# Chapter 15

## Population Growth Negatively Related to Technology and Its Growth

Signpost to Chapter 15

This Chapter states one lucky discovery that the less the rate of change in population the more the rate of technological progress in the endogenous-equilibrium. For example, if an annual growth rate of population of a country is beyond 3%, it is difficult for the country to maintain endogenous equilibrium moderately and sustainably. Adversely, even if an annual growth rate of population of a country is minus 0.5%, it is all right for the country to maintain endogenous equilibrium moderately and sustainably. This discovery commonly works in developing and developed countries. This discovery simultaneously realizes stop-macro inequality since the level of the relative share of capital is indifferent from inequality. This discovery eventually follows the law of the Nature. This discovery is cyclical and peaceful with limited resources of the Earth, because the rate of technological progress is essentially accelerated by limited resources.

Now the time has come when everlasting green technological progress becomes at the best. For us green cyclical economics are most welcome. The endogenous system ever starts with the rate of technological progress. Now we preserve and enjoy an endogenous rate of technological progress with mankind, animals, and plants on this universe Earth. The rate of technological progress is endowed with pure quality. Yet it is possible for the same level of quality to exist at different levels of spirituality, transiting from money and expansion to love Nature, people, and animals and plants.

Recall, in Chapter 1, BOX 1-3 'Cross-Roads Scientific Discovery (C-RSD) Diagram: positioning of natural, social, and behavioral sciences on a two dimensional topology.' We remain a fixed level of spirituality. The *EES*, for the sake of finding scientific discoveries, stays at the same level of spirituality. Within the current fixed level of spirituality, we are now embracing love Nature, people, and animals and plants. People have already stepped into various natural fields and sciences. People, leaders, and policy-makers, as a result, recover calm spirit with our lucky discovery of Chapter 15 as a highlight of the *EES*.

### 15.1 Introduction: Endogenous Framework of Population to Technology

This chapter challenges for an unsolved problem lying between population and technological progress. Theoretical and empirical proofs are reinforced by hyperbolas at the end. Chapter 14 challenged for 'sin' business cycle by sector, with capital (stock) and the ratio of net investment to output (flow), $i = I/Y$. Chapter 15 simulates population (stock) and the rate of change in population (flow), $n_E = n$, and revisits a few memorial papers. Technological progress, using stock and flow, is measured by the growth rate of total factor productivity (*TFP*, stock), $g^*_{TFP}$, and the rate of technological progress (flow), $g^*_A = i(1-\beta^*)$. For $g^*_{TFP}$, see Chapter 6 that simultaneously measures capital stock and its rate of return. The rate of technological progress is related to the growth rates of per capita output and output, commonly to the literature.

This chapter spreads population-simulation as a means. Simulates different arbitrary levels of net investment and gets resultant population levels, here apart from the data measured at the endogenous-equilibrium. An idea of 'Plans' is set up. The author sets Plans by length of periods, 10, 20, and 50 years, and calculates each discount rate of population by arbitrary net investment level. Notation is the same for (i) the (endogenous) rate of change in population, $n_E = n$, under the endogenous-equilibrium and for (ii) an arbitrary discount rate used for simulation, $n_E = n$. Only difference is the length of periods: (i), infinite versus (ii), finite, 10, 20, and 50 years. [1]

The idea of Plans was born with two incentives: First; there is no definite answer to population and technology in the literature. Second; Shanghai City now plans to build a green economy at Island Zhangjim, 張江. This island faces to Shanghai, which has 20 million residents. Shanghai government experiments a 'green economy area' on this Island. The project starts in 2012. A problem remains: Whether it is endogenously acceptable or not for the island to rapidly raise population from the current 50 thousands up to 250 thousands by 2022. The level of green economy is characterized by the Earth, mankind, and high philosophy of Island. The author hears that Jianxiong Wang is responsible for cyclical eco-oriented work. Thus the author has experimented population-simulations using KEWT database 6.12, 1990-2010 (for some results, see Special Note to Jianxiong, at the end of this Chapter).

## 15.2 Simulation Results of the Rate of Change in Population, from the Viewpoint of Whole Policies

This section presents simulation results of the change in population on growth and returns under the endogenous-equilibrium. The rate of change in population is one of the most fundamental ratios in the endogenous system. Maddison, A. (in particular, 1987,

[1] A fixed discount rate is originally used in an infinite time as $\sum_{n=1}^{\infty}(1+r)^{-n} = 1/r$. For example, the endogenous-system, based on Samuelson's (155-161, 1937) utility idea, measures a rate of return endogenously instead of an external rate of interest. It is justified for a policy-maker to measure the relative discount rate of consumer goods to capital goods, *rho/r*, as a preferences function of the propensity to consume, $c = C/Y$, where $(rho/r)$ indicates national taste/preferences/culture: $(rho/r)(c)$ and $(rho/r) = 13.301c^2 - 22.608c + 10.566$. This is because technology and national taste/ preferences/culture are favorably integrated at the endogenous-system.

1991, 1995, and 1996) historically clarified the importance between the rate of change in population and *GDP*. Before starting, the author needs to clarify the relationship between the rate of change in population and the discount rate used for population-simulation. The relationship is indispensable for the framework of population and technology. The rate of change in population is denoted as $n_E$. The growth rate of population in statistics is denoted as $n = (L_t - L_{t-1})/L_{t-1}$. KEWT 6.12 sets $n_E = n$. $n_E = n$ implies that there exists no unemployment because the rate of unemployment is endogenously zero under a condition of $n_E = n$.

The discount rate holds with a sufficient condition that a simulated rate of net investment to output is free from the rate of net investment to output endogenously measured at the endogenous-system. As a result, we are able to freely compare respective values of variables by $i = I/Y$. The discount rate also holds with a necessary condition that guarantees $n_E = n$ at population-simulation. Thus, the discount rate is defined as a rate of change in population that guarantees full-employment, $n_E = n$, each for three Plans; 10, 20, and 50 periods/years.

**BOX 15-1** shows simulation results, with related **Figure P1**, and **Tables P1** to **P3**.

**BOX 15-1** Endogenous results of simulation by population-change, using China data-sets in KEWT

| Simulation | $i=I/Y$ | $n$ | $\alpha$ | $\Omega$ | $\beta^*$ | $B^*=(1-\beta^*)/\beta^*$ | $\delta_0$ | $g_A^*=i(1-\beta^*)$ | $1/\lambda^*$ | $g_y^*$ | $r^*=\alpha/\Omega$ | $g_Y^*=r^*/x$ | $v^*=V^*/K$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **China T** | 0.53 | 0.00617 | 0.54 | 3.17 | 0.8793 | 0.137 | 0.4187 | 0.0645 | **24.81** | 0.1411 | 0.1712 | 0.1481 | 7.42 |
| Case 1 | 0.20 | 0.17462 | 0.20 | 2.00 | 1.18956 | (0.159) | #NUM! | (0.0379) | **#NUM!** | (0.0474) | 0.1000 | 0.1190 | (5.28) |
| Case 2 | 0.20 | 0.09596 | 0.20 | 2.00 | 0.98919 | 0.011 | 0.8465 | 0.0022 | **12.97** | 0.0027 | 0.1000 | 0.0989 | 92.52 |
| Case 3 | 0.20 | **0.05241** | 0.20 | 2.00 | 0.86893 | 0.151 | 0.6336 | 0.0262 | **19.40** | 0.0328 | 0.1000 | **0.0869** | 7.63 |
| Case 4 | 0.20 | **0.02257** | 0.20 | 2.00 | 0.78227 | 0.278 | 0.4580 | 0.0435 | **24.01** | 0.0544 | 0.1000 | **0.0782** | 4.59 |
| Case 5 | 0.20 | 0.17462 | 0.25 | 2.00 | 1.18057 | (0.153) | #NUM! | (0.0361) | **#NUM!** | (0.0482) | 0.1250 | 0.1181 | 18.01 |
| Case 6 | 0.20 | 0.09596 | 0.25 | 2.00 | 0.98970 | 0.010 | 0.8482 | 0.0021 | **13.83** | 0.0027 | 0.1250 | 0.0990 | 4.80 |
| Case 7 | 0.20 | **0.05241** | 0.25 | 2.00 | 0.87497 | 0.143 | 0.6437 | 0.0250 | **20.74** | 0.0333 | 0.1250 | **0.0875** | 3.33 |
| Case 8 | 0.20 | **0.02257** | 0.25 | 2.00 | 0.79222 | 0.262 | 0.4821 | 0.0416 | **26.01** | 0.0554 | 0.1250 | **0.0792** | 2.73 |
| Case 1-2 | 0.20 | 0.17462 | 0.20 | 1.50 | 1.09669 | (0.088) | #NUM! | (0.0193) | **#NUM!** | (0.0242) | 0.1333 | 0.1462 | (10.34) |
| Case 2-2 | 0.20 | 0.09596 | 0.20 | 1.50 | 0.90824 | 0.101 | 0.8231 | 0.0184 | **12.50** | 0.0229 | 0.1333 | 0.1211 | 10.90 |
| Case 3-2 | 0.20 | **0.05241** | 0.20 | 1.50 | 0.79587 | 0.256 | 0.7020 | 0.0408 | **18.49** | 0.0510 | 0.1333 | **0.1061** | 4.90 |
| Case 4-2 | 0.20 | **0.02257** | 0.20 | 1.50 | 0.71523 | 0.398 | 0.5597 | 0.0570 | **23.19** | 0.0712 | 0.1333 | **0.0954** | 3.51 |
| Case 5-2 | 0.20 | 0.17462 | 0.25 | 2.50 | 1.24062 | (0.194) | #NUM! | (0.0481) | **#NUM!** | (0.0642) | 0.1000 | 0.0992 | 133.26 |
| Case 6-2 | 0.20 | 0.09596 | 0.25 | 2.50 | 1.04287 | (0.041) | #NUM! | (0.0086) | **#NUM!** | (0.0114) | 0.1000 | 0.0834 | 6.03 |
| Case 7-2 | 0.20 | **0.05241** | 0.25 | 2.50 | 0.92350 | 0.083 | 0.6321 | 0.0153 | **22.25** | 0.0204 | 0.1000 | **0.0739** | 3.83 |
| Case 8-2 | 0.20 | **0.02257** | 0.25 | 2.50 | 0.83715 | 0.195 | 0.4403 | 0.0326 | **28.45** | 0.0434 | 0.1000 | **0.0670** | 3.03 |
| KEWT6.12 | $i=I/Y$ | $n$ | $\alpha$ | $\Omega$ | $\beta^*$ | $B^*=(1-\beta^*)/\beta^*$ | $\delta_0$ | $g_A^*=i(1-\beta^*)$ | $1/\lambda^*$ | $g_y^*$ | $r^*=\alpha/\Omega$ | $g_Y^*=r^*/x$ | $v^*=V^*/K$ |
| Japan, 2010 | 0.05 | **(0.00126)** | 0.10 | 3.69 | 0.7837 | 0.276 | (0.0138) | 0.0103 | **107.87** | 0.0114 | 0.0261 | 0.0101 | 1.63 |
| the US, 201 | 0.02 | **0.00947** | 0.21 | 2.00 | 0.9386 | 0.065 | 0.7462 | 0.0015 | **126.96** | 0.0019 | 0.1042 | 0.0114 | 1.12 |
| China, 2010 | 0.53 | **0.00617** | 0.54 | 3.17 | 0.8793 | 0.137 | 0.4187 | 0.0645 | **24.81** | 0.1411 | 0.1712 | 0.1481 | 7.42 |
| India, 2010 | 0.22 | **0.01374** | 0.20 | 1.60 | 0.7023 | 0.424 | 0.4513 | 0.0644 | **21.56** | 0.0800 | 0.1219 | 0.0949 | 4.50 |

**Note 1:** For the above simulation, the discount rate of Cases 1 to 8 and 1-2 to 8-2 were tested. The followings are selected moderate cases:

**Note 2:** The rate of change in population presents a base for any whole policies by area. The above simulations roughly suggest that the rate of change in population should be less than 5.0%; or more moderately, 2.25%. If the rate of change in population is too high, the endogenous- equilibrium is broken at any country (see the speed years, $1/\lambda^*$, shown by bold in the above BOX 15-1).

| base | Periods | i=I/Y | n | α | Ω |
|---|---|---|---|---|---|
| | **10yrs** | | | | |
| Case 3 & 4 | Plan 10 | 0.20 | 0.05241 fixed | 0.20 | 1.50 |
| | Plan 10-2 | 0.20 | 0.05242→0 | 0.20 | 1.50 |
| | Plan 10-3 | 0.20 | 0→0.05242 | 0.20 | 1.50 |
| | **20 yrs** | | | | |
| Case 3 & 4 | Plan 20 | 0.20 | 0.05241 fixed | 0.20 | 1.50 |
| | Plan 20-2 | 0.20 | 0.05242→0 | 0.20 | 1.50 |
| | Plan 20-3 | 0.20 | 0→0.05242 | 0.20 | 1.50 |
| | **50yrs** | | | | |
| Case 7 & 8 | Plan 50 | 0.20 | Min at 25yrs | 0.25 | 2.50 |
| | Plan 50-2 | 0.20 | 0.02257 fixed | 0.25 | 2.50 |
| | Plan 50-3 | 0.20 | Max at 25yrs | 0.25 | 2.50 |

After deleting unstable Case 1 (n=0.17463) & Case 2 (n=0.09596).

**Note 3:** Seven endogenous parameters determine all the parameters and variables simultaneously using the discrete Cobb-Douglas production function under constant returns to scale. Seven endogenous parameters are: the ratio of net investment to output, $i = I/Y$; the rate of change in population, $n_E = n$; the relative share of capital, $\alpha = \Pi/Y$; the capital-output ratio, $\Omega = K/Y$; the technology coefficient or the qualitative/quantitative net investment coefficient, $\beta^*$; the diminishing returns to capital coefficient, $\delta_0$. (For each equation, see Notations at the beginning of the *EES*). The above simulations, each time, set $i = I/Y$, $n_E = n$, and $\alpha = \Pi/Y$ fixed.

**Data source:** KEWT 6.12 of 81 countries by sector, 1990-2010, whose ten original data for the real assets come from *International Financial Statistics Yearbook*, IMF.

Now look at **Tables P1, P2,** and **P3** and confirm simulation results numerically in these tables, in particular, the valuation ration, by sector.

1. Changes in population, implicitly and explicitly and, in the long run, influence the execution of policy-makers by country.
2. Each country has its own characteristics in whole economic policies to real, financial, market, and the central bank.
3. Policy-makers' efforts are respectable by year, cooperating national taste, preferences, culture, and even civilization. The author accepts their sincere efforts over years, beyond description. Results reflect philosophy of leaders and policy-makers.
4. What is a simple litmus paper to their efforts and prompt execution of policies? This is the balance between the government sector and the private sector, as well as the balance between actual/statistics data and endogenous data.
5. The above balances must be moderate or within a controllability of leaders and policy-makers.
6. Democracy is not the best but the second political system. Democracy needs immediate openness and publication, as advocated by Kant. People must be interested in country's future and responsible for next generations, each by each and cooperatively.

**BOX 15-2** Summing up: three discount rates, increasing, fixed, and decreasing, to control periods under the rate of change in population

1. Periods: 50 years. 50 years are divided into three periods: The first 20 years, constant 10 years, and the third 20 years.

2. The rate of change in population, $n_E = n$:

Cases 10 and 20, 0.05241, each fixed by year. Case 10-2; decreasing, set from 0.05241 to 0.00591 for 10 years. Case 20-2; decreasing, set from 0.05241 to 0.00510 for 20 years. Cases 10-3; increasing, set from 0.00591 to 0.05221 for 10 years. Case 20-3; increasing, set from 0.005 to 0.05262 for 20 years.

Case 50; set 0.02257 fixed, by year and for 50 years.

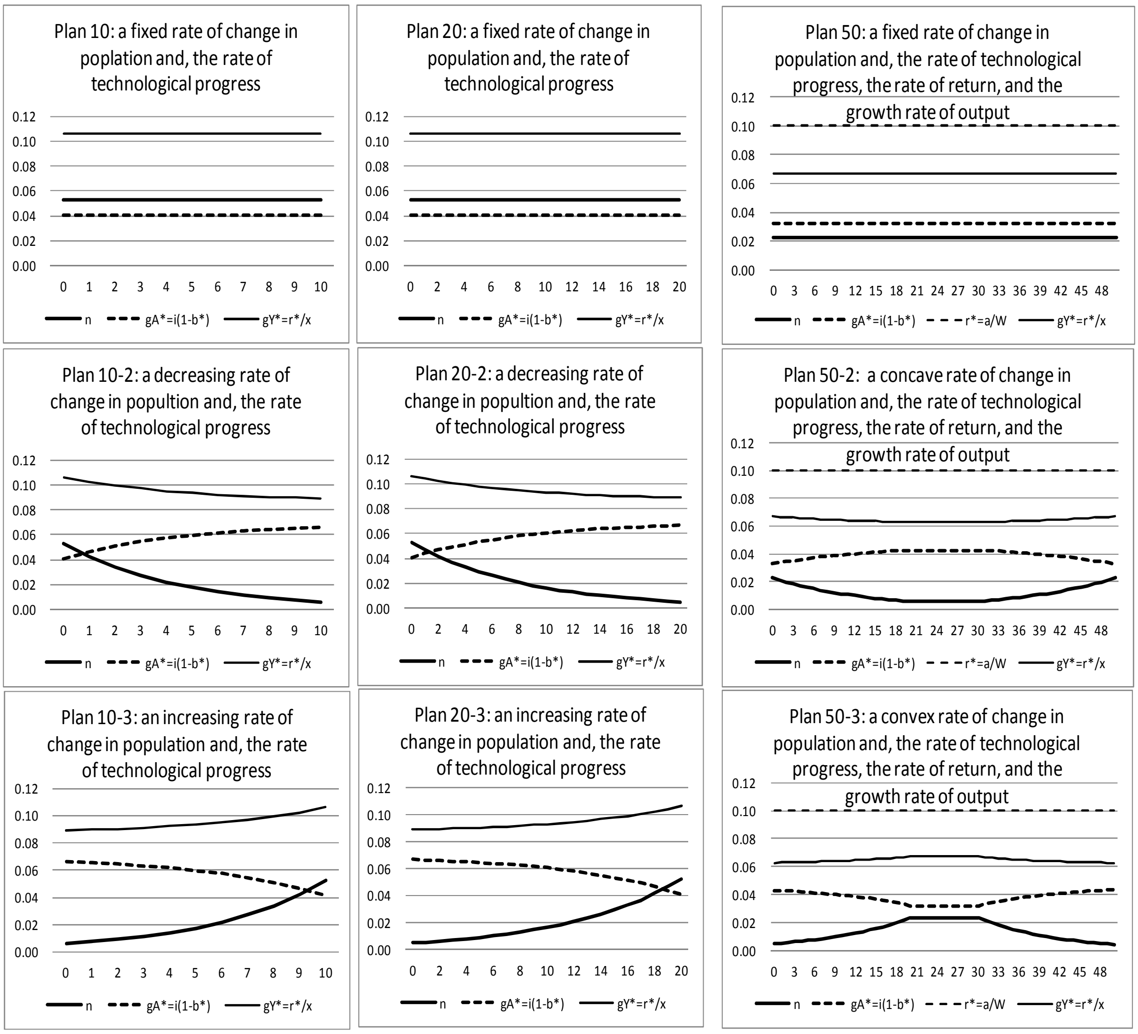
Case 50-2 concave; set from 0.02257 to 0.00569 for the first 20 years; set 0.00568 for 10 years; and set from 0.00568 to 0.02265 for the third 20 years.

Case 50-3, convex; set from 0.005 to 0.02330 for the first 20 years; set 0.02330 for 10 years; and set from 0.02330 to 0.00440 for the third 20 years.
Minimum is 0.00617; average is 0.02257; maximum is 0.05241.

3. For the discount rate: Cases 10, 20, and 50; the discount rate is *constant* over years, no estimation needed. Case 10-2, 0.1960967 estimated; Case 10-3, 0.2434174 estimated. Case 20-2, 0.11 estimated; Case 20-3, 0.1247788 estimated. Case 50-2, 0.0666137 estimated; Case 50-3, 0.08 estimated.

4. Four common ratios for simulations: $i = I/Y$; the rate of change in population, $n_E = n$; the relative share of capital, $\alpha = \Omega^* \cdot r^*$; and the capital-output ratio, $\Omega^* = K/Y$. BOX 15-1 uses changes in $n_E = n$, as shown at the above 1.

5. Ratios drawn from BOX 15-1: $n_E = n$ and; $g^*_{A(FLOW)} = i(1-\beta^*)$, $r^* = \alpha/\Omega^*$, and $g^*_Y$. These items, for comparison, are summarized at Tables P1, P2, and P3, by sector (the total economy, the government sector, and the private sector).




**Note:** Periods of each Plan are 10, 20, and 50 years, respectively. The lower the rate of change in population, the higher the rate of technological progress is. Plan 50 uses a fixed rate of change in population, $n = (L_t - L_{t-1})/L_{t-1}$; Plan 50-2, based on a concave rate of change in population; Plan 50-3, based on a convex rate of change in population. Simulation of three Plans was set consistently with data source below. Three Plans are connected with those for net investment embodiment in Chapter 14.

**Data source:** KEWT 6.12 of 81 countries by sector, 1990-2010, where 10 original data of the real assets and 15 original data, each from *International Financial Statistics Yearbook*, IMF.

**Figure P1** Population changes, negatively related to technology and growth

**Table P1** Plan 50-T: By the rate of change in population, negatively related to technology and growth; using Japan, the US, China, and India, at the total economy

| Simulation | $i=I/Y$ | $n$ | $\alpha$ | $\Omega$ | $\beta^*$ | $B^*=(1-\beta^*)/[$ | $\delta_0$ | $g_A^*=i(1-\beta^*)$ | $1/\lambda^*$ | $r^*=\alpha/\Omega$ | $x=\alpha/(i\cdot\beta^*)$ | $g_Y^*=r^*/x$ | $v^*=r^*/(r^*-g_Y$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Japan T** | 0.0475 | **(0.00126)** | 0.0962 | 3.6885 | 0.7837 | 0.276 | (0.0138) | 0.0103 | 107.87 | 0.0261 | 2.58 | 0.0101 | 1.63 |
| Case 1 | 0.0475 | **(0.00500)** | 0.0962 | 3.6885 | 0.7256 | 0.378 | (0.3421) | 0.0130 | 77.15 | 0.0261 | 2.79 | 0.0093 | 1.56 |
| Case 2 | 0.0475 | **0.00000** | 0.0962 | 3.6885 | 0.8032 | 0.245 | 0.0719 | 0.0093 | 115.32 | 0.0261 | 2.52 | 0.0103 | 1.66 |
| Case 3 | 0.0475 | **0.00500** | 0.0962 | 3.6885 | 0.8801 | 0.136 | 0.3453 | 0.0057 | 121.29 | 0.0261 | 2.30 | 0.0113 | 1.77 |
| Case 4 | 0.0475 | **0.01000** | 0.0962 | 3.6885 | 0.9565 | 0.046 | 0.5775 | 0.0021 | 100.89 | 0.0261 | 2.12 | 0.0123 | 1.89 |
| | | | | | | | | | | | | | |
| **the US T** | 0.0242 | **0.00947** | 0.2081 | 1.9974 | 0.9386 | 0.065 | 0.7462 | 0.0015 | **126.96** | 0.1042 | 9.17 | 0.0114 | 1.12 |
| Case 1 | 0.0242 | **(0.00500)** | 0.2081 | 1.9974 | 0.5974 | 0.674 | (0.7524) | 0.0097 | 76.32 | 0.1042 | 14.41 | 0.0072 | 1.07 |
| Case 2 | 0.0242 | **0.00000** | 0.2081 | 1.9974 | 0.7161 | 0.396 | 0.2522 | 0.0069 | 194.77 | 0.1042 | 12.02 | 0.0087 | 1.09 |
| Case 3 | 0.0242 | **0.00500** | 0.2081 | 1.9974 | 0.8339 | 0.199 | 0.5713 | 0.0040 | 176.02 | 0.1042 | 10.32 | 0.0101 | 1.11 |
| Case 4 | 0.0242 | **0.01000** | 0.2081 | 1.9974 | 0.9509 | 0.052 | 0.7666 | 0.0012 | 122.02 | 0.1042 | 9.05 | 0.0115 | 1.12 |
| | | | | | | | | | | | | | |
| **China T** | 0.5341 | **0.00617** | 0.5428 | 3.1712 | 0.8793 | 0.137 | 0.4187 | 0.0645 | **24.81** | 0.1712 | 1.16 | 0.1481 | 7.42 |
| Case 1 | 0.5341 | **(0.00500)** | 0.5428 | 3.1712 | 0.8697 | 0.150 | 0.3920 | 0.0696 | 24.98 | 0.1712 | 1.17 | 0.1465 | 6.94 |
| Case 2 | 0.5341 | **0.00000** | 0.5428 | 3.1712 | 0.8740 | 0.144 | 0.4041 | 0.0673 | 24.93 | 0.1712 | 1.16 | 0.1472 | 7.15 |
| Case 3 | 0.5341 | **0.00500** | 0.5428 | 3.1712 | 0.8783 | 0.139 | 0.4160 | 0.0650 | 24.84 | 0.1712 | 1.16 | 0.1479 | 7.37 |
| Case 4 | 0.5341 | **0.01000** | 0.5428 | 3.1712 | 0.8825 | 0.133 | 0.4276 | 0.0628 | 24.69 | 0.1712 | 1.15 | 0.1486 | 7.60 |
| | | | | | | | | | | | | | |
| **India T** | 0.2163 | **0.01374** | 0.1953 | 1.6014 | 0.7023 | 0.424 | 0.4513 | 0.0644 | **21.56** | 0.1219 | 1.29 | 0.0949 | 4.50 |
| Case 1 | 0.2163 | **(0.00500)** | 0.0962 | 1.6014 | 0.6247 | 0.601 | 0.0756 | 0.0812 | 14.18 | 0.0601 | 0.71 | 0.0844 | (2.47) |
| Case 2 | 0.2163 | **0.00000** | 0.0962 | 1.6014 | 0.6392 | 0.564 | 0.1768 | 0.0780 | 15.57 | 0.0601 | 0.70 | 0.0863 | (2.28) |
| Case 3 | 0.2163 | **0.00500** | 0.0962 | 1.6014 | 0.6537 | 0.530 | 0.2588 | 0.0749 | 16.65 | 0.0601 | 0.68 | 0.0883 | (2.13) |
| Case 4 | 0.2163 | **0.01000** | 0.0962 | 1.6014 | 0.6681 | 0.497 | 0.3267 | 0.0718 | 17.43 | 0.0601 | 0.67 | 0.0902 | (1.99) |

| Simulation | $i=I/Y$ | $n$ | $\alpha$ | $\Omega$ | $\beta^*$ | $B^*=(1-\beta^*)/[$ | $\delta_0$ | $g_A^*=i(1-\beta^*)$ | $1/\lambda^*$ | $r^*=\alpha/\Omega$ | $x=\alpha/(i\cdot\beta^*)$ | $g_Y^*=r^*/x$ | $v^*=r^*/(r^*-g_Y$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Japan T** | 0.0475 | **(0.00126)** | 0.0962 | 3.6885 | 0.7837 | 0.276 | (0.0138) | 0.0103 | 107.87 | 0.0261 | 2.58 | 0.0101 | 1.63 |
| Case 1 | 0.0475 | **0.01000** | 0.0962 | 3.6885 | 0.9565 | 0.046 | 0.5775 | 0.0021 | 100.89 | 0.0261 | 2.12 | 0.0123 | 1.89 |
| Case 2 | 0.0475 | **0.02000** | 0.0962 | 3.6885 | 1.1073 | (0.097) | #NUM! | (0.0051) | #NUM! | 0.0261 | 1.83 | 0.0143 | 2.21 |
| Case 3 | 0.0475 | **0.03000** | 0.0962 | 3.6885 | 1.2558 | (0.204) | #NUM! | (0.0121) | #NUM! | 0.0261 | 1.61 | 0.0162 | 2.63 |
| Case 4 | 0.0475 | **0.05000** | 0.0962 | 3.6885 | 1.5459 | (0.353) | #NUM! | (0.0259) | #NUM! | 0.0261 | 1.31 | 0.0199 | 4.22 |
| | | | | | | | | | | | | | |
| **the US T** | 0.0242 | **0.00947** | 0.2081 | 1.9974 | 0.9386 | 0.065 | 0.7462 | 0.0015 | **126.96** | 0.1042 | 9.17 | 0.0114 | 1.12 |
| Case 1 | 0.0242 | **0.01000** | 0.2081 | 1.9974 | 0.95092 | 0.052 | 0.7666 | 0.0012 | 122.02 | 0.1042 | 9.05 | 0.0115 | 1.12 |
| Case 2 | 0.0242 | **0.02000** | 0.2081 | 1.9974 | 1.18241 | (0.154) | #NUM! | (0.0044) | #NUM! | 0.1042 | 7.28 | 0.0143 | 1.16 |
| Case 3 | 0.0242 | **0.03000** | 0.2081 | 1.9974 | 1.41066 | (0.291) | #NUM! | (0.0099) | #NUM! | 0.1042 | 6.10 | 0.0171 | 1.20 |
| Case 4 | 0.0242 | **0.05000** | 0.2081 | 1.9974 | 1.85768 | (0.462) | #NUM! | (0.0207) | #NUM! | 0.1042 | 4.63 | 0.0225 | 1.28 |
| | | | | | | | | | | | | | |
| **China T** | 0.5341 | **0.00617** | 0.5428 | 3.1712 | 0.8793 | 0.137 | 0.4187 | 0.0645 | **24.81** | 0.1712 | 1.16 | 0.1481 | 7.42 |
| Case 1 | 0.5341 | **0.01000** | 0.5428 | 3.1712 | 0.88250 | 0.133 | 0.4276 | 0.0628 | 24.69 | 0.1712 | 1.15 | 0.1486 | 7.60 |
| Case 2 | 0.5341 | **0.02000** | 0.5428 | 3.1712 | 0.89086 | 0.123 | 0.4503 | 0.0583 | 24.28 | 0.1712 | 1.14 | 0.1500 | 8.11 |
| Case 3 | 0.5341 | **0.03000** | 0.5428 | 3.1712 | 0.89908 | 0.112 | 0.4723 | 0.0539 | 23.72 | 0.1712 | 1.13 | 0.1514 | 8.68 |
| Case 4 | 0.5341 | **0.05000** | 0.5428 | 3.1712 | 0.91511 | 0.093 | 0.5146 | 0.0453 | 22.29 | 0.1712 | 1.11 | 0.1541 | 10.05 |
| | | | | | | | | | | | | | |
| **India T** | 0.2163 | **0.01374** | 0.1953 | 1.6014 | 0.7023 | 0.424 | 0.4513 | 0.0644 | **21.56** | 0.1219 | 1.29 | 0.0949 | 4.50 |
| Case 1 | 0.2163 | **0.01000** | 0.0962 | 1.6014 | 0.66805 | 0.497 | 0.3267 | 0.0718 | 17.43 | 0.0601 | 0.67 | 0.0902 | (1.99) |
| Case 2 | 0.2163 | **0.02000** | 0.0962 | 1.6014 | 0.69652 | 0.436 | 0.4332 | 0.0656 | 18.09 | 0.0601 | 0.64 | 0.0941 | (1.76) |
| Case 3 | 0.2163 | **0.03000** | 0.0962 | 1.6014 | 0.72463 | 0.380 | 0.5133 | 0.0596 | 17.82 | 0.0601 | 0.61 | 0.0979 | (1.59) |
| Case 4 | 0.2163 | **0.05000** | 0.0962 | 1.6014 | 0.77981 | 0.282 | 0.6276 | 0.0476 | 15.89 | 0.0601 | 0.57 | 0.1053 | (1.33) |

**Table P2** Plan 50-G: By the rate of change in population, negatively related to technology and growth; using Japan, the US, China, and India, at the government sector

| Simulation | $i_G=I_G/Y_G$ | $n_G$ | $\alpha_G$ | $\Omega_G=K_G/Y_G$ | $\beta^*_G$ | $B^*_G=(1-\beta^*_G)$ | $d_{0\,G}$ | $g^*_{A\,G}$ | $1/\lambda^*_G$ | $r^*_G=\alpha_G/\Omega_G$ | $x_G$ | $g^*_{Y\,G}=r^*_G/x_G$ | $v^*_G$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Japan G** | 0.3202 | **(0.00126)** | (0.2739) | 7.2225 | 0.8456 | 0.183 | (0.1625) | 0.0494 | 17.90 | (0.0379) | (1.01) | 0.0375 | 0.50 |
| Case 1 | 0.3202 | **(0.00500)** | (0.2739) | 7.2225 | 0.8324 | 0.201 | (0.2334) | 0.0537 | 16.72 | (0.0379) | (1.03) | 0.0369 | 0.51 |
| Case 2 | 0.3202 | **0.00000** | (0.2739) | 7.2225 | 0.8501 | 0.176 | (0.1395) | 0.0480 | 18.28 | (0.0379) | (1.01) | 0.0377 | 0.50 |
| Case 3 | 0.3202 | **0.00500** | (0.2739) | 7.2225 | 0.8675 | 0.153 | (0.0521) | 0.0424 | 19.61 | (0.0379) | (0.99) | 0.0385 | 0.50 |
| Case 4 | 0.3202 | **0.01000** | (0.2739) | 7.2225 | 0.8849 | 0.130 | 0.0305 | 0.0369 | 20.62 | (0.0379) | (0.97) | 0.0392 | 0.49 |
| **the US G** | 0.5966 | **0.00947** | 0.1734 | 2.7319 | 0.7794 | 0.283 | 0.2037 | 0.1316 | **8.88** | 0.0635 | 0.37 | 0.1702 | (0.59) |
| Case 1 | 0.5966 | **(0.00500)** | 0.1734 | 2.7319 | 0.7615 | 0.313 | 0.1342 | 0.1423 | 8.40 | 0.0635 | 0.38 | 0.1663 | (0.62) |
| Case 2 | 0.5966 | **0.00000** | 0.1734 | 2.7319 | 0.7677 | 0.303 | 0.1593 | 0.1386 | 8.58 | 0.0635 | 0.38 | 0.1677 | (0.61) |
| Case 3 | 0.5966 | **0.00500** | 0.1734 | 2.7319 | 0.7739 | 0.292 | 0.1832 | 0.1349 | 8.75 | 0.0635 | 0.38 | 0.1690 | (0.60) |
| Case 4 | 0.5966 | **0.01000** | 0.1734 | 2.7319 | 0.7800 | 0.282 | 0.2061 | 0.1312 | 8.89 | 0.0635 | 0.37 | 0.1703 | (0.59) |
| **China G** | 0.3328 | **0.00617** | 0.2364 | 1.8028 | 0.7136 | 0.401 | 0.3546 | 0.0953 | **15.10** | 0.1311 | 1.00 | 0.1318 | (205.66) |
| Case 1 | 0.3328 | **(0.00500)** | 0.2364 | 1.8028 | 0.6933 | 0.442 | 0.2775 | 0.1021 | 14.30 | 0.1311 | 1.02 | 0.1280 | 42.12 |
| Case 2 | 0.3328 | **0.00000** | 0.2364 | 1.8028 | 0.7025 | 0.424 | 0.3139 | 0.0990 | 14.72 | 0.1311 | 1.01 | 0.1297 | 91.91 |
| Case 3 | 0.3328 | **0.00500** | 0.2364 | 1.8028 | 0.7115 | 0.405 | 0.3472 | 0.0960 | 15.04 | 0.1311 | 1.00 | 0.1314 | (528.24) |
| Case 4 | 0.3328 | **0.01000** | 0.2364 | 1.8028 | 0.7205 | 0.388 | 0.3778 | 0.0930 | 15.26 | 0.1311 | 0.99 | 0.1330 | (68.60) |
| **India G** | 0.4692 | **0.01374** | 0.2079 | 3.2909 | 0.8266 | 0.210 | 0.2373 | 0.0813 | **13.71** | 0.0632 | 0.54 | 0.1179 | (1.16) |
| Case 1 | 0.4692 | **(0.00500)** | 0.2079 | 3.2909 | 0.7984 | 0.253 | 0.1345 | 0.0946 | 12.84 | 0.0632 | 0.56 | 0.1138 | (1.25) |
| Case 2 | 0.4692 | **0.00000** | 0.2079 | 3.2909 | 0.8060 | 0.241 | 0.1637 | 0.0910 | 13.14 | 0.0632 | 0.55 | 0.1149 | (1.22) |
| Case 3 | 0.4692 | **0.00500** | 0.2079 | 3.2909 | 0.8136 | 0.229 | 0.1915 | 0.0875 | 13.39 | 0.0632 | 0.54 | 0.1160 | (1.20) |
| Case 4 | 0.4692 | **0.01000** | 0.2079 | 3.2909 | 0.8211 | 0.218 | 0.2181 | 0.0840 | 13.59 | 0.0632 | 0.54 | 0.1171 | (1.17) |

| Simulation | $i_G=I_G/Y_G$ | $n_G$ | $\alpha_G$ | $\Omega_G=K_G/Y_G$ | $\beta^*_G$ | $B^*_G=(1-\beta^*_G)$ | $d_{0\,G}$ | $g^*_{A\,G}$ | $1/\lambda^*_G$ | $r^*_G=\alpha_G/\Omega_G$ | $x_G$ | $g^*_{Y\,G}=r^*_G/x_G$ | $v^*_G$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Japan G** | 0.3202 | **(0.00126)** | (0.2739) | 7.2225 | 0.8456 | 0.183 | (0.1625) | 0.0494 | 17.90 | (0.0379) | (1.01) | 0.0375 | 0.50 |
| Case 1 | 0.3202 | **0.01000** | (0.2739) | 7.2225 | 0.8849 | 0.130 | 0.0305 | 0.0369 | 20.62 | (0.0379) | (0.97) | 0.0392 | 0.49 |
| Case 2 | 0.3202 | **0.02000** | (0.2739) | 7.2225 | 0.9191 | 0.088 | 0.1863 | 0.0259 | 21.48 | (0.0379) | (0.93) | 0.0407 | 0.48 |
| Case 3 | 0.3202 | **0.03000** | (0.2739) | 7.2225 | 0.9527 | 0.050 | 0.3417 | 0.0151 | 20.75 | (0.0379) | (0.90) | 0.0422 | 0.47 |
| Case 4 | 0.3202 | **0.05000** | (0.2739) | 7.2225 | 1.0184 | (0.018) | #NUM! | (0.0059) | #NUM! | (0.0379) | (0.84) | 0.0452 | 0.46 |
| **the US G** | 0.5966 | **0.00947** | 0.1734 | 2.7319 | 0.7794 | 0.283 | 0.2037 | 0.1316 | **8.88** | 0.0635 | 0.37 | 0.1702 | (0.59) |
| Case 1 | 0.5966 | **0.01000** | 0.1734 | 2.7319 | 0.7800 | 0.282 | 0.2061 | 0.1312 | 8.89 | 0.0635 | 0.37 | 0.1703 | (0.59) |
| Case 2 | 0.5966 | **0.02000** | 0.1734 | 2.7319 | 0.7922 | 0.262 | 0.2489 | 0.1240 | 9.12 | 0.0635 | 0.37 | 0.1730 | (0.58) |
| Case 3 | 0.5966 | **0.03000** | 0.1734 | 2.7319 | 0.8041 | 0.244 | 0.2884 | 0.1169 | 9.26 | 0.0635 | 0.36 | 0.1756 | (0.57) |
| Case 4 | 0.5966 | **0.05000** | 0.1734 | 2.7319 | 0.8275 | 0.208 | 0.3591 | 0.1029 | 9.32 | 0.0635 | 0.35 | 0.1807 | (0.54) |
| **China G** | 0.3328 | **0.00617** | 0.2364 | 1.8028 | 0.7136 | 0.401 | 0.3546 | 0.0953 | **15.10** | 0.1311 | 1.00 | 0.1318 | (205.66) |
| Case 1 | 0.3328 | **0.01000** | 0.2364 | 1.8028 | 0.7205 | 0.388 | 0.3778 | 0.0930 | 15.26 | 0.1311 | 0.99 | 0.1330 | (68.60) |
| Case 2 | 0.3328 | **0.02000** | 0.2364 | 1.8028 | 0.7384 | 0.354 | 0.4320 | 0.0871 | 15.45 | 0.1311 | 0.96 | 0.1363 | (25.20) |
| Case 3 | 0.3328 | **0.03000** | 0.2364 | 1.8028 | 0.7559 | 0.323 | 0.4787 | 0.0812 | 15.33 | 0.1311 | 0.94 | 0.1396 | (15.52) |
| Case 4 | 0.3328 | **0.05000** | 0.2364 | 1.8028 | 0.7904 | 0.265 | 0.5560 | 0.0698 | 14.46 | 0.1311 | 0.90 | 0.1459 | (8.85) |
| **India G** | 0.4692 | **0.01374** | 0.2079 | 3.2909 | 0.8266 | 0.210 | 0.2373 | 0.0813 | **13.71** | 0.0632 | 0.54 | 0.1179 | (1.16) |
| Case 1 | 0.4692 | **0.01000** | 0.2079 | 3.2909 | 0.8211 | 0.218 | 0.2181 | 0.0840 | 13.59 | 0.0632 | 0.54 | 0.1171 | (1.17) |
| Case 2 | 0.4692 | **0.02000** | 0.2079 | 3.2909 | 0.8359 | 0.196 | 0.2682 | 0.0770 | 13.85 | 0.0632 | 0.53 | 0.1192 | (1.13) |
| Case 3 | 0.4692 | **0.03000** | 0.2079 | 3.2909 | 0.8504 | 0.176 | 0.3147 | 0.0702 | 13.92 | 0.0632 | 0.52 | 0.1212 | (1.09) |
| Case 4 | 0.4692 | **0.05000** | 0.2079 | 3.2909 | 0.8789 | 0.138 | 0.3991 | 0.0568 | 13.56 | 0.0632 | 0.50 | 0.1253 | (1.02) |

**Table P3** Plan 50-PRI: By the rate of change in population, negatively related to technology and growth; using Japan, the US, China, and India, at the private sector

| Simulation | $i_{PRI}=I_{PRI}/Y_P$ | $n_{PRI}$ | $\alpha_{PRI}$ | $\Omega_{PRI}$ | $\beta^*_{PRI}$ | $B^*_P=(1-\beta^*_P)/$ | $\delta_{0\ PRI}$ | $g^*_{A\ PRI}$ | $\lambda^*_{PRI}$ | $r^*_{PRI}$ | $x_{PRI}$ | $g^*_{Y\ PRI}$ | $v^*_{PRI}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Japan PRI** | (0.0132) | **(0.00126)** | 0.1785 | 2.9022 | 0.8402 | 0.190 | 0.3580 | (0.0021) | (418.52) | 0.0615 | (16.08) | (0.0038) | 0.94 |
| Case 1 | (0.0132) | **(0.00500)** | 0.1785 | 2.9022 | 1.0217 | (0.021) | #NUM! | 0.0003 | #NUM! | 0.0615 | (13.22) | (0.0047) | 0.93 |
| Case 2 | (0.0132) | **0.00000** | 0.1785 | 2.9022 | 0.7794 | 0.283 | 0.1558 | (0.0029) | (406.31) | 0.0615 | (17.33) | (0.0035) | 0.95 |
| Case 3 | (0.0132) | **0.00500** | 0.1785 | 2.9022 | 0.5389 | 0.856 | (5.8283) | (0.0061) | (26.67) | 0.0615 | (25.06) | (0.0025) | 0.96 |
| Case 4 | (0.0132) | **0.01000** | 0.1785 | 2.9022 | 0.3003 | 2.330 | 2.2599 | (0.0092) | 50.34 | 0.0615 | (44.98) | (0.0014) | 0.98 |
| | | | | | | | | | | | | | |
| **the US PR** | (0.1517) | **0.00947** | 0.2188 | 1.7718 | 0.6624 | 0.510 | 0.1512 | (0.0512) | **(27.73)** | 0.1235 | (2.18) | (0.0567) | 0.69 |
| Case 1 | (0.1517) | **(0.00500)** | 0.2188 | 1.7718 | 0.7109 | 0.407 | 0.3642 | (0.0438) | (31.46) | 0.1235 | (2.03) | (0.0608) | 0.67 |
| Case 2 | (0.1517) | **0.00000** | 0.2188 | 1.7718 | 0.6940 | 0.441 | 0.3016 | (0.0464) | (30.85) | 0.1235 | (2.08) | (0.0594) | 0.68 |
| Case 3 | (0.1517) | **0.00500** | 0.2188 | 1.7718 | 0.6773 | 0.477 | 0.2283 | (0.0489) | (29.53) | 0.1235 | (2.13) | (0.0580) | 0.68 |
| Case 4 | (0.1517) | **0.01000** | 0.2188 | 1.7718 | 0.6606 | 0.514 | 0.1412 | (0.0515) | (27.48) | 0.1235 | (2.18) | (0.0565) | 0.69 |
| | | | | | | | | | | | | | |
| **China PRI** | 0.5768 | **0.00617** | 0.6078 | 3.4615 | 0.9025 | 0.108 | 0.4421 | 0.0562 | **29.60** | 0.1756 | 1.17 | 0.1504 | 6.97 |
| Case 1 | 0.5768 | **(0.00500)** | 0.6078 | 3.4615 | 0.8947 | 0.118 | 0.4197 | 0.0607 | 30.04 | 0.1756 | 1.18 | 0.1491 | 6.63 |
| Case 2 | 0.5768 | **0.00000** | 0.6078 | 3.4615 | 0.8982 | 0.113 | 0.4298 | 0.0587 | 29.87 | 0.1756 | 1.17 | 0.1497 | 6.78 |
| Case 3 | 0.5768 | **0.00500** | 0.6078 | 3.4615 | 0.9017 | 0.109 | 0.4398 | 0.0567 | 29.66 | 0.1756 | 1.17 | 0.1503 | 6.93 |
| Case 4 | 0.5768 | **0.01000** | 0.6078 | 3.4615 | 0.9052 | 0.105 | 0.4497 | 0.0547 | 29.39 | 0.1756 | 1.16 | 0.1508 | 7.10 |
| | | | | | | | | | | | | | |
| **India PRI** | 0.1627 | **0.01374** | 0.1926 | 1.2430 | 0.6505 | 0.537 | 0.6497 | 0.0569 | **32.25** | 0.1549 | 1.82 | 0.0851 | 2.22 |
| Case 1 | 0.1627 | **(0.00500)** | 0.1926 | 1.2430 | 0.5899 | 0.695 | 0.4018 | 0.0667 | 27.88 | 0.1549 | 2.01 | 0.0772 | 1.99 |
| Case 2 | 0.1627 | **0.00000** | 0.1926 | 1.2430 | 0.6062 | 0.650 | 0.4958 | 0.0641 | 30.96 | 0.1549 | 1.95 | 0.0793 | 2.05 |
| Case 3 | 0.1627 | **0.00500** | 0.1926 | 1.2430 | 0.6224 | 0.607 | 0.5647 | 0.0614 | 32.50 | 0.1549 | 1.90 | 0.0814 | 2.11 |
| Case 4 | 0.1627 | **0.01000** | 0.1926 | 1.2430 | 0.6385 | 0.566 | 0.6176 | 0.0588 | 32.72 | 0.1549 | 1.85 | 0.0836 | 2.17 |

| Simulation | $i_{PRI}=I_{PRI}/Y_P$ | $n_{PRI}$ | $\alpha_{PRI}$ | $\Omega_{PRI}$ | $\beta^*_{PRI}$ | $B^*_P=(1-\beta^*_P)/$ | $\delta_{0\ PRI}$ | $g^*_{A\ PRI}$ | $\lambda^*_{PRI}$ | $r^*_{PRI}$ | $x_{PRI}$ | $g^*_{Y\ PRI}$ | $v^*_{PRI}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Japan PRI** | (0.0132) | **(0.00126)** | 0.1785 | 2.9022 | 0.8402 | 0.190 | 0.3580 | (0.0021) | (418.52) | 0.0615 | (16.08) | (0.0038) | 0.94 |
| Case 1 | (0.0132) | **0.01000** | 0.1785 | 2.9022 | 0.3003 | 2.330 | 2.2599 | (0.0092) | 50.34 | 0.0615 | (44.98) | (0.0014) | 0.98 |
| Case 2 | (0.0132) | **0.02000** | 0.1785 | 2.9022 | (0.1714) | (6.835) | #NUM! | (0.0155) | #NUM! | 0.0615 | 78.82 | 0.0008 | 1.01 |
| Case 3 | (0.0132) | **0.03000** | 0.1785 | 2.9022 | (0.6359) | (2.573) | #NUM! | (0.0216) | #NUM! | 0.0615 | 21.24 | 0.0029 | 1.05 |
| Case 4 | (0.0132) | **0.05000** | 0.1785 | 2.9022 | (1.5440) | (1.648) | #NUM! | (0.0336) | #NUM! | 0.0615 | 8.75 | 0.0070 | 1.13 |
| | | | | | | | | | | | | | |
| **the US PR** | (0.1517) | **0.00947** | 0.2188 | 1.7718 | 0.6624 | 0.510 | 0.1512 | (0.0512) | **(27.73)** | 0.1235 | (2.18) | (0.0567) | 0.69 |
| Case 1 | (0.1517) | **0.01000** | 0.2188 | 1.7718 | 0.6606 | 0.514 | 0.1412 | (0.0515) | (27.48) | 0.1235 | (2.18) | (0.0565) | 0.69 |
| Case 2 | (0.1517) | **0.02000** | 0.2188 | 1.7718 | 0.6277 | 0.593 | (0.0952) | (0.0565) | (21.64) | 0.1235 | (2.30) | (0.0537) | 0.70 |
| Case 3 | (0.1517) | **0.03000** | 0.2188 | 1.7718 | 0.5952 | 0.680 | (0.4839) | (0.0614) | (14.78) | 0.1235 | (2.42) | (0.0509) | 0.71 |
| Case 4 | (0.1517) | **0.05000** | 0.2188 | 1.7718 | 0.5315 | 0.881 | (3.5302) | (0.0710) | (3.54) | 0.1235 | (2.71) | (0.0455) | 0.73 |
| | | | | | | | | | | | | | |
| **China PRI** | 0.5768 | **0.00617** | 0.6078 | 3.4615 | 0.9025 | 0.108 | 0.4421 | 0.0562 | **29.60** | 0.1756 | 1.17 | 0.1504 | 6.97 |
| Case 1 | 0.5768 | **0.01000** | 0.6078 | 3.4615 | 0.9052 | 0.105 | 0.4497 | 0.0547 | 29.39 | 0.1756 | 1.16 | 0.1508 | 7.10 |
| Case 2 | 0.5768 | **0.02000** | 0.6078 | 3.4615 | 0.9120 | 0.096 | 0.4690 | 0.0507 | 28.74 | 0.1756 | 1.16 | 0.1520 | 7.44 |
| Case 3 | 0.5768 | **0.03000** | 0.6078 | 3.4615 | 0.9187 | 0.088 | 0.4880 | 0.0469 | 27.96 | 0.1756 | 1.15 | 0.1531 | 7.81 |
| Case 4 | 0.5768 | **0.05000** | 0.6078 | 3.4615 | 0.9318 | 0.073 | 0.5252 | 0.0393 | 26.12 | 0.1756 | 1.13 | 0.1553 | 8.65 |
| | | | | | | | | | | | | | |
| **India PRI** | 0.1627 | **0.01374** | 0.1926 | 1.2430 | 0.6505 | 0.537 | 0.6497 | 0.0569 | **32.25** | 0.1549 | 1.82 | 0.0851 | 2.22 |
| Case 1 | 0.1627 | **0.01000** | 0.1926 | 1.2430 | 0.6385 | 0.566 | 0.6176 | 0.0588 | 32.72 | 0.1549 | 1.85 | 0.0836 | 2.17 |
| Case 2 | 0.1627 | **0.02000** | 0.1926 | 1.2430 | 0.6704 | 0.492 | 0.6936 | 0.0536 | 30.70 | 0.1549 | 1.77 | 0.0877 | 2.31 |
| Case 3 | 0.1627 | **0.03000** | 0.1926 | 1.2430 | 0.7019 | 0.425 | 0.7460 | 0.0485 | 27.37 | 0.1549 | 1.69 | 0.0919 | 2.46 |
| Case 4 | 0.1627 | **0.05000** | 0.1926 | 1.2430 | 0.7638 | 0.309 | 0.8147 | 0.0384 | 21.06 | 0.1549 | 1.55 | 0.1000 | 2.82 |

## Chapter 15

The author answers the unsolved problems in macroeconomics as follows:

1. A fixed rate of change in population over years never influences technology, returns, and growth, in the endogenous-equilibrium.
2. Concave-oriented rate of change in population negatively influences technology, returns, and growth, in the endogenous-equilibrium.
3. If the rate of change in population increases, the rate of technology, the rate of return and the growth rate of output decreases. This endogenous fact differs from common sense. The fact urges us the importance of qualitative labor effectiveness, similarly to capital stock (recall, another endogenous fact in Chapter 14 that the rate of return is maximized with minimum net investment). This fact is discussed in the next section using the technological coefficient (i.e., the qualitative/quantitative net investment coefficient), $\beta^* \; or \; 1-\beta^*$.
4. What is a sign of unstable rate of change in population? Again, it is the valuation ratio; $v^* = r^*/(r^* - g_Y^*)$. Watch the speed years in Tables P1 to P3. When the rate of change in population overruns a upper limit, the speed years falls into endogenous disequilibrium. This is because the rate of technological progress is directly oppressed. The decrease in population never aggravates growth and returns but is only used for an excuse of the failures of whole policies in immature democratic countries. Recall that population is a mixture of quality and quantity and that human capital works for strategies to reinforce labor. If the valuation ratio by year is lower, then the damage is smaller. Each country must be responsible for other countries and the Earth environment. This spirit will return back to cooperative countries. This is the spirit of moderation and altruistic.

### 15.3 For Population-related Hyperbolas Precisely

This section clarifies the contents of hyperbola equations/functions related to the increase/decrease in actual population by year (see **BOX 15-3**). These equations are obtained each by reducing corresponding endogenous equations in the endogenous system and accordingly, KEWT series data-sets by year, country, and sector.

There are twelve basic hyperbola equations/functions in KEWT. The standard form of hyperbola is expressed by $y = \frac{cx+d}{ax+b}$, or $\left(y - \frac{c}{a}\right)\left(x + \frac{b}{a}\right) = \frac{f}{a}$. When each of four elements, a, b, c, and d, has a value except for zero, the standard form holds, where $f = d - \frac{b \cdot c}{a}$ is calculated. The vertical asymptote (VA) is shown by $VA = \frac{-b}{a}$, and the horizontal asymptote (HA) by $HA = -\frac{c}{a}$. When one or two of four elements are zero, standard form is reduced. A reduced form is called a type. Six types exist by function including the standard form of $y = \frac{cx+d}{ax+b}$: If a=0, $y = \frac{cx+d}{b}$; if b=0, $y = \frac{cx+d}{ax}$; if c=0, $y=\frac{d}{ax+b}$; if d=0, $y=\frac{cx}{ax+b}$; if c=d=0, $y=\frac{1}{ax+b}$. If a=0 and b=0 happen at the same time, there exists no hyperbola. In short, basic concepts are composed of four elements, six forms, and twelve hyperbolas.

**BOX 15-3** Population-related hyperbolic framework designed for an optimum policy-system

Hyperbolas to population-related framework

As a base for sustainable growth under a given actual population change by year.

For the rate of technological progress, $g_A^* = i(1-\beta^*)$:

| | | |
|---|---|---|
| (1) | $n \to i=I/Y$ | $i(n)$ |
| (2) | $n \to \beta^*$ | $\beta^*(n)$ or $\widetilde{\beta^*}(n)$, |

$\beta^*(i)$ or $\widetilde{\beta^*}(i)$, connects the above (1) and (2).

**Notes:**

1. $i(n)$ determines a range of net investment, to which $\beta^*(n)$ corresponds.
2. Then, $\beta^*(i)$ and $r^*(i)$ lead to an optimum range of $i=I/Y$, where $\Omega^*(i)$, $\Omega^*(n)$, and accordingly, $\Omega^*(\beta^*)$ are examined for optimums.
3. $\alpha(i)$ and $\alpha(n)$ are examined to review stop-macro inequality.
4. These hyperbolas are essentially related to full-employment with low inflation.

For population-related hyperbolas, the following conceptual framework is required in advance.

First, assume that the rate of unemployment is zero at $n_E = n$. The condition of $n_E = n$ implies that if the actual growth rate, *n*, of population equals the rate of change in population in equilibrium, $n_E$, there exists no unemployment. KEWT 6.12, 1990-2010, satisfies this condition always in a moderate range of equilibrium. KEWT 5.11, 1990-2009, allowed the rate of unemployment to be the last means for maintaining a moderate range of equilibrium, where an endogenous NAIRU (a non-accelerated-inflation rate of unemployment) endogenously exists. It is convenient for KEWT 5.11 to draw a hyperbola of $r^*(n_E)$ and prove the existence of the endogenous NAIRU. The hyperbola of $r^*(n_E)$ reduces to a linear form since $r^*(n_E)$ is shown by $y=\frac{cx+d}{b}$, where a=0. In the case of KEWT 6.12, $r^*(n_E)$ only shows a point at the hyperbola origin due to $n_E - n = 0$.

Population-related hyperbolas each set as the x axis the rate of change in population or the growth rate of actual population, $n_E = n$. This setting is a base for population-related hyperbolas. Population-related framework is shown in **Figure P1** and aims at an optimum policy-system. The author recognizes that 'the Mirrlees review' for the Institute for Fiscal Studies (see at the next section) is optimum-oriented. Therefore, the author intends to clarify some differences between KEWT and Mirrlees's system. The rate of technological progress is shown by $g_A^* = i(1-\beta^*)$. Therefore, $i(n)$, $\beta^*(n)$ or $\widetilde{\beta^*}(n)$, and accordingly, $\beta^*(i)$ or $\widetilde{\beta^*}(i)$ and $\Omega^*(i)$ are most fitted for population-related hyperbolas. It is not necessary to use $\widetilde{\beta^*}(i)$ instead of $\beta^*(i)$. Both express the same results differently in shape.

An optimum range of the endogenous-equilibrium is measured using $r^*(i)$. The optimum range is first measured by the rate of return to $i = I/Y$ in equilibrium. An optimum condition is determined by a maximized rate of return to a minimized net investment to output in equilibrium. $i = I/Y$ is connected with not only the qualitative net investment coefficient, $\beta^*$ or $\widetilde{\beta^*}$, but also $n_E = n$.

Furthermore, $\alpha = r^* \cdot \Omega^*$ constitutes a core of policy-making as the structural ratio. In this respect, $\Omega^*(n)$ and $\Omega^*(\beta^*)$ or $\Omega^*(\widetilde{\beta^*})$ is also useful to the review of population-related hyperbolas. Figure P1 indicates how important these contents are. And, for stop-macro inequality, $\alpha(i)$ and $\alpha(n)$ are examined to review stop-macro inequality and dynamic balances between hyperbolas. In the literature, the relative share of capital or profits/returns are in vague. Since Solow, R. M. (618-631, 1958), profits or returns have remained unsolved partly due to the SNA recording that shows final redistribution income and neglects government income. Hyperbolas, $\alpha(i)$ and $\alpha(n)$, will clarify unknown policy-oriented problems precisely and empirically.

The above hyperbolas are concisely put in order as shown in **BOX 15-4**. Also, for empirical proofs, population-related hyperbola graphs, the author show **Figures H2, H3, H4, H5, H6,** and **H7**, each by type, fact, explanation, and implication. These hyperbola graphs are thoroughly consistent with the results simulated in the previous section. After reviewing a few articles in the next section, some facts proved empirically are summarized in the final section of Conclusions.

**BOX 15-4** Hyperbolas of inflation, returns, and technology to net investment and change in population

**I.** $y=\frac{cx+d}{ax}$, b=0 and VA=0:

1). $r^*(i)$, where $r^*(i)$ guarantees a maximized rate of return with a minimized net investment in a moderate endogenous-equilibrium Also, the rates of inflation/deflation are determined by $r^*-HA_{r^*(i)}$.

2). $\beta^*(i)$ or $\widetilde{\beta^*}(i)$. $\beta^*$ is the quantitative net investment coefficient and, $\widetilde{\beta^*}=1-\beta^*$ is the qualitative net investment coefficient but, the same technology coefficient. This hyperbola presents an endogenous base for the rate of technological progress, $g_A^*=i(1-\beta^*)$. Endogenous technology is tied up with green economies nowadays.

**II.** $y=\frac{cx+d}{b}$ , a=0 and VA=0:

3). $r^*(n)$, where the relationship between the rate of change in population or the increase/decrease in actual population and the rate of return is shown (for the use, see note 1).

**III.** $y=\frac{cx}{ax+b}$,

6). $\Omega^*(i)$, where net investment and the capital-output ratio are examined.

7). $i(n)$, where labor and net investment are examined.

8). $\Omega^*(\beta^*)$, where $\Omega^*$ is the capital-output ratio, $\Omega=K/Y$. Similarly, $\Omega^*(\widetilde{\beta^*})$ shows the relationship between technology and capital stock, towards green economics.

**IV.** $y=\frac{d}{ax+b}$,

9). $\Omega^*(n)$, where labor and capital are examined.

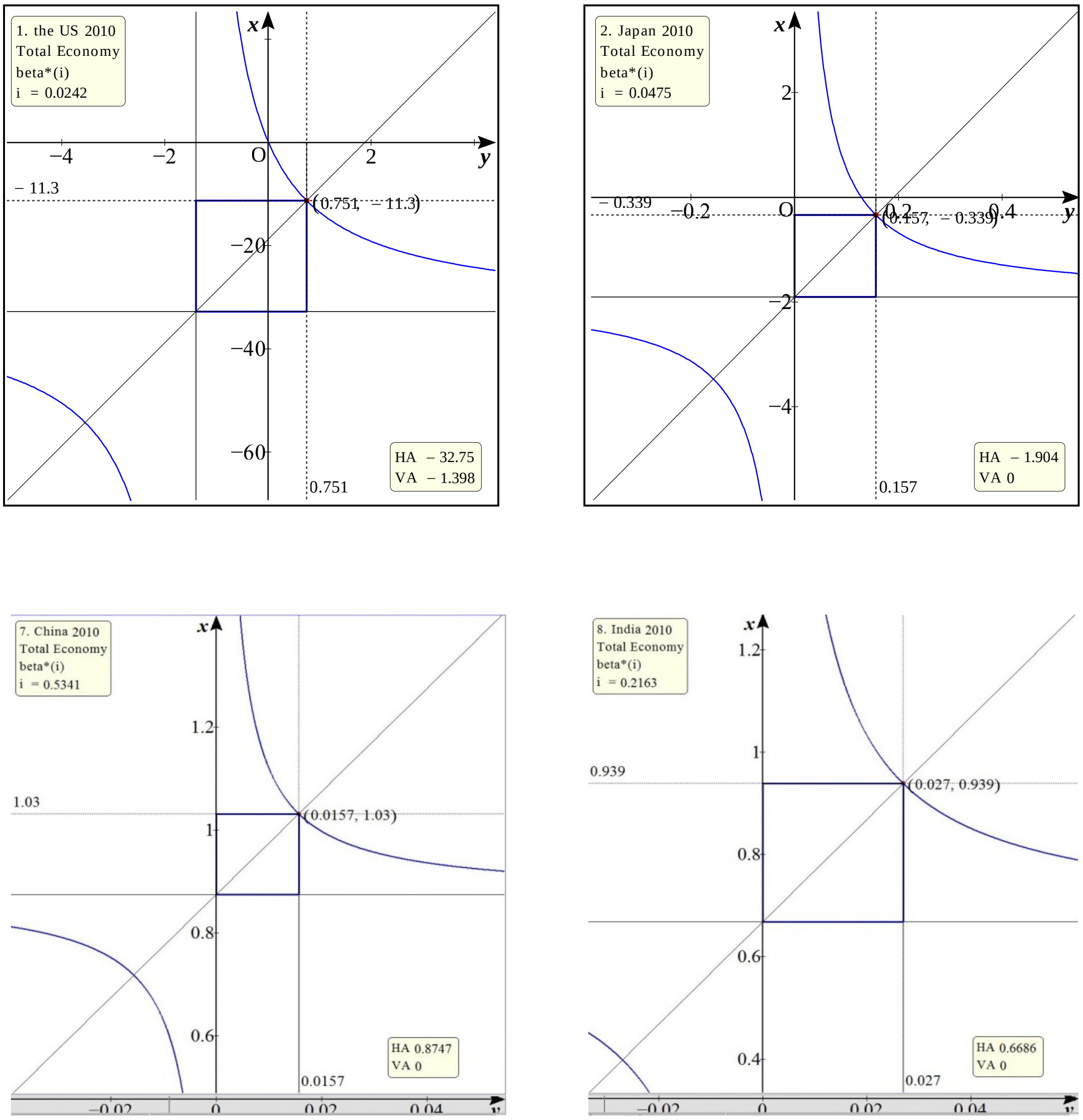
**V.** $y=\frac{cx+d}{ax+b}$, $VA=\frac{-b}{a}$ and $HA=-\frac{c}{a}$:

10). $\beta^*(n)$ or $\widetilde{\beta^*}(n)$, where even if $n_E=n$, this hyperbola presents the relationship between the qualitative net investment coefficient and the increase/decrease in actual population.

11). $\alpha(i)$. This hyperbola determines an optimum range of stop-macro inequality to net investment.

12). $\alpha(n)$. This hyperbola determines stop-macro inequality and the increase/decrease in actual population.

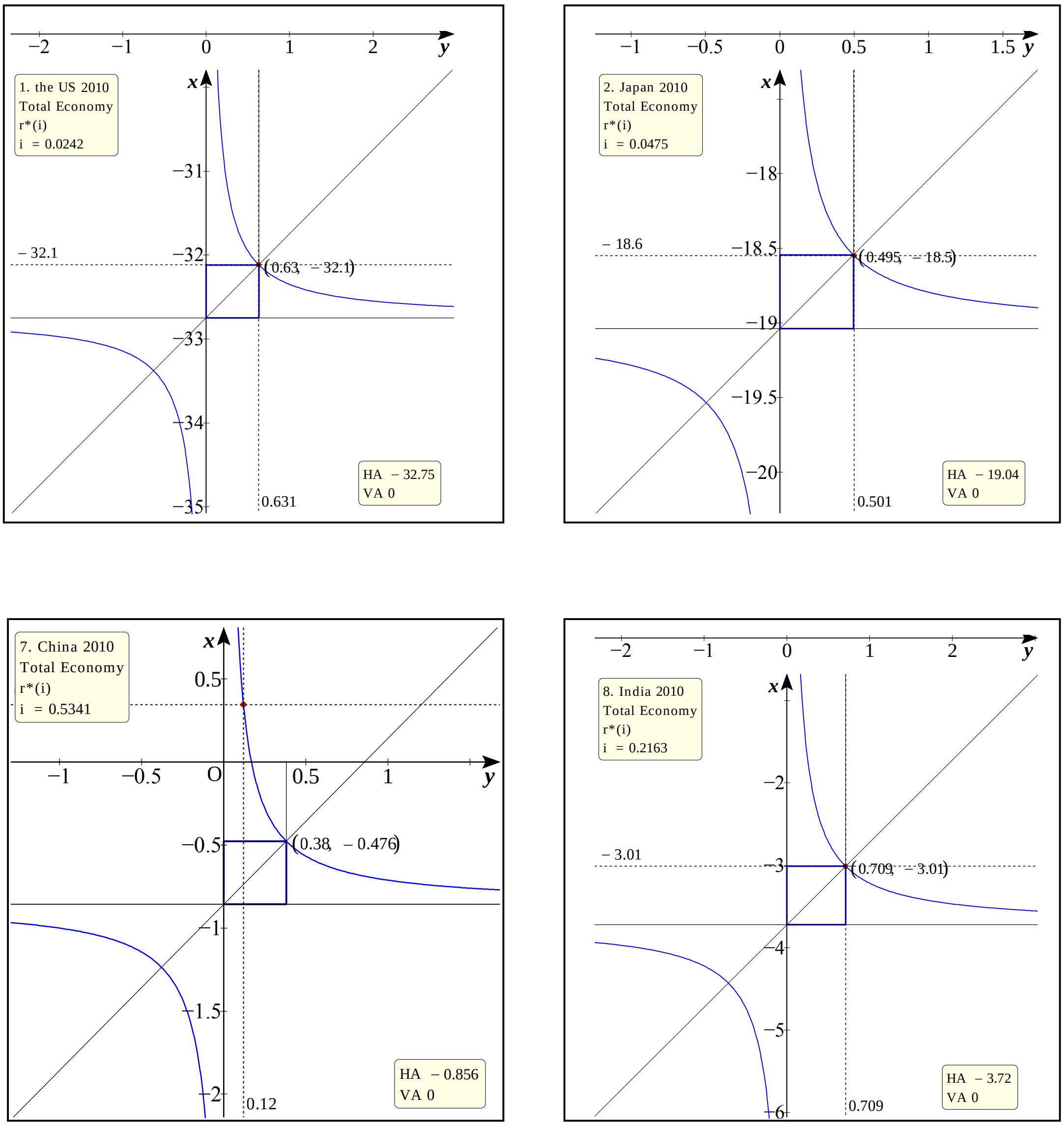
**Note:** In the above hyperbolas, the author does not include the speed years for convergence by country hyperbolas each to $i=I/Y$ and $n_E=n$: $speed(i)$and $speed\ (n)$ (see Chapter 7). Chapter 10 discusses the background of hyperbolas, spiritually but exceptionally in the *EES*. A whole version of hyperbolas is each by each numerically explained in Appendix at the end of the *EES*.




**Data source:** KEWT 6.12 of 81 countries by sector, 1990-2010, whose ten original data for the real assets and 15 from the financial assets come from *International Financial Statistics Yearbook*, IMF.

**Fact finding and explanation:** The technology coefficient or the qualitative net investment coefficient is strongly green-oriented nowadays. $\beta^*$, endogenously and wholly, determines technology level. A high level of $i = I/Y$ is a quick remedy of growth but, it delays sustainable progress of technology in the long run. Policy-makers are able to look for a moderate range of minimum level of net investment using $\beta^*(i)$. Hyperbolic curves of four countries seem to be similar. But, each curve differs significantly by country. The origin of hyperbola is not the same as the origin of the x axis and the y axis. The horizontal asymptote differs significantly. Higher technology is essentially more green-oriented, with higher offering spirit.

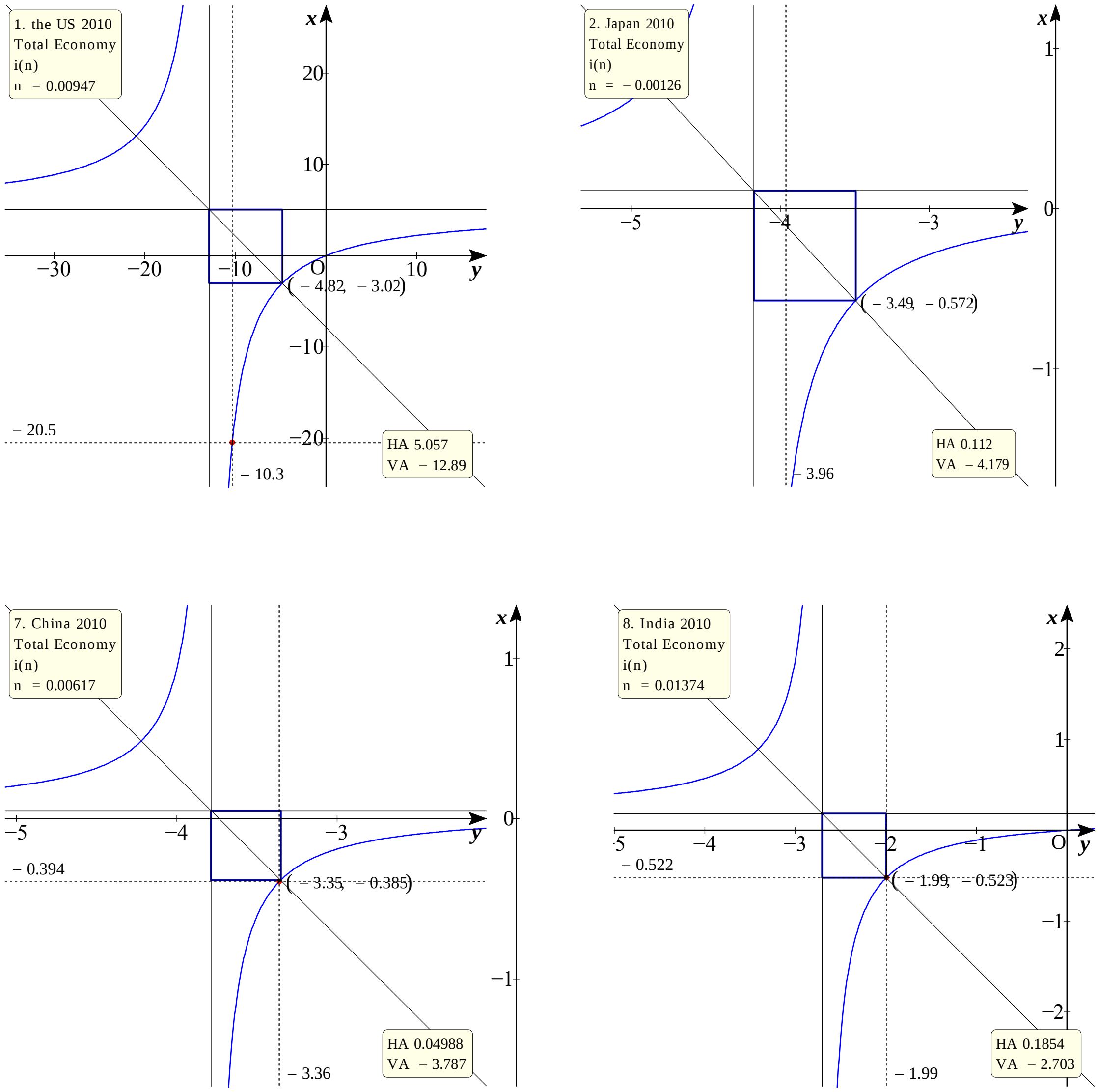
**Figure H2** Hyperbola of the technology coefficient to changes in population, $\beta^*(i)$




**Data source:** KEWT 6.12 of 81 countries by sector, 1990-2010, whose ten original data for the real assets and 15 from the financial assets come from *International Financial Statistics Yearbook*, IMF.

**Fact finding and explanation:** The fact is that the rate of return should be higher with less net investment. This fact is against a notion that a low interest rate or a low rate of return helps to raise net investment and accordingly, net investment accelerates growth. The closer to zero the rate of return the more risky of deflation is. This fact results in raising the real cost of capital. Policy-makers need to watch the HA (horizontal asymptote) that shows a limit of inflation or deflation. Deflation has its own cause; policy-makers first of all must decrease deficit by year. Any strategies cannot convert deflation to inflation without recovering the balance between the government sector and the private sector.

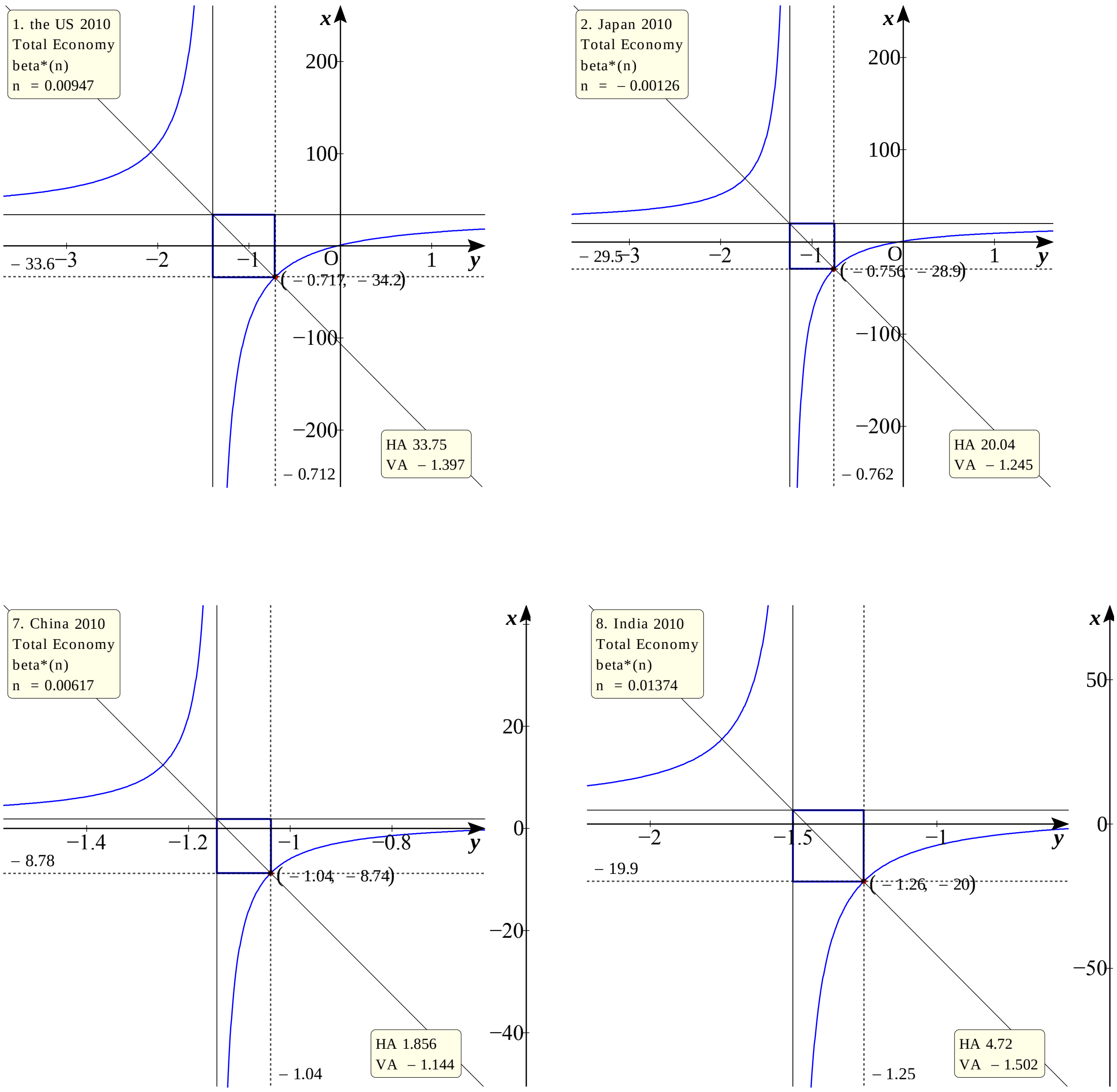
**Figure H3** Hyperbola of the rate of return to changes in net investment, $r^*(i)$




**Data source:** KEWT 6.12 of 81 countries by sector, 1990-2010, whose ten original data for the real assets and 15 from the financial assets come from *International Financial Statistics Yearbook*, IMF.

**Fact finding and explanation:** Both $i = I/Y$ and the rate of change in population, $n_E = n$, are fixed by year and its transitional path. Nevertheless, $i = I/Y$ is negatively related to $n_E = n$. This fact encourages developed countries. Of course, policy-makers of developed countries must accelerate technology higher than that of developing countries. The differences between developed and developing countries are much less important than those between the government sector and the private sector by country and also those between statistics actual data and endogenous data. This fact implicitly expresses that policy-makers must focus the improvement of the qualitative net investment coefficient, $\beta^*$.

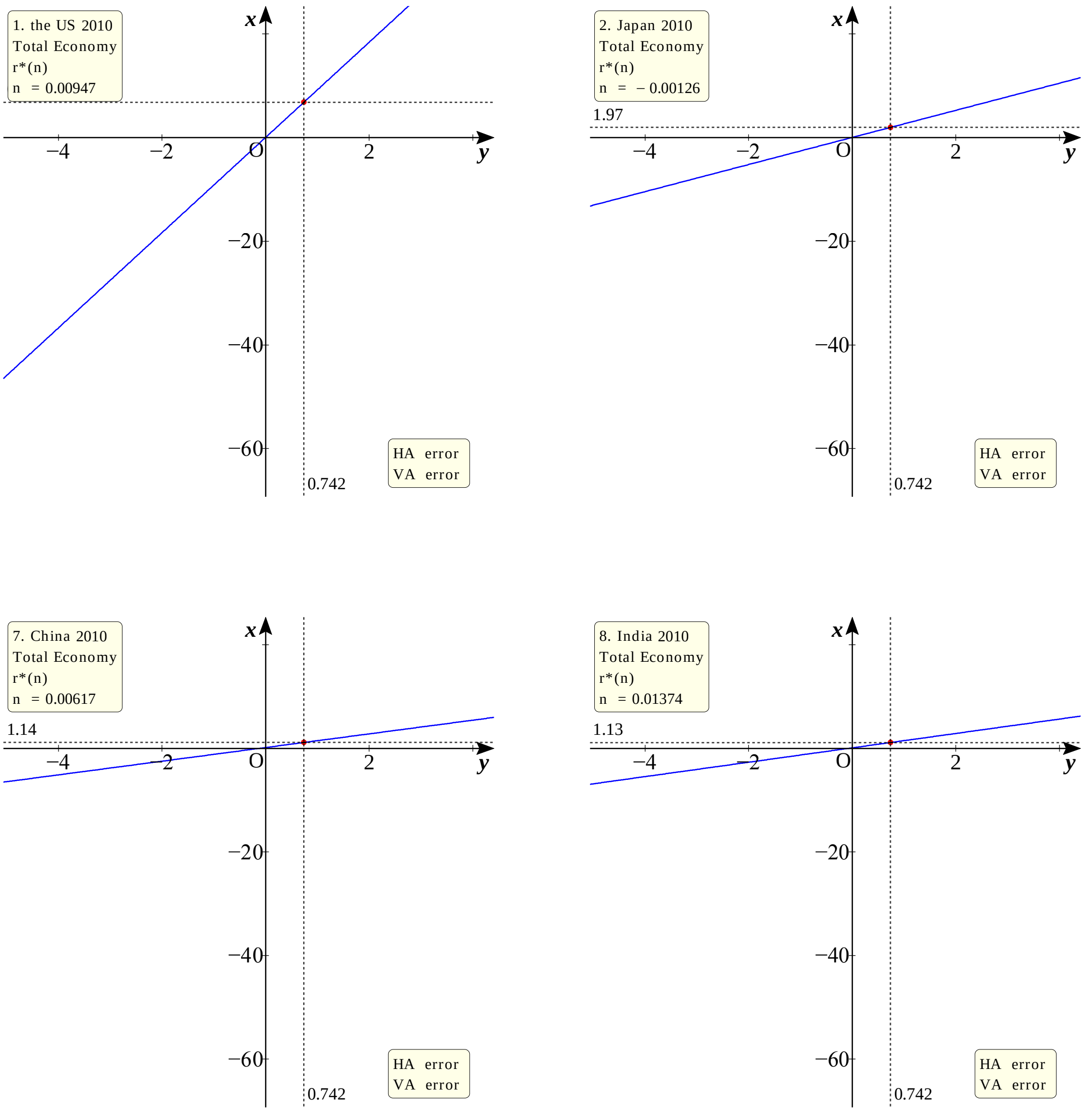
**Figure H4** Hyperbola of net investment to changes in population, $i(n)$




**Data source:** KEWT 6.12 of 81 countries by sector, 1990-2010, whose ten original data for the real assets and 15 from the financial assets come from *International Financial Statistics Yearbook*, IMF.

**Fact finding and explanation:** The technology coefficient or the qualitative net investment coefficient, $\beta^*$, is negatively related to the rate of change in population. Negative was proved using simulation as shown in this chapter. This fact is consistent with the essence of technology towards green economics. The origin of the hyperbola differs significantly by country, partly due to national taste, culture, and history. This fact is against a notion that the increase in population is essential to technology and growth. Compare the origin of the hyperbola and the origin of the x axis and the y axis, confirming the values of the HA (horizontal asymptote) and the VA (vertical asymptote). Strategies to reinforce a whole set of policies must differ by country.

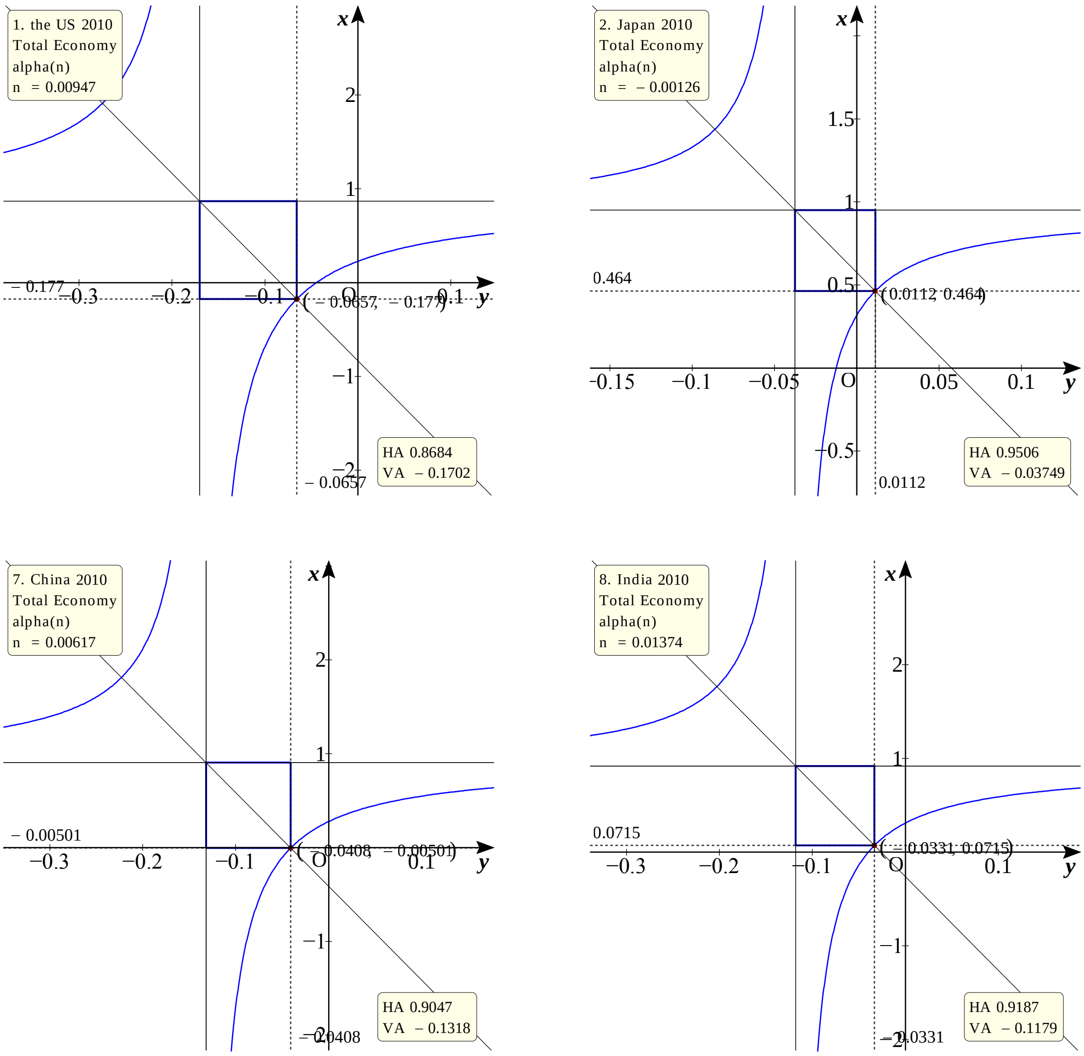
**Figure H5** Hyperbola of the technology coefficient to changes in population, $\beta^*(n)$




**Data source:** KEWT 6.12 of 81 countries by sector, 1990-2010, whose ten original data for the real assets and 15 from the financial assets come from *International Financial Statistics Yearbook*, IMF.

**Fact finding and explanation:** The rate of return exceptionally reduces to a linear line. Hyperbola software only shows error to the HA and the VA since the reduction is due to denominator's zero. $r^*(n)$ is worthy of attention. This is because the slope positively indicates the relationship between returns and full-employment. For example, if the slope is $45^o$, wages and unemployment are correlated strongly. Full employment is in reality if actual data approach endogenous data. Policy-makers need to simultaneously integrate $r^*(n)$ with $r^*(i)$ that controls inflation and deflation.

**Figure H6** Hyperbola of the rate of return to changes in population, $r^*(n)$




**Data source:** KEWT 6.12 of 81 countries by sector, 1990-2010, whose ten original data for the real assets and 15 from the financial assets come from *International Financial Statistics Yearbook*, IMF.

**Fact finding and explanation:** The relative share of capital, $\alpha$, is determined as the product of the capital-output ratio and the rate of return. When the rate of return is high with less net investment, the capital-output ratio is also not so high. This fact warns against a wrong notion that it is necessary for policy-makers to increase $\alpha$, which in turn aggravates stop-macro inequality. Each country has its proper $\alpha$, in corporation with national taste, culture and history and in harmony with globalization. Political leaders are apt to spend money at the cost of next generations. People must study that a preferable choice is to decrease government expenditures with a government minimum net investment. People must be responsible for a true meaning of democracy that one person must determine everything without relying on others. Then, government size will be determined by people. Stop-macro inequality is indifferent of $\alpha$. These facts march with government openness and publication.

**Figure H7** Hyperbola of net investment to changes in population, $\alpha(n)$

## 15.4 Revisit Maddison, A. (1987, 1995), Mirrlees, J. A. (2010, 2011), and MRW (1992)

This section revisits a few memorial papers. First, rather historically and philosophically, the author takes Maddison, A. and Mirrlees, J. A.; with thoughts behind, backing to Kant Immanuel, 1724-1804, whose translation, Nisbet, H. B. (1970). Second, the author revisits Mankiw, Romer, and Weil (1992) as a preparatory step to answer problems unsolved at neoclassical school that uses the Cobb-Douglas production function.

First, Maddison, A. (in particular, 1987, 1991, 1995, and 1996) historically publishes long trends of economic data for the total economy by country. His methodology differs from the author's. This section does not directly compare the differences of each data. The author impressively admires his efforts to publish his life work, creating his own data when there had been no reliable data, and intuitively beyond scientific approach. The author's KEWT database, purely endogenous data, is universally and accurately measured by country, 1990-2010, for 81 countries. But without *International Financial Statistics Yearbooks*, IMF, KEWT database does not exist.

From the viewpoint of an open developed country tax system, Sir Mirrlees, J. A. published *Dimensions of Tax Design* (xii, 1347, 2010) and also, *Tax by Design* (xvii, 533, 2011); each as the Mirrlees review / chair and for the Institute for Fiscal Studies (IFS). His intention is, to the author's understanding, to integrate a tax system of the UK, historically, theoretically, empirically, and more openly. His conceptual thought is influenced and supported by Meade, J. E. (1962, Revised) and Meade, J. E., and J. R. N., Stone (1969). It implies that his design for tax system is consistent with KEWT database if the three-item equality of income, expenditures, and output at the SNA (1993) were realized in his use of data. Endogenous data at KEWT database satisfies the three-item equality everywhere. The author indicates that Mirrlees' system is consistent with KEWT database in that statistics data exist always within a certain range of endogenous data; apart from author's policy-oriented integration of real, financial/market, and the central bank. A similarity is related to Mirrlees' neutrality of a tax system.

'The Mirrlees review' directs towards neutrality, openness, and transparency. This thought is traced back to Kant, Immanuel. Reiss, Hans -edited and Nisbet, H. B. -translated (1970, 1977), translated Kant's essence under the title of *Kant's Political Writings*. According to Reiss, H. (189, 16-29 in Appendix, ibid.) human beings only modestly follow genuine principles of right; citing here:

> And in view of the frailty of human nature and the fortuitous circumstances which can intensify its efforts, we can expect man's hopes of progress to be fulfilled only under the positive condition of a higher wisdom (which, if it is invisible to us, is known as providence); and in so far as *human beings* can themselves accomplish anything or anything can be expected of them, it can only be through their negative wisdom in furthering their own ends. In the latte event, they will find themselves compelled to ensure that *war*, the greatest

> obstacle to morality and the invariable enemy of progress, first becomes gradually more humane, then, more infrequent, and finally disappears completely as a mode of aggression. They will thereby enter into a constitution based on genuine principles of right, which is by its very nature capable of constant progress and improvement without forfeiting its strength.

Kant and, accordingly, Reiss, H. concludes: Eternal peace is never a hollow idea but a homework we human beings must obey. This task will be solved gradually by openness and publications as it is.[2] The periods when the same magnitude progress occurs as the goal will become gradually and inevitably shorter. Thus, we human beings approach eternal peace continuously ever and more closely.

What the author wishes express here is that human beings and a variety of systems have historically bright future ahead. Mankind future is beyond religions and, ideas and philosophy and; robustly in harmony with these, beyond the differences between each. Keynesian spirit started with the establishment of IMF in 1944 and is ever alive today.

Turning back to KEWT database by country, KEWT follows scientific proofs defined as the same as mathematics proofs, where any proof, regardless of the difference of partiality levels, holds consistently with the whole proofs as much as possible to spread the level. The *EES* has only one chapter for the Essence of Endogenous System and Geometrical Philosophy. In fact, hyperbolas are tightly related to geometric philosophy. This chapter does not repeat geometric philosophy but follows mathematics proofs with Kant. The author wishes: readers who are interested in hyperbolas in this chapter pay attention to Chapter 10 that steps into 'beyond space and time.' Physics and element chemistry, quantum and macro, have entered into this area earlier and faced at the entrance to prove methodologies to connect spiritual with physical zones. However, they need expensive tools specified for proofs.

Contrarily KEWT does not need any new methodology to prove 'beyond space and time.' A reason is that money magnitudes invented by human are uniquely homogenous quantity-oriented in an open economy and among countries using the exchange markets. As a result, the endogenous system and KEWT database were invented consistently by country, sector, and year and over years. Hyperbolas summed up in this chapter, without device, spread beyond space and time. In a moderate level of the endogenous-equilibrium, the 1$^{st}$ quadrant is a base for hyperbolas. In the close-to-equilibrium, each hyperbola extends its dimension to the 2$^{nd}$ or the 3$^{rd}$ quadrant. These are examined and analyzed in the next section to find facts and hypotheses.

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[2] Also, the author is grateful to Yoshiaki Utsunomiya, translator to Japanese, *For Eternal Peace*, and Iwanami pocket edition 625.9, 1985 up to 2011. The author is deeply impressed with Kunitsugu Kosaka, *Study of Zen/Good* (2006, 518 p.), Kodansha Academic 1781. Also; Daisetsu Suzuki, *Mind of the Orient* (1965, 1996, 208p.), Shunjusha. As Kant foresaw, Peace is coming, harmonizing the West with the Orient.

Lastly, let the author refer to optimum principles in ‘the Mirrlees review’ (see, Mirrlees, James, A., 107-108, 1090-1094, 1104, 2010). The Mirrlees review is supplemented by empirical data. For optimum terminology, there are a few different uses. For example, *Dimensions of Tax Design* (1335 for index, ibid.) shows optimal income tax model, optimal tax theory, and Mirrlees model. According to 2.2.2 at the Mirrlees model (ibid.,101-105), i) the optimal top marginal tax rate, and ii) optimal marginal tax schedule, are each explained, with equations. The methodology differs from KEWT in that the Mirrlees review is much micro-oriented and, aims at the difference of income and uses effective marginal tax rate (EMTR). The importance of *neutrality* and *transparency* in tax design, however, correspond with the spirit of KEWT, apart from each point of view. The Mirrlees review extends its view into changes in population demographics, the growth of new technologies, and the broadened objectives of policy makers, as shown in abstract of *Tax by Design* (2011; see Wikipedia, the free encyclopedia). Each system has its own spread and extension. KEWT does not enter into the micro level but concentrates on the macro integration of economic policies, real, financial, market, and central bank by country and among areas, and towards an optimum policy-system.

Second, turning to Mankiw, Romer, and Weil (1992; here under MRW), MRW starts with the Solow model and separates human capital from physical capital under a *given* rate of technological progress. MRW sets capital quantitative and human capital qualitative. Saving is used for quantitative investment similarly to capital stock. According to empirical analysis in MRW, the rate of saving *positively* and population *negatively* each influence the growth rate; saving/investment and population, each differently from Solow’s. The endogenous-system is based on a discrete Cobb-Douglas (C-D) production function; $Y = AK^{\alpha}L^{1-\alpha}$. Both stocks, capital $K$ and labor $L$, cannot separate quality from quantity. Net investment is flow and its quality is expressed by the rate of technological progress. The rate of technological progress is purely endogenous and qualitative.

The endogenous system accepts human capital, education, R & D, knowledge and leaning by doing, each as an object of strategies to support whole economic policies solely expressed by seven endogenous parameters in the discrete C-D production function. This point definitely differs from neo-classical school: For example, Lucas, R. E. (1988) introduces human capital instead of the level of technology.[3] Romer, P. M. (S71-S102, 1990) selects R & D, instead of human capital, with learning by doing parameter.[4]

Nevertheless, the empirical results of MRW do not contradict those of the

[3] $y_1(t) = H_1^{\theta}k(t)^{\alpha}$ and $y_2(t) = H_2^{\theta}k(t)^{1-\alpha}$.

[4] Romer, P. M. (1986) assumes that the relative share of profit (*alpha*) is 1.0 in his first endogenous model. $y(t) = Ak(t)$. Romer, P. M. (1990) later stresses that R&D-based ideas are vital factors in economic growth: $A(t) = BK(t)^{\phi}$and $Y(t) = K(t)^{\alpha}B^{1-\alpha}K(t)^{\phi(1-\alpha)}L(t)^{1-\alpha}$, where a “learning by doing” parameter that expresses knowledge accumulation, $\phi$ , is related to population growth (refer to Romer , D. (116-117, 1996)). Now assuming $\alpha = 1.0$, $y = Ak^{\alpha}$ reduces to $y = Ak$, but the endogenous-equilibrium is destroyed, as shown in KEWT database.

endogenous system and its database of KEWT 6.12. What is the reason? This is because if empirical results are, though exogenously, close to those of the endogenous system, no contradiction exists. Because, original statistical data are similar and human capital only differently works each at exogenous and endogenous models.

Differences: The endogenous system holds using the discrete C-D production function under constant returns to scale. MRW requires an assumption of constant returns to capital (CRC), even following the market equilibrium.

## 15.5 Conclusions: Empirical Results and Implications as Answers to Unsolved Problems

Researchers have suffered from the mismatches of models and data.[5] Some start with discrete models and finally apply continuous methodology. Others insist no using of the production functions as seen in Keynesian school. An endogenous rate of technological progress is a conclusive factor as shown in the endogenous system. For purely endogenous, any parameter and variable, including national taste or macro utility, must not be estimated or forecasted using assumptions and the correlation coefficient, values of elasticity, and probability. Any parameter and variable must be precisely measured. Three, $i = I/Y$, $n_E = n$, and $\alpha$, must be endogenous, and these three after measurement are fixed in the transitional path.

There are a few facts uniquely found in the endogenous system and KEWT database:

(1) Population and labor are negatively related to technological progress and, endogenously, precisely, and numerically. This is a fact hidden in the neoclassical school historically and, holds commonly to any model and data in the discrete time. Population or labor is a mixture of quantity and quality, similarly to capital. Population or labor, however, *negatively* related to technology, differently to capital. And, the rate of change in population is most fundamentally related to the rate of technological progress.

(2) Ratio of net investment to output, $i = I/Y$, is *negatively* related to the rate of change in population.

(3) The technology coefficient, $\beta^*$, is *negatively* related to the rate of change in population.

(4) The relative share of capital, $\alpha$, is *negatively* related to the rate of change in population.

The above facts imply that the rate of change in population is negatively related to not only the rate of technological progress but also $i = I/Y$, $\beta^*$, and $\alpha$. The above (1), (2), and (3) belong to technological progress. (4) is related to a fact that stop-macro inequality is indifferent of $\alpha$. Policy-makers are endogenously free from a threat that the

[5] Stylized facts of Kaldor (1978) are found in actual statistics data in the discrete time and no mismatch happens. Nevertheless, an endogenous rate of technological progress is derived solely using the discrete time, which neoclassical school has not formulated up to date (see facts of Jones C. I. (1998)).

higher the level of $\alpha$, the worse the stop-macro inequality is. Social policy separated is able to reinforce micro-stop inequality.

The above facts absorb the relationship between unemployment and the rate of change of money wage rates, as investigated by Phillips, A. W. (1958) and price expectations as strictly framed by R. E. Jr., Lucas, et al. (1969). Conclusively no unemployment spreads with no assumption and under perfect competition by country.

Human and technology march together, due to a fact that human capital creates technology. Mankind and food march together and agriculture is a base for life. This fact has been respected historically. Maddison A. (1987, 1995), as the author revisited in the previous section, naturally took this idea and estimated the relationship between population and *GDP*, for so long Centuries surprisingly.

Nevertheless, mankind or human has its will and decision-making, differently from capital. Thus, population or labor has a wider range of technology selected by leaders; between natural science that follows Absolute Existence and social science that accepts money-oriented. Philosophy and idea, therefore, must be a base for technology. The endogenous system remains a receptacle. Results depend on human philosophy. Thus, in the previous section, the author revisited the openness and disclosure of Kant, referring to Nisbet, H. B. (1970), and similar to Mirrlees J. A. (2010, 2011).

This chapter has not referred to demographic, transitional, or post-transitional aspects that are based on the lifecycle of production and consumption. A reason is that the endogenous system holds with an endogenous rate of technological progress under no assumption, while the concept of lifecycle and the reallocation system holds with some assumptions such as a highly stylized model of the economy, steady-state, and golden rule growth, as shown by Wang Feng (7, 8, 2005). The author is stimulated by the proofs of the demographic dividends and the support ratio used as tools for the prime working ages and production-deficit ages.

The author is confident that the age structure will cooperate with the endogenous system in the near future and, that the actual/estimated consumption of demographic study and the endogenous consumption integrated with technology will be precisely connected when the models behind demographic study become completely free from the above assumptions. A clue is the relationship between exogenous and endogenous or $C_{MAX} \leftrightarrow W$ in the literature and $Y = C + S = W + \Pi$ in the endogenous-equilibrium. The author intends to show a preparative framework and empirically compare elasticity results of the assumption-oriented Cobb-Douglas production function with those of author's production function.

Conclusively, Chapter 15 reaches six nature-aspects in Essence of Earth Endogenous System, which is also united with six organic aspects for measure in Notations. Measure and nature in the *EES* are only distinguished by role/function, as summarized in this chapter. Therefore, distinguished characteristics by stream and its school reduce to common essentials, historically and in the current streams. And, we find, these streams approach results of natural science endowed with no human decision.

It implies that agriculture must be a base for human life. Earlier economists suppose this direction to be gradually inclined to money-oriented so called mercantilism with international trade expansion. Eventually, money is the unique assets in that its quality=its quantity in this world. And endogenously, money-neutral prevails by country all over the world, as externally tested by country. For example, agriculture makes us alive by barter trading in under-populated areas in mountains, small islands, and villages far from cities. This fact suggest us up-stream of organic and nature- aspects in the *EES*.

In this sense, sum-up facts listed in Conclusions here are useful to people all over the world. In particular, technology is a strange but everlasting monster in favor of human and people. Strange is endogenous an evidence such that adverse of common sense is correct as in quiz.

Essence of Earth Endogenous System of the top of the *EES* is the unique water filtered from endogenous data under two ways of results = causes. Water after tested by corresponding hyperbolas each reduced from endogenous equations in the *EES*. The author has investigated the first appearance of hyperbola in the literature, whichever of academic fields. The originals appear in the later part of 1850s but, the author confirms that hyperbola remains *supposed* one, not yet concreted historically, and up-date. Here the author never steps into another (spiritual of five-dimensions) world, to order to stay at scientific as in mathematics (see Appendices in Chapter 10).

At the end of this chapter, the author sums up six types of hyperbolas using positive (+) and negative (−) of each diagonal. Policy-makers feel relaxed to know the differences of + and −.

1) Hyperbola of the technology coefficient to changes in net investment, $\beta^*(i)$: +.
2) Hyperbola of the rate of return to changes in net investment, $r^*(i)$: +.
3) Hyperbola of net investment to changes in population, $i(n)$: −.
4) Hyperbola of the technology coefficient to changes in population, $\beta^*(n)$: −.
5) Hyperbola of the rate of return to changes in population, $r^*(n)$:+, as a reduced line.
6) Hyperbola of net investment to changes in population, $\alpha(n)$: −.

The above results are consistent with those in simulations (see, Tables P1 to P3).

## Chapter 15

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# Chapter 15

**<u>Special Note to Wang, Jianxiong</u>:**

This chapter tests each of 36 countries for proving the relationship between the rate of technological progress and the rate of change in population by country. I presented China data-sets in this chapter. One reason is related to my graduate student, Dr. Wang Jianxiong, Shanghai, President of Japan-China Cooperation Association for small and medium enterprises. Jianxiong asked me how to set up and realize an eco- and cyclical-experimental green area at an island in the River facing at City Shanghai. Jianxiong was, exceptionally at that time, a green-oriented student when he was attending at a forest university near his home town. He has not changed his original intention since then. I have similar experiences attending at Lincoln College, Canterbury, New Zealand, in the early 1980s. Lincoln, at University of Canterbury, was established in 1878 by Queen Elizabeth as the first agricultural college in the South Hemisphere. We hope that China will spread green areas with the spirit of Moderation, step by step.

## Proposal to a plan for Island Changxing, Shanghai in China

Theory and practice are united at the endogenous system. Here, I present a proposal. For causes and reasons, see Chapters 14 and 15, and for stage risky difficulties, see Chapter 11. The proposal is successful since endogenous circular is endogenously guaranteed at Island Changxing**.**

The size is similar to Island Oshima, Prefecture Yamaguchi; 160 $km^2$ in length and roughly 67 $km^2$ for living area. Currently, 50,000 people live. After ten years the island has population of 250,000. Ideal area will be realized after years. The plan realizes sustainable moderation between the rate of technology, growth, and returns/profits by year.

Natural agriculture, forest, and fishing are by nature cooperative with small and intermediate enterprises. Environmental Utopia is already indispensable. Once urgently required, this model case spread over other areas in China. China has leadership and execution power, towards clean air, water, and cyclical country. Policies published become moderate and controllable, by single tax rate of rentals for government totally-owned lands, as George Henry's (1898) discovered.

**Results:**

1. Capital and population are fitted for sustainability without bubbles or at the least cost for management.
2. The rate of technological progress is 5-6% by year.
3. The growth rate of output is 8-9% by year.
4. The rate of return is 10-13% at a high level.
5. No inflation and full-employment along with human capital education-oriented.
6. The capital-output ratio is stable and less than 2.5-3.0, where agriculture is a base using no chemicals and preventing medical care in advance.
7. People feel happy, out of money and money, and celebrated by high human philosophy of Island.
8. Economic robustness essentially comes from a fact that government owns lands, whose rentals are replaced by tax increase and thus, endogenously minimize government size.