.0710 | 0.1594 | 0.4680 | 0.0573 |
| 1986 | 2.2782 | 5.7630 | 1.8620 | 0.0466 | (0.0107) | 0.0677 | 0.1551 | 0.4618 | 0.0492 |
| 1987 | 2.3524 | 5.1957 | 1.9499 | 0.0450 | 0.0207 | 0.0541 | 0.1659 | 0.4378 | 0.0603 |
| 1988 | 2.4059 | 5.0968 | 2.0050 | 0.0432 | 0.0322 | 0.0473 | 0.1828 | 0.4001 | 0.0722 |
| 1989 | 2.4662 | 5.3380 | 2.0478 | 0.0426 | 0.0269 | 0.0486 | 0.1883 | 0.4185 | 0.0659 |
| 1990 | 2.4964 | 5.0904 | 2.1002 | 0.0414 | 0.0358 | 0.0435 | 0.2029 | 0.3250 | 0.1116 |
| 1991 | 2.5594 | 3.8792 | 2.2771 | 0.0399 | 0.0982 | 0.0186 | 0.1943 | 0.2531 | 0.1585 |
| 1992 | 2.6715 | 4.1466 | 2.3626 | 0.0393 | 0.0858 | 0.0222 | 0.1767 | 0.2987 | 0.1568 |
| 1993 | 2.6916 | 3.8669 | 2.4130 | 0.0435 | 0.0360 | 0.0464 | 0.1413 | 0.2901 | 0.0831 |
| 1994 | 2.8734 | 4.5649 | 2.5090 | 0.0424 | 0.0035 | 0.0576 | 0.1303 | 0.3036 | 0.0660 |
| 1995 | 2.9851 | 4.8580 | 2.5806 | 0.0428 | (0.0050) | 0.0623 | 0.1224 | 0.3201 | 0.0537 |
| 1996 | 3.0639 | 5.1846 | 2.6206 | 0.0429 | (0.0144) | 0.0666 | 0.1245 | 0.2705 | 0.0722 |
| 1997 | 3.1250 | 5.1886 | 2.6800 | 0.0424 | (0.0098) | 0.0642 | 0.1142 | 0.2227 | 0.0752 |
| 1998 | 3.2871 | 6.1856 | 2.7384 | 0.0430 | (0.0362) | 0.0769 | 0.0841 | 0.2590 | 0.0311 |
| 1999 | 3.3718 | 7.1979 | 2.7362 | 0.0433 | (0.0569) | 0.0872 | 0.0770 | 0.2711 | 0.0188 |
| 2000 | 3.4470 | 6.7781 | 2.8300 | 0.0436 | (0.0499) | 0.0850 | 0.0694 | 0.2042 | 0.0189 |
| 2001 | 3.5518 | 6.8355 | 2.9219 | 0.0449 | (0.0518) | 0.0882 | 0.0597 | 0.1686 | 0.0221 |
| 2002 | 3.6254 | 7.9644 | 2.9059 | 0.0453 | (0.0721) | 0.0986 | 0.0413 | 0.1590 | 0.0040 |
| 2003 | 3.7060 | 7.9354 | 2.9769 | 0.0458 | (0.0687) | 0.0984 | 0.0254 | 0.1144 | 0.0051 |
| 2004 | 3.6890 | 8.0498 | 2.9517 | 0.0464 | (0.0718) | 0.1009 | 0.0183 | 0.0576 | (0.0081) |
| 2005 | 3.6655 | 7.1673 | 2.9918 | 0.0465 | (0.0569) | 0.0941 | 0.0270 | 0.0509 | 0.0192 |

Note: *alpha* = $\Omega \cdot r$ holds. Net investemnt equals the sum of quantitative and qualitative net investment.

Data source: KEWT 1.07.

**Table A7 The capital-output ratio, the rate of return, and the ratio of net investment to output (= income) by sector: The US KEWT, Base**

| | Capital-output ratio, $\Omega=K/Y$ | | | Rate of return, $r=\Pi/K$ | | | Net investment/$Y$; $i=I/Y$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Gov. | Private | Total | Gov. | Private | Total | Gov. | Private |
| 1960 | 2.1145 | 0.8029 | 2.5515 | 0.0510 | 0.0922 | 0.0467 | 0.0535 | 0.0714 | 0.0253 |
| 1961 | 2.0717 | 0.8434 | 2.4744 | 0.0501 | 0.0480 | 0.0504 | 0.0567 | 0.0688 | 0.0335 |
| 1962 | 1.9720 | 0.8611 | 2.3204 | 0.0478 | 0.0085 | 0.0524 | 0.0808 | 0.0650 | 0.0575 |
| 1963 | 1.9508 | 0.8730 | 2.2949 | 0.0482 | 0.0348 | 0.0498 | 0.0797 | 0.0669 | 0.0564 |
| 1964 | 1.8858 | 0.9022 | 2.1841 | 0.0490 | 0.0235 | 0.0522 | 0.0849 | 0.0642 | 0.0728 |
| 1965 | 1.8403 | 0.8821 | 2.1332 | 0.0505 | 0.0559 | 0.0498 | 0.1092 | 0.0586 | 0.1116 |
| 1966 | 1.7689 | 0.8442 | 2.0503 | 0.0569 | 0.0415 | 0.0588 | 0.1318 | 0.0571 | 0.1404 |
| 1967 | 1.8119 | 0.9210 | 2.0564 | 0.0606 | 0.0066 | 0.0672 | 0.1439 | 0.0583 | 0.1634 |
| 1968 | 1.7880 | 0.9835 | 1.9810 | 0.0648 | (0.0968) | 0.0840 | 0.1534 | 0.0586 | 0.1367 |
| 1969 | 1.8107 | 0.8478 | 2.0827 | 0.0694 | 0.0793 | 0.0683 | 0.1615 | 0.0514 | 0.1796 |
| 1970 | 1.8528 | 0.8780 | 2.1139 | 0.0671 | 0.0418 | 0.0699 | 0.1579 | 0.0502 | 0.1970 |
| 1971 | 1.8856 | 0.9678 | 2.0997 | 0.0618 | (0.0655) | 0.0754 | 0.1554 | 0.0523 | 0.1789 |
| 1972 | 1.8738 | 0.9452 | 2.0845 | 0.0704 | (0.0603) | 0.0839 | 0.1718 | 0.0517 | 0.1930 |
| 1973 | 1.8820 | 0.8928 | 2.1136 | 0.0656 | (0.0190) | 0.0740 | 0.1580 | 0.0451 | 0.1751 |
| 1974 | 1.7908 | 0.8895 | 1.9705 | 0.1547 | (0.0775) | 0.1756 | 0.2380 | 0.0491 | 0.2593 |
| 1975 | 1.8216 | 0.9167 | 1.9830 | 0.1816 | (0.1558) | 0.2094 | 0.2491 | 0.0584 | 0.2924 |
| 1976 | 2.0076 | 0.9836 | 2.1909 | 0.0714 | (0.2198) | 0.0948 | 0.1739 | 0.0636 | 0.1781 |
| 1977 | 1.9863 | 0.9102 | 2.1897 | 0.0797 | (0.1128) | 0.0949 | 0.1938 | 0.0712 | 0.2136 |
| 1978 | 1.9435 | 0.9073 | 2.1274 | 0.1115 | (0.1096) | 0.1282 | 0.2222 | 0.0757 | 0.2342 |
| 1979 | 1.9321 | 0.8327 | 2.1331 | 0.1500 | (0.0414) | 0.1637 | 0.2502 | 0.0672 | 0.2729 |
| 1980 | 1.9741 | 0.8527 | 2.1660 | 0.1601 | (0.1217) | 0.1791 | 0.2562 | 0.0695 | 0.2825 |
| 1981 | 2.1329 | 0.8335 | 2.3806 | 0.0773 | (0.1189) | 0.0904 | 0.1903 | 0.0675 | 0.2056 |
| 1982 | 2.1571 | 0.9153 | 2.3683 | 0.0895 | (0.2143) | 0.1095 | 0.2061 | 0.0758 | 0.2317 |
| 1983 | 2.2377 | 1.0588 | 2.4116 | 0.0601 | (0.3814) | 0.0887 | 0.1818 | 0.0721 | 0.1855 |
| 1984 | 2.3022 | 0.9684 | 2.5248 | 0.0433 | (0.3166) | 0.0663 | 0.1618 | 0.0584 | 0.1703 |
| 1985 | 2.2995 | 0.9612 | 2.5258 | 0.0411 | (0.3303) | 0.0650 | 0.1518 | 0.0680 | 0.1544 |
| 1986 | 2.3161 | 0.9495 | 2.5553 | 0.0401 | (0.3144) | 0.0631 | 0.1474 | 0.0693 | 0.1523 |
| 1987 | 2.3289 | 0.8342 | 2.6343 | 0.0398 | (0.1940) | 0.0549 | 0.1371 | 0.0451 | 0.1510 |
| 1988 | 2.2632 | 0.8543 | 2.5323 | 0.0425 | (0.1788) | 0.0567 | 0.1490 | 0.0532 | 0.1602 |
| 1989 | 2.2332 | 0.8552 | 2.4911 | 0.0504 | (0.1489) | 0.0632 | 0.1642 | 0.0609 | 0.1777 |
| 1990 | 2.3344 | 0.9648 | 2.5861 | 0.0401 | (0.1818) | 0.0553 | 0.1119 | 0.1005 | 0.1103 |
| 1991 | 2.3183 | 1.0044 | 2.5495 | 0.0399 | (0.2694) | 0.0613 | 0.1137 | 0.0587 | 0.1090 |
| 1992 | 2.3210 | 1.0568 | 2.5321 | 0.0398 | (0.2787) | 0.0620 | 0.1164 | 0.0583 | 0.1245 |
| 1993 | 2.3191 | 1.0606 | 2.5331 | 0.0477 | (0.2238) | 0.0671 | 0.0798 | 0.0570 | 0.0841 |
| 1994 | 2.2882 | 0.9995 | 2.5238 | 0.0493 | (0.1403) | 0.0630 | 0.0815 | 0.0504 | 0.0885 |
| 1995 | 2.2302 | 0.9783 | 2.4577 | 0.0424 | (0.0958) | 0.0524 | 0.1089 | 0.0470 | 0.1242 |
| 1996 | 2.2364 | 0.9606 | 2.4740 | 0.0431 | (0.0578) | 0.0504 | 0.1041 | 0.0444 | 0.1156 |
| 1997 | 2.2423 | 0.8830 | 2.5254 | 0.0453 | 0.0463 | 0.0452 | 0.0947 | 0.0428 | 0.1107 |
| 1998 | 2.2616 | 0.8608 | 2.5712 | 0.0551 | 0.0942 | 0.0522 | 0.0762 | 0.0413 | 0.0828 |
| 1999 | 2.2091 | 0.7979 | 2.5473 | 0.0576 | 0.1778 | 0.0486 | 0.0851 | 0.0410 | 0.1007 |
| 2000 | 2.1667 | 0.7530 | 2.5293 | 0.0620 | 0.2504 | 0.0476 | 0.0912 | 0.0428 | 0.1102 |
| 2001 | 2.1698 | 0.8331 | 2.4811 | 0.0705 | 0.1221 | 0.0665 | 0.0745 | 0.0465 | 0.0837 |
| 2002 | 2.1542 | 1.0044 | 2.3706 | 0.0739 | (0.1052) | 0.0882 | 0.0747 | 0.0520 | 0.0715 |
| 2003 | 2.1144 | 1.0904 | 2.2876 | 0.0690 | (0.2042) | 0.0910 | 0.0891 | 0.0563 | 0.0882 |
| 2004 | 2.0844 | 1.0692 | 2.2582 | 0.0703 | (0.1936) | 0.0917 | 0.0973 | 0.0550 | 0.0991 |
| 2005 | 2.0620 | 0.9932 | 2.2594 | 0.0719 | (0.1337) | 0.0886 | 0.1017 | 0.0508 | 0.1063 |

Note: $alpha = \Omega \cdot r$ holds. Net investemnt equals the sum of quantitative and qualitative net investment.

Data source: KEWT 1.07.

**Table A8** ***beta***$^{*}$ **at convergence as a base of technological progress and resultant growth rates at the current situation and at convergence by sector: Japan KEWT, Base**

| | Quantitative/total, β* | | | Growth rate of $Y^*$, $g_Y{}^*$ | | | Current growth rate of $Y$, $g_Y$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Gov. | Private | Total | Gov. | Private | Total | Gov. | Private |
| 1960 | 0.6379 | 0.5954 | 0.6518 | 0.1075 | 0.1004 | 0.0788 | | | |
| 1961 | 0.6440 | 0.5993 | 0.6576 | 0.1188 | 0.1105 | 0.0860 | 0.1789 | 0.2028 | 0.1754 |
| 1962 | 0.6547 | 0.6507 | 0.6636 | 0.1072 | 0.1065 | 0.0747 | 0.1551 | 0.0843 | 0.1660 |
| 1963 | 0.6673 | 0.7275 | 0.6671 | 0.1020 | 0.1112 | 0.0677 | 0.1385 | 0.1022 | 0.1436 |
| 1964 | 0.6687 | 0.6191 | 0.6875 | 0.0980 | 0.0907 | 0.0684 | 0.1722 | 0.1272 | 0.1785 |
| 1965 | 0.6811 | 0.3769 | 0.7541 | 0.0842 | 0.0466 | 0.0588 | 0.1133 | (0.0645) | 0.1367 |
| 1966 | 0.6978 | 0.6742 | 0.7296 | 0.0827 | 0.0890 | 0.0538 | 0.1408 | 0.1495 | 0.1399 |
| 1967 | 0.6760 | 0.5845 | 0.8164 | 0.0892 | 0.0846 | 0.0246 | 0.1525 | 0.1368 | 0.1542 |
| 1968 | 0.6718 | 0.5989 | 0.7657 | 0.0963 | 0.0897 | 0.0331 | 0.1824 | 0.2062 | 0.1798 |
| 1969 | 0.6706 | 0.6269 | 0.7287 | 0.1024 | 0.0990 | 0.0436 | 0.1823 | 0.2297 | 0.1771 |
| 1970 | 0.6707 | 0.7242 | 0.6680 | 0.1069 | 0.1833 | 0.0810 | 0.1737 | 0.5187 | 0.1340 |
| 1971 | 0.6863 | 0.7925 | 0.6706 | 0.0958 | 0.1906 | 0.0702 | 0.1223 | 0.2283 | 0.1060 |
| 1972 | 0.6930 | 0.7838 | 0.6844 | 0.0939 | 0.1819 | 0.0668 | 0.1426 | 0.0791 | 0.1535 |
| 1973 | 0.6831 | 0.7777 | 0.6742 | 0.1070 | 0.1772 | 0.0781 | 0.2165 | 0.2512 | 0.2109 |
| 1974 | 0.6811 | 0.9025 | 0.6329 | 0.1028 | 0.1800 | 0.0736 | 0.1887 | 0.2594 | 0.1770 |
| 1975 | 0.6866 | 0.8601 | 0.6485 | 0.0913 | 0.1562 | 0.0600 | 0.1428 | (0.1476) | 0.1942 |
| 1976 | 0.6875 | 0.7394 | 0.6919 | 0.0840 | 0.1220 | 0.0603 | 0.1180 | 0.0284 | 0.1294 |
| 1977 | 0.6888 | 0.7679 | 0.6905 | 0.0786 | 0.1270 | 0.0486 | 0.1148 | 0.0605 | 0.1210 |
| 1978 | 0.6918 | 0.7603 | 0.7007 | 0.0779 | 0.1279 | 0.0490 | 0.1026 | 0.0182 | 0.1118 |
| 1979 | 0.6997 | 0.8230 | 0.6798 | 0.0807 | 0.1304 | 0.0476 | 0.0784 | 0.1257 | 0.0736 |
| 1980 | 0.7075 | 0.8349 | 0.6848 | 0.0773 | 0.1176 | 0.0459 | 0.0829 | 0.1097 | 0.0800 |
| 1981 | 0.7124 | 0.8284 | 0.6961 | 0.0716 | 0.1065 | 0.0410 | 0.0772 | 0.1349 | 0.0710 |
| 1982 | 0.7239 | 0.8368 | 0.7120 | 0.0646 | 0.0953 | 0.0347 | 0.0494 | 0.0201 | 0.0528 |
| 1983 | 0.7359 | 0.8529 | 0.7341 | 0.0561 | 0.0844 | 0.0245 | 0.0420 | (0.0242) | 0.0493 |
| 1984 | 0.7364 | 0.8156 | 0.7588 | 0.0548 | 0.0715 | 0.0261 | 0.0650 | 0.1162 | 0.0597 |
| 1985 | 0.7393 | 0.8132 | 0.7712 | 0.0532 | 0.0667 | 0.0243 | 0.0607 | 0.1259 | 0.0536 |
| 1986 | 0.7415 | 0.8754 | 0.7294 | 0.0505 | 0.0701 | 0.0193 | 0.0444 | 0.0763 | 0.0407 |
| 1987 | 0.7448 | 0.8185 | 0.7715 | 0.0525 | 0.0690 | 0.0239 | 0.0419 | 0.2112 | 0.0217 |
| 1988 | 0.7446 | 0.8236 | 0.7545 | 0.0566 | 0.0647 | 0.0272 | 0.0582 | 0.1063 | 0.0514 |
| 1989 | 0.7490 | 0.8810 | 0.7266 | 0.0572 | 0.0691 | 0.0234 | 0.0562 | 0.0360 | 0.0592 |
| 1990 | 0.7475 | 0.8530 | 0.7239 | 0.0608 | 0.0545 | 0.0385 | 0.0753 | 0.1202 | 0.0688 |
| 1991 | 0.7514 | 0.8807 | 0.7145 | 0.0570 | 0.0575 | 0.0497 | 0.0555 | 0.4038 | 0.0023 |
| 1992 | 0.7619 | 0.9222 | 0.7120 | 0.0504 | 0.0664 | 0.0473 | 0.0259 | 0.0081 | 0.0297 |
| 1993 | 0.7679 | 1.7369 | 0.1559 | 0.0403 | 0.1303 | 0.0054 | 0.0475 | 0.1593 | 0.0241 |
| 1994 | 0.7838 | 0.9994 | 0.6357 | 0.0355 | 0.0665 | 0.0167 | (0.0187) | (0.0926) | (0.0012) |
| 1995 | 0.7898 | 0.9687 | 0.6368 | 0.0324 | 0.0638 | 0.0133 | 0.0037 | 0.0059 | 0.0032 |
| 1996 | 0.7943 | 0.9232 | 0.7246 | 0.0323 | 0.0482 | 0.0200 | 0.0156 | (0.0114) | 0.0214 |
| 1997 | 0.7987 | 0.8616 | 0.7753 | 0.0292 | 0.0370 | 0.0218 | 0.0176 | 0.0440 | 0.0121 |
| 1998 | 0.8138 | 1.0610 | 0.5217 | 0.0208 | 0.0444 | 0.0059 | (0.0244) | (0.1245) | (0.0028) |
| 1999 | 0.8193 | 1.0075 | 0.5092 | 0.0187 | 0.0379 | 0.0035 | (0.0024) | (0.1070) | 0.0175 |
| 2000 | 0.8235 | 1.0955 | 0.4009 | 0.0166 | 0.0330 | 0.0027 | (0.0017) | 0.0949 | (0.0178) |
| 2001 | 0.8322 | 1.1976 | 0.3771 | 0.0140 | 0.0295 | 0.0029 | (0.0129) | 0.0167 | (0.0184) |
| 2002 | 0.8426 | 1.1235 | (0.6278) | 0.0096 | 0.0224 | (0.0009) | (0.0090) | (0.1243) | 0.0131 |
| 2003 | 0.8632 | 1.0981 | 0.1131 | 0.0059 | 0.0158 | 0.0002 | (0.0150) | 0.0183 | (0.0205) |
| 2004 | 0.8689 | 1.0063 | 0.8680 | 0.0043 | 0.0072 | (0.0024) | 0.0096 | (0.0071) | 0.0125 |
| 2005 | 0.8469 | 0.7357 | 0.9079 | 0.0062 | 0.0052 | 0.0058 | 0.0139 | 0.1312 | (0.0060) |

Note: By the golden rule under endogenous technology, $r^* = (\alpha / i \cdot \beta^*) g_Y^*$ holds at convergence*.

Data source: KEWT 1.07.

**Table A9 *beta** at convergence as a base of technological progress and resultant growth rates at the current situation and at convergence by sector: The US KEWT, Base**

| | Quantitative/total, β* | | | Growth rate of $Y^*$, $g_Y{}^*$ | | | Current growth rate of $Y$, $g_Y$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Gov. | Private | Total | Gov. | Private | Total | Gov. | Private |
| 1960 | 0.9026 | 0.6195 | 0.8734 | 0.0228 | 0.0551 | 0.0086 | | | |
| 1961 | 0.8839 | 0.7086 | 0.9303 | 0.0242 | 0.0578 | 0.0126 | 0.0493 | 0.0366 | 0.0536 |
| 1962 | 0.8063 | 0.5028 | 0.9389 | 0.0330 | 0.0379 | 0.0233 | 0.0955 | 0.0594 | 0.1073 |
| 1963 | 0.7973 | 0.5022 | 0.9288 | 0.0326 | 0.0385 | 0.0228 | 0.0539 | 0.0682 | 0.0495 |
| 1964 | 0.7781 | 0.3483 | 0.9281 | 0.0350 | 0.0248 | 0.0310 | 0.0833 | 0.0418 | 0.0965 |
| 1965 | 0.7419 | 0.3977 | 0.8215 | 0.0440 | 0.0264 | 0.0430 | 0.0893 | 0.0956 | 0.0874 |
| 1966 | 0.7177 | 0.7260 | 0.7222 | 0.0535 | 0.0491 | 0.0495 | 0.1241 | 0.1206 | 0.1252 |
| 1967 | 0.7180 | 0.2300 | 0.7987 | 0.0570 | 0.0146 | 0.0635 | 0.0605 | (0.0214) | 0.0854 |
| 1968 | 0.7099 | 0.5339 | 0.7535 | 0.0609 | 0.0318 | 0.0520 | 0.1085 | (0.0043) | 0.1394 |
| 1969 | 0.7121 | 0.3926 | 0.7646 | 0.0635 | 0.0238 | 0.0659 | 0.0842 | 0.2349 | 0.0480 |
| 1970 | 0.7253 | 0.4787 | 0.7622 | 0.0618 | 0.0274 | 0.0710 | 0.0683 | 0.0242 | 0.0808 |
| 1971 | 0.7325 | 0.3985 | 0.7805 | 0.0604 | 0.0215 | 0.0665 | 0.0709 | (0.0410) | 0.1008 |
| 1972 | 0.7227 | 0.4702 | 0.7618 | 0.0663 | 0.0257 | 0.0705 | 0.1079 | 0.0831 | 0.1137 |
| 1973 | 0.7203 | 0.3251 | 0.7731 | 0.0605 | 0.0164 | 0.0640 | 0.0869 | 0.1151 | 0.0805 |
| 1974 | 0.7340 | 1.6737 | 0.6996 | 0.0975 | 0.0924 | 0.0921 | 0.2120 | 0.0624 | 0.2470 |
| 1975 | 0.7526 | 0.9820 | 0.7603 | 0.1029 | 0.0626 | 0.1121 | 0.1387 | 0.0363 | 0.1592 |
| 1976 | 0.7358 | (1.0508) | 0.9589 | 0.0637 | (0.0679) | 0.0779 | (0.0066) | (0.0035) | (0.0072) |
| 1977 | 0.7350 | 0.2748 | 0.7905 | 0.0717 | 0.0215 | 0.0771 | 0.1200 | 0.1723 | 0.1106 |
| 1978 | 0.7415 | 0.6334 | 0.7612 | 0.0848 | 0.0528 | 0.0838 | 0.1540 | 0.0946 | 0.1652 |
| 1979 | 0.7561 | 0.9697 | 0.7533 | 0.0979 | 0.0782 | 0.0964 | 0.1555 | 0.1851 | 0.1503 |
| 1980 | 0.7683 | 0.8540 | 0.7758 | 0.0997 | 0.0696 | 0.1012 | 0.1247 | 0.0632 | 0.1359 |
| 1981 | 0.7514 | (0.3105) | 0.8795 | 0.0670 | (0.0251) | 0.0760 | 0.0162 | 0.1132 | (0.0004) |
| 1982 | 0.7570 | 0.6623 | 0.7709 | 0.0723 | 0.0548 | 0.0754 | 0.0932 | (0.0072) | 0.1124 |
| 1983 | 0.7540 | 0.2224 | 0.8148 | 0.0613 | 0.0151 | 0.0627 | 0.0492 | (0.0723) | 0.0699 |
| 1984 | 0.7553 | 0.4681 | 0.7898 | 0.0531 | 0.0282 | 0.0533 | 0.0455 | 0.1634 | 0.0281 |
| 1985 | 0.7574 | 0.6134 | 0.7738 | 0.0500 | 0.0434 | 0.0473 | 0.0720 | 0.0842 | 0.0699 |
| 1986 | 0.7607 | 0.6045 | 0.7770 | 0.0484 | 0.0441 | 0.0463 | 0.0603 | 0.0920 | 0.0549 |
| 1987 | 0.7638 | 0.7212 | 0.7719 | 0.0450 | 0.0390 | 0.0442 | 0.0567 | 0.2033 | 0.0310 |
| 1988 | 0.7558 | (0.0579) | 0.8521 | 0.0498 | (0.0036) | 0.0539 | 0.1015 | 0.0412 | 0.1139 |
| 1989 | 0.7539 | 0.3362 | 0.8021 | 0.0554 | 0.0239 | 0.0572 | 0.0939 | 0.0755 | 0.0974 |
| 1990 | 0.7878 | 0.5424 | 0.8104 | 0.0378 | 0.0565 | 0.0346 | 0.0048 | (0.0105) | 0.0077 |
| 1991 | 0.7977 | 0.9584 | 0.7706 | 0.0391 | 0.0560 | 0.0330 | 0.0589 | 0.0201 | 0.0660 |
| 1992 | 0.7961 | 0.3244 | 0.8550 | 0.0399 | 0.0179 | 0.0420 | 0.0516 | 0.0060 | 0.0596 |
| 1993 | 0.8298 | 0.5016 | 0.8695 | 0.0286 | 0.0270 | 0.0289 | 0.0365 | 0.0530 | 0.0337 |
| 1994 | 0.8181 | 0.4049 | 0.8713 | 0.0291 | 0.0204 | 0.0306 | 0.0509 | 0.1175 | 0.0396 |
| 1995 | 0.7831 | (0.1502) | 0.8865 | 0.0383 | (0.0072) | 0.0448 | 0.0787 | 0.0731 | 0.0797 |
| 1996 | 0.7861 | 0.4620 | 0.8223 | 0.0366 | 0.0213 | 0.0384 | 0.0459 | 0.0677 | 0.0420 |
| 1997 | 0.7972 | 0.6478 | 0.8087 | 0.0337 | 0.0314 | 0.0355 | 0.0413 | 0.1433 | 0.0223 |
| 1998 | 0.8197 | 0.9671 | 0.7822 | 0.0276 | 0.0464 | 0.0252 | 0.0261 | 0.0776 | 0.0153 |
| 1999 | 0.8031 | 0.6059 | 0.8193 | 0.0309 | 0.0312 | 0.0324 | 0.0648 | 0.1373 | 0.0487 |
| 2000 | 0.7925 | 0.6445 | 0.8012 | 0.0333 | 0.0366 | 0.0349 | 0.0643 | 0.1235 | 0.0501 |
| 2001 | 0.8108 | 1.0263 | 0.7461 | 0.0278 | 0.0573 | 0.0252 | 0.0341 | (0.0427) | 0.0539 |
| 2002 | 0.8073 | 0.9892 | 0.7557 | 0.0280 | 0.0512 | 0.0228 | 0.0434 | (0.1253) | 0.0827 |
| 2003 | 0.7944 | 0.5317 | 0.8336 | 0.0335 | 0.0275 | 0.0321 | 0.0636 | (0.0287) | 0.0810 |
| 2004 | 0.7751 | 0.5611 | 0.8049 | 0.0362 | 0.0289 | 0.0353 | 0.0641 | 0.0752 | 0.0622 |
| 2005 | 0.7739 | 0.6183 | 0.7957 | 0.0382 | 0.0316 | 0.0374 | 0.0633 | 0.1345 | 0.0511 |

Note: By the golden rule under endogenous technology, $r^* = (\alpha / i \cdot \beta^*) g_Y^*$ holds at convergence*.

Data source: KEWT 1.07.

**Table A10 Comparison of the depreciation rate by sector, each KEWT versus ESRI and BEA**

| | Depreciation rate $d_{DEP}=D_{EP}/K$ | | | | Depreciation rate $d_{DEP}=D_{EP}/K$ | | | | Difference of $d_{DEP}$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Japan, KEWT 1.07 | | The US, **KEWT** 1.07 | | Japan, SERI, GOJ | | The US, **BEA** | | Japan | The US |
| | Total | Gov. | Total | Gov. | Total | Gov. | Total | Gov. | Total | Total |
| 1960 | 0.0838 | 0.0838 | 0.0600 | 0.0222 | 0.0838 | 0.0150 | 0.0375 | 0.0417 | 0.0000 | (0.0225) |
| 1961 | 0.0883 | 0.0883 | 0.0600 | 0.0204 | 0.0883 | 0.0150 | 0.0372 | 0.0408 | 0.0000 | (0.0228) |
| 1962 | 0.0841 | 0.0841 | 0.0600 | 0.0189 | 0.0841 | 0.0150 | 0.0370 | 0.0395 | 0.0000 | (0.0230) |
| 1963 | 0.0867 | 0.0867 | 0.0600 | 0.0191 | 0.0867 | 0.0150 | 0.0376 | 0.0399 | 0.0000 | (0.0224) |
| 1964 | 0.0904 | 0.0904 | 0.0600 | 0.0177 | 0.0904 | 0.0150 | 0.0368 | 0.0388 | 0.0000 | (0.0232) |
| 1965 | 0.0907 | 0.0907 | 0.0600 | 0.0167 | 0.0907 | 0.0150 | 0.0368 | 0.0380 | 0.0000 | (0.0232) |
| 1966 | 0.1018 | 0.0930 | 0.0600 | 0.0169 | 0.1018 | 0.0150 | 0.0370 | 0.0369 | 0.0000 | (0.0230) |
| 1967 | 0.1044 | 0.0938 | 0.0600 | 0.0158 | 0.1044 | 0.0150 | 0.0371 | 0.0360 | 0.0000 | (0.0229) |
| 1968 | 0.1055 | 0.0948 | 0.0600 | 0.0149 | 0.1055 | 0.0150 | 0.0367 | 0.0355 | 0.0000 | (0.0233) |
| 1969 | 0.1046 | 0.0964 | 0.0600 | 0.0151 | 0.1111 | 0.0150 | 0.0373 | 0.0347 | 0.0065 | (0.0227) |
| 1970 | 0.1033 | 0.0280 | 0.0600 | 0.0143 | 0.1044 | 0.0154 | 0.0373 | 0.0327 | 0.0011 | (0.0227) |
| 1971 | 0.1002 | 0.0240 | 0.0600 | 0.0135 | 0.0992 | 0.0147 | 0.0364 | 0.0320 | (0.0010) | (0.0236) |
| 1972 | 0.1011 | 0.0208 | 0.0600 | 0.0136 | 0.0906 | 0.0131 | 0.0364 | 0.0309 | (0.0104) | (0.0236) |
| 1973 | 0.1024 | 0.0182 | 0.0600 | 0.0127 | 0.0778 | 0.0107 | 0.0354 | 0.0299 | (0.0245) | (0.0246) |
| 1974 | 0.0999 | 0.0171 | 0.0600 | 0.0138 | 0.0714 | 0.0099 | 0.0346 | 0.0301 | (0.0285) | (0.0254) |
| 1975 | 0.0912 | 0.0169 | 0.0600 | 0.0160 | 0.0681 | 0.0107 | 0.0370 | 0.0320 | (0.0231) | (0.0230) |
| 1976 | 0.0902 | 0.0166 | 0.0600 | 0.0162 | 0.0666 | 0.0107 | 0.0371 | 0.0287 | (0.0236) | (0.0229) |
| 1977 | 0.0886 | 0.0159 | 0.0600 | 0.0196 | 0.0672 | 0.0107 | 0.0371 | 0.0294 | (0.0214) | (0.0229) |
| 1978 | 0.0871 | 0.0154 | 0.0600 | 0.0208 | 0.0670 | 0.0109 | 0.0374 | 0.0308 | (0.0201) | (0.0226) |
| 1979 | 0.0843 | 0.0148 | 0.0600 | 0.0201 | 0.0630 | 0.0104 | 0.0371 | 0.0315 | (0.0212) | (0.0229) |
| 1980 | 0.0829 | 0.0150 | 0.0600 | 0.0204 | 0.0621 | 0.0109 | 0.0372 | 0.0311 | (0.0207) | (0.0228) |
| 1981 | 0.0793 | 0.0153 | 0.0625 | 0.0203 | 0.0617 | 0.0123 | 0.0382 | 0.0291 | (0.0176) | (0.0243) |
| 1982 | 0.0762 | 0.0146 | 0.0625 | 0.0207 | 0.0615 | 0.0113 | 0.0398 | 0.0294 | (0.0147) | (0.0227) |
| 1983 | 0.0750 | 0.0142 | 0.0600 | 0.0170 | 0.0629 | 0.0115 | 0.0401 | 0.0285 | (0.0120) | (0.0199) |
| 1984 | 0.0733 | 0.0137 | 0.0590 | 0.0151 | 0.0629 | 0.0114 | 0.0405 | 0.0312 | (0.0104) | (0.0185) |
| 1985 | 0.0731 | 0.0129 | 0.0590 | 0.0177 | 0.0645 | 0.0112 | 0.0413 | 0.0311 | (0.0085) | (0.0177) |
| 1986 | 0.0720 | 0.0123 | 0.0590 | 0.0182 | 0.0659 | 0.0111 | 0.0407 | 0.0304 | (0.0062) | (0.0183) |
| 1987 | 0.0709 | 0.0118 | 0.0590 | 0.0135 | 0.0657 | 0.0109 | 0.0407 | 0.0317 | (0.0052) | (0.0183) |
| 1988 | 0.0704 | 0.0112 | 0.0590 | 0.0156 | 0.0662 | 0.0106 | 0.0408 | 0.0325 | (0.0042) | (0.0182) |
| 1989 | 0.0731 | 0.0110 | 0.0590 | 0.0178 | 0.0673 | 0.0102 | 0.0416 | 0.0322 | (0.0058) | (0.0174) |
| 1990 | 0.0716 | 0.0257 | 0.0590 | 0.0260 | 0.0655 | 0.0094 | 0.0421 | 0.0332 | (0.0061) | (0.0169) |
| 1991 | 0.0723 | 0.0259 | 0.0590 | 0.0146 | 0.0665 | 0.0088 | 0.0437 | 0.0332 | (0.0058) | (0.0153) |
| 1992 | 0.0711 | 0.0272 | 0.0590 | 0.0138 | 0.0668 | 0.0088 | 0.0434 | 0.0322 | (0.0044) | (0.0156) |
| 1993 | 0.0774 | 0.0260 | 0.0588 | 0.0134 | 0.0739 | 0.0087 | 0.0426 | 0.0342 | (0.0034) | (0.0162) |
| 1994 | 0.0757 | 0.0262 | 0.0600 | 0.0126 | 0.0739 | 0.0088 | 0.0431 | 0.0346 | (0.0018) | (0.0169) |
| 1995 | 0.0746 | 0.0262 | 0.0605 | 0.0120 | 0.0743 | 0.0092 | 0.0433 | 0.0333 | (0.0003) | (0.0172) |
| 1996 | 0.0741 | 0.0320 | 0.0605 | 0.0115 | 0.0749 | 0.0389 | 0.0431 | 0.0337 | 0.0009 | (0.0174) |
| 1997 | 0.0729 | 0.0323 | 0.0606 | 0.0121 | 0.0746 | 0.0391 | 0.0434 | 0.0346 | 0.0017 | (0.0172) |
| 1998 | 0.0726 | 0.0318 | 0.0621 | 0.0120 | 0.0771 | 0.0399 | 0.0434 | 0.0365 | 0.0045 | (0.0186) |
| 1999 | 0.0703 | 0.0312 | 0.0631 | 0.0129 | 0.0773 | 0.0406 | 0.0436 | 0.0360 | 0.0070 | (0.0194) |
| 2000 | 0.0712 | 0.0309 | 0.0642 | 0.0142 | 0.0801 | 0.0411 | 0.0442 | 0.0361 | 0.0089 | (0.0200) |
| 2001 | 0.0702 | 0.0311 | 0.0654 | 0.0139 | 0.0816 | 0.0423 | 0.0450 | 0.0353 | 0.0114 | (0.0203) |
| 2002 | 0.0686 | 0.0313 | 0.0664 | 0.0129 | 0.0821 | 0.0435 | 0.0434 | 0.0331 | 0.0134 | (0.0230) |
| 2003 | 0.0716 | 0.0319 | 0.0660 | 0.0129 | 0.0861 | 0.0446 | 0.0425 | 0.0312 | 0.0145 | (0.0234) |
| 2004 | 0.0737 | 0.0328 | 0.0675 | 0.0129 | 0.0874 | 0.0451 | 0.0417 | 0.0296 | 0.0138 | (0.0258) |
| 2005 | 0.0730 | 0.0326 | 0.0687 | 0.0128 | 0.0869 | 0.0450 | 0.0431 | 0.0287 | 0.0139 | (0.0256) |

Note: The depreciation rate of KEWT, $D_{EP}/K$, is consistently connected with the KEWT system as s whole.

The difference of the depreciation rate comes from assets-removal and discrepancies for measuring net saving (see Table 11).

Data source: KEWT 1.07 and BEA, the US.

**Table A11 Differences of investment-based with saving-based in the US: KEWT versus BEA**

| | (*S-I*): **Current external** vs. *BOP* | | | **S** ←***ΔK***: Saving =(*S-I*) - ***ΔK*** | | | **ΔK**← ***S***: Net invest.=-((*S-I*) - ***S***) | | |
|---|---|---|---|---|---|---|---|---|---|
| | **KEWT** | BEA | difference | **KEWT** | BEA | difference | KEWT | **BEA** | difference |
| 1960 | 8 | 3 | 5 | 24 | 53 | (29) | 32 | 56 | 23 |
| 1961 | 10 | 4 | 5 | 27 | 53 | (26) | 36 | 57 | 21 |
| 1962 | 8 | 4 | 4 | 42 | 62 | (20) | 50 | 66 | 16 |
| 1963 | 9 | 5 | 4 | 43 | 66 | (22) | 53 | 71 | 18 |
| 1964 | 13 | 8 | 5 | 50 | 71 | (21) | 63 | 78 | 16 |
| 1965 | 4 | 6 | (2) | 70 | 83 | (13) | 74 | 89 | 15 |
| 1966 | 2 | 4 | (2) | 95 | 89 | 6 | 97 | 93 | (4) |
| 1967 | 2 | 4 | (2) | 110 | 85 | 25 | 112 | 89 | (23) |
| 1968 | (1) | 2 | (3) | 130 | 92 | 38 | 129 | 94 | (35) |
| 1969 | (1) | 2 | (3) | 148 | 99 | 50 | 147 | 100 | (47) |
| 1970 | 1 | 4 | (3) | 155 | 82 | 73 | 156 | 86 | (70) |
| 1971 | (3) | 1 | (4) | 163 | 93 | 70 | 160 | 94 | (66) |
| 1972 | (8) | (4) | (4) | 200 | 115 | 85 | 192 | 111 | (81) |
| 1973 | 1 | 9 | (9) | 200 | 143 | 57 | 201 | 153 | (48) |
| 1974 | (3) | 7 | (10) | 365 | 132 | 233 | 362 | 139 | (223) |
| 1975 | 14 | 21 | (8) | 435 | 88 | 347 | 449 | 109 | (339) |
| 1976 | (2) | 9 | (11) | 302 | 128 | 174 | 299 | 137 | (162) |
| 1977 | (24) | (9) | (15) | 377 | 177 | 200 | 353 | 168 | (185) |
| 1978 | (26) | (10) | (16) | 498 | 226 | 272 | 472 | 216 | (257) |
| 1979 | (24) | 1 | (25) | 648 | 235 | 413 | 624 | 237 | (388) |
| 1980 | (15) | 11 | (26) | 747 | 195 | 552 | 732 | 207 | (525) |
| 1981 | (15) | 6 | (21) | 563 | 260 | 303 | 549 | 267 | (282) |
| 1982 | (21) | (0) | (20) | 667 | 202 | 465 | 647 | 202 | (444) |
| 1983 | (51) | (32) | (19) | 618 | 198 | 420 | 566 | 166 | (401) |
| 1984 | (103) | (87) | (16) | 575 | 388 | 187 | 472 | 301 | (171) |
| 1985 | (116) | (111) | (5) | 578 | 372 | 206 | 462 | 261 | (202) |
| 1986 | (133) | (139) | 7 | 595 | 341 | 254 | 462 | 202 | (260) |
| 1987 | (143) | (151) | 8 | 585 | 386 | 199 | 442 | 235 | (207) |
| 1988 | (108) | (112) | 4 | 700 | 430 | 270 | 592 | 317 | (275) |
| 1989 | (80) | (88) | 9 | 844 | 389 | 455 | 764 | 300 | (464) |
| 1990 | (69) | (70) | 1 | 578 | 328 | 250 | 509 | 258 | (251) |
| 1991 | (20) | 14 | (33) | 622 | 225 | 397 | 602 | 238 | (364) |
| 1992 | (30) | (37) | 7 | 669 | 233 | 436 | 639 | 196 | (443) |
| 1993 | (65) | (70) | 5 | 476 | 256 | 219 | 411 | 186 | (225) |
| 1994 | (94) | (105) | 12 | 510 | 342 | 168 | 417 | 237 | (180) |
| 1995 | (91) | (91) | (0) | 736 | 397 | 339 | 645 | 306 | (338) |
| 1996 | (96) | (100) | 4 | 736 | 473 | 262 | 639 | 373 | (266) |
| 1997 | (102) | (110) | 9 | 697 | 597 | 100 | 595 | 487 | (109) |
| 1998 | (160) | (87) | (73) | 575 | 656 | (81) | 415 | 569 | 153 |
| 1999 | (261) | (274) | 13 | 684 | 847 | (163) | 423 | 573 | 150 |
| 2000 | (380) | (397) | 17 | 780 | 979 | (199) | 401 | 583 | 182 |
| 2001 | (367) | (370) | 3 | 660 | 747 | (87) | 292 | 376 | 84 |
| 2002 | (424) | (458) | 34 | 690 | 655 | 35 | 266 | 197 | (69) |
| 2003 | (501) | (512) | 11 | 875 | 635 | 240 | 374 | 123 | (252) |
| 2004 | (624) | (649) | 25 | 1017 | 757 | 260 | 393 | 108 | (285) |
| 2005 | (727) | (771) | 45 | 1130 | 779 | 351 | 404 | 7 | (396) |

Note: I use the data of IMF as a base for commparison as many as posible. I organize KEWT and obtain net saving.

For the US, BEA publishes both net saving and net investment in B-32. However, capital estimation is another issue.

Data source: KEWT 1.07 and BEA, the US.

# Appendix

This appendix shows equations of three specific parameters, *beta*, *delta*, and *lambda* and main variables, after summarizing basic accounting identities in the framework and the wage function to consumption derived from utility/preference concept at the macro level (for processes to each equation, see Kamiryo (2007c, 2008c)). Saving and investment are shown by 'net' ('gross' less depreciation).

(1) $Y=(C+S)=(C_G+S_G)+(C_{PRI}+S_{PRI})$ or,

$Y=(W+\Pi)=(W_G+\Pi_G)+(W_{PRI}+\Pi_{PRI})$.

(2) $(S-I)=(S_G-I_G)+(S_{PRI}-I_{PRI})$, where

$(S-I)$ is the *BOP* or the current external balance, $(S_G-I_G)$ is budget surplus/deficit, and $(S_{PRI}-I_{PRI})$ is the difference between saving and investment of the private sector.

(3) $Y_G=W_G+\Pi_G=C_G+S_G$ under $(rho/r)_G=1$.

$S_G-I_G=T_{AX}-(C_G+I_G)$ and $T_{AX}=C_G+S_G$.

By introducing the concept of instantaneous utility by Cass David (1964, 4–5), $C=U(C)$, the theoretical wage function of consumption/utility is obtained:

$$U(C)=C/rho=\sum_{t=0}^{\infty}\frac{C}{(1+rho)} \text{ and } U(W)=W/r=\sum_{t=0}^{\infty}\frac{W}{(1+r)}, \text{ where } U(C)=U(W) \text{ holds.}$$

(4) $1-\alpha=c/(rho/r)$,

where $1-\alpha=W/Y$ and $c=C/Y$. The present value of $U(C)$ or $U(W)$ is social welfare as a stock.

Next, *beta* is the ratio of quantitative investment to total investment, 1 − *beta* is the qualitative investment to total investment, *delta* is the parameter that neutralizes diminishing returns to capital in the transitional path, *lambda* is the convergence coefficient, and 1 / *lambda* is the speed of convergence. The *beta*$^*$ is measured by setting the growth rate of per capita capital including $i_K^*=i\cdot\beta^*$ to be equal to the growth rate of per capita output that includes $i_A^*=i(1-\beta^*)$. The ratio of investment to output, *i*, is fixed at the initial/current situation in the transitional path: $i=i_A^*+i_K^*$.

Set $g_k^*=\frac{1}{1+n}\left(\frac{i_K^*}{\Omega^*}-n\right)$ equals $g_k^*=g_y^*=\frac{i_A^*}{(1-\alpha)}$ (as in Solow (1956)), where $A^*\cdot k^{*\alpha-1}$ is replaced by $1/\Omega^*$.[21) ] Thus, $\Omega^* = \dfrac{i_K^*}{i_A^*(1+n)/(1-\alpha)+n}$ or $\Omega^* = \dfrac{\beta^* \cdot i\ (1-\alpha)}{i\,(1-\beta^*)(1+n)+n(1-\alpha)}$ is obtained.

As a result,

(5-1) $\beta^* = \dfrac{\Omega^*\left(n(1-\alpha)+i\ (1+n)\right)}{i\,(1-\alpha)+\Omega^* \cdot i\,(1+n)}$ at convergence.

(5-2) $\beta(0) = \dfrac{\Omega(0)\left(n(1-\alpha)k(0)^{0-\alpha}+i\ (1+n)\right)}{i\,(1-\alpha)k(0)^{0-\alpha}+\Omega(0)\cdot i\,(1+n)}$ at the current situation.

(5-3) $1-\beta^* = \dfrac{i\,(1-\alpha)+i\,\Omega^*(1+n)-\Omega^*\left(n(1-\alpha)+i\,(1+n)\right)}{i\,(1-\alpha)+i\,\Omega^*(1+n)}$ at convergence.

(5-4) $B^* \equiv \dfrac{1-\beta^*}{\beta^*} = \dfrac{i\,(1-\alpha)+i\cdot\Omega^*(1+n)-\Omega^*\left(n(1-\alpha)+i\,(1+n)\right)}{\Omega^*\left(n\,(1-\alpha)+i\,(1+n)\right)}$ at convergence.

Set total factor productivity, $TFP(t) \equiv B_{TFP(1-\delta,1-\alpha)}(t)^{1-\delta(t)} \cdot k(t)^{1-\alpha}$.

To measure *delta*, assume $TFP(t) \equiv B_{TFP(1-\delta,1-\alpha)}(t)^{1-\delta(t)} \cdot k(t)^{1-\delta(t)}$. Then,

(6-1) $\delta(0) = 1-\dfrac{LN(1/\Omega(0))}{LN(B^*)}$ at the current situation,

where $\delta(t)-\alpha$ converges to $0=\alpha-\alpha$ at convergence and $k^*=1=k^{*0}$.

(6-2) $\Omega^* = 1/B^{*(1-\alpha)}$ at the current situation,

where $\Omega^*$ is newly used, by eliminating the assumption of $\Omega(0)=\Omega^*$ (see Figure 8).

(7) $\lambda = (1-\alpha)n+(1-\delta)g_A^*$ and the speed of convergence is $1/\lambda$.

The above endogenous convergence coefficient, λ, reduces to the exogenous one if *delta* is replaced by *alpha*: $\lambda = (1-\alpha)(n+g_A^*)$ is comparable to $\beta=(1-\alpha)(n+x)$ in Sala-i-Martin (1990a, b). "Quantitative Aspects of Post-War European Economic Growth" edited by van Ark, Bart, and Nicholas Crafts (1996) shows several good researches for the speed of convergence in the EU countries based on Sala-i-Martin (ibid.), one of which is Javier Andres, Rafael Doménech and César Molinas (ibid., pp. 347–387). However, these empirical researches use econometric approaches. This is because there has been found no endogenous equation and data for the speed of convergence in the literature.

For the rate of technological progress and the growth rate of output, as the author touched in formulating *beta* above,

(8) The rate of technological progress, $i_A^* = i\,(1-\beta^*)$ at convergence.

21) $1/\Omega^* = k^{*1-\alpha}\cdot k^{*\alpha-1}/\Omega^* = A^*\cdot k^{*\alpha-1}$, where $\Omega(0)=\Omega^*$ is assumed. This assumption is needed to avoid a circle argument between $\beta^*$ and $\Omega^*$.

(9) The growth rate of output/capital, $g_K^* = g_Y^* = \frac{i_A^*(1+n)}{(1-\alpha)} + n$ at convergence.

(10) The rate of return, $r^* = \frac{\alpha}{\Omega^*} = \frac{i\,(1-\beta^*)(1+n)+n(1-\alpha)}{\beta^* \cdot i\ (1-\alpha)}$ at convergence.

By using Eqs. 9 and 10 (confer Schreyer Paul (2004)),

(11) The technology-golden rule, $g_Y^* = \left(\frac{i \cdot \beta^*}{\alpha}\right) \cdot r^*$.

(12) The cost of capital, $r^* - g_Y^* = g_Y^* \left(\frac{\alpha}{i \cdot \beta^*} - 1\right)$.

(13) The valuation ratio, $v_K \equiv V^* / K$, $v_K \equiv \frac{r^*}{r^* - g_Y^*}$, and $v_K = \frac{\alpha}{\alpha - i \cdot \beta^*}$.

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