The Capital-Output Ratio: Its Mathematical Aspect with Recursive Programming

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1. Introduction

This paper is composed of two sections, aiming at theoretical mechanics and empirical evidences on the capital-output ratio in the transitional path: (1) the mathematical approach and solution, by Yoshiomi Furuta, and (2) the structure of recursive programming for the transitional path as a base of endogenous model, by Hideyuki Kamiryo. Both sections use the datasets of Kamiryo Endogenous World Table (KEWT) 4.10 of 59 countries, by country, sector, and year. KEWT 4.10 was renewed in Jan/Feb, 2010, by Hideyuki Kamiryo. KEWT 4.10 includes some of 24 hyperbola equations combined with the endogenous growth model.

The main research in this paper is Furuta's whole mathematical review and summarized approach with proofs. At first and as a preliminary discussion, Kamiryo clarifies its background and some problems inherent in the endogenous model. The endogenous model, for the last few decades, has been tested with recursive programming. The current recursive programming to the transitional path assumes that the initial capital-output ratio equals the capital-output ratio at convergence (or, at steady-state of the literature). This is because without this assumption the essential equations of the endogenous model such as $\Omega^* = (\frac{i \cdot \beta^*(1-\alpha)}{i(1-\beta^*)(1+n)+n(1-\alpha)})$ and $\beta^* = \frac{(1+n)\Omega^* \cdot i + (1-\alpha)\Omega^* \cdot n}{i((1-\alpha)+\Omega^*(1+n))}$ could not be formulated consistently by year, over years, and with no later corrections.

Also, the recursive programming needs another assumption that endogenous parameters such as *beta* (t) and *delta* (t) change each linearly by time/year, during the speed years for convergence and after convergence in the transitional path. As a result, the maximum capital-output ratio under DRC or the minimum capital-output ratio under IRC and the capital-output ratio at convergence differ a little bit or to some extent, depending on the level of diminishing/increasing, by country and by sector.

Yoshiomi Furuta has assisted Kamiryo for the improvement of the endogenous model year by year, exposing mathematical rules and principles and often answering Kamiryo's questions, as a rigid professor of mathematics. Without his advice and suggestions, Kamiryo could not complete the endogenous growth model. This time, Furuta accepted Kamiryo's sincere offer and this joint paper is published. The endogenous model must last, we hope, just like the 'Cobb'-Douglas. KEWT has solved problems, with renewal of KEWT series by year. KEWT series started in 2006; 1.06, 2.07, 3.09, and 4.10 in Jan 2010, after preliminary trial and error series before 2005. KEWT series have reduced assumptions by year and now, $\Omega_0 = \Omega^*$ is only one left. This paper is related to this issue.

2. Review and discussion of Recursive Programming by Kamiryo

The results of recursive programming applied to a country by year match those of the data-sets (in KEWT4.10) of the corresponding country by year. Recursive programming shows the initial values and the values at convergence similarly to the data-sets of KEWT. Recursive programming shows discrete values by time/year in the transitional path, while the data-sets each year show the results after changes in policies during the last one year. Both the data-sets and recursive programming are based on the 'discrete' Cobb-Douglas production function. Note that there is no literature that uses the discrete Cobb-Douglas production function except for the endogenous model and its KEWT data-sets.

2.1 *Framework of recursive programming*

This section first shows basic framework of recursive programming and second procedure of recursive programming. The basic framework is shown using nine endogenous parameters, λ^*, Ω^*, α, β^*, δ_0 and, n, n_G, i, i_G, and several variables of growth rates and rates of return in equilibrium. The basic framework is summarized as follows:

1. Constant endogenous parameters in transitional path are: the ratio of net investment to output, $i = I / Y$, the growth rate of population, n, the relative share of capital, *alpha.*, and the speed years for convergence, $1/\lambda^*$.
2. Endogenous parameters that change by time/year are: the capital-output ratio, *Omega* = *K/Y*, the capital-labor ratio, $k = K/L$.
3. Two endogenous parameters, *beta*(*t*) and *delta*(*t*), by assumption, each change 'linearly' by time/year, using each constant discount rate of *beta* and *delta*.

4. Endogenous variables are: the level of technology or total factor productivity as stock, $A(t)=TFP(t)$, the rate of technological progress, $g_A(t)$, the growth rate of per capita capital, $g_k(t)$, the growth rate of per capita output, $g_y(t)$, the growth rate of capital, $g_K(t)$, and the growth rate of output, $g_Y(t)$, the rate of return, $r(t)$, and the wage rate, $w(t)$.
5. The elasticity of substitution, *sigma*, and the relative price level, p, each maintain 1.0 by time/year in transitional path (note that KEWT shows $sigma \neq 1$ but $p=1$).

Procedure of recursive programming is shown step by step as follows:

1. $\beta(t)=\beta(0)(1+r_\beta)^t$ and $\delta(t)=\delta(0)(1+r_\delta)^t$, where r_β and r_{δ_0} are respectively the discount rate.[1] These discount rates are assumed to change compound by time/year during speed years for convergence in the discrete case; $\beta(t)\to\beta^*$ and $\delta(t)\to\alpha$.
2. $i(t)=i\cdot y(t)$, where $TFP(0)=\dfrac{k(0)^{1-\alpha}}{\Omega(0)}$ and $y(0)=TFP(0)\cdot k(0)^\alpha$. For convenience, A is used for *TFP*.
3. $L(t)=L(0)(1+n)^t$ holds. However, (1) for the first following approach to clarify k and y, $L(0)$ = 1.0000 is used and (2) for the following second approach to clarify absolute values such as K and Y, $L_{POPU}(0)$, is used as actual population at the initial time/year.

For the first approach to clarify k and y:

4. Using $i_K(t)=i(t)\cdot\beta(t)$, $k(t)=k(t-1)+i_K(t)$ holds.
5. Using $i_A(t)=i(t)(1-\beta(t))/k(t)^{\delta(t)}$, $A(t)=A(t-1)+i_A(t)$ holds. Note that $i(t)\neq i_K(t)+i_A(t)$ holds, due to the introduction of $k(t)^{\delta(t)}$ into $i_A(t)$.
6. Each variable of $g_A(t)$, $g_k(t)$, and $g_y(t)$ is calculated using each difference of $A(t)$ and $A(t-1)$, $k(t)$ and $k(t-1)$, and $y(t)$ and $y(t-1)$: e.g., $g_{A(STOCK)}(t)=(A(t)-A(t-1))/A(t-1)$.
7. $\Omega(t)=k(t)/y(t)$ is derived as an endogenous parameter.
8. $r(t)=\alpha/\Omega(t)$ is derived as an endogenous variable. $r(t)=\alpha/\Omega(t)$ reduces to $r(t)=\alpha\cdot A(t)\cdot k(t)^{\alpha-1}$.
9. $w(t)=(1-\alpha)y(t)$ is derived as an endogenous variable.
10. The growth rate of A as stock, $g_{A\ STOCK}(t)$, equals the growth rate of A as flow, $g_{A(FLOW)}(t)$.

1) These discount rates are shown as: $r_\beta=\dfrac{LN(\beta^*)-LN(\beta_0)}{1/\lambda^*}$ and $r_{\delta_o}=\dfrac{LN(\alpha)-LN(\delta_0)}{1/\lambda^*}$ (see 158, *PRSCE*: 49 (Sep, 1), 2008), where $LN(1+r_\beta)\fallingdotseq r_\beta$ holds using Maclaurin's series. The speed of convergence is derived using the growth rate in equilibrium: $speed=\dfrac{1}{(1-\alpha)n+(1-\delta_0)i(1-\beta^*)}=\dfrac{1}{\lambda^*}$.

There are two methods to measure $g_{A\,FLOW}(t)$ in the transitional path: (1) Using $y(t) = A(t)k(t)^{\alpha}$ and $g_y(t) = g_A(t) + \alpha \cdot g_k(t)$, $g_{A\,FLOW}(t) = g_y(t) - \alpha \cdot g_k(t)$ is derived. (2) Using the weighted average of $r(t)$ and $w(t)$, $g_{A\,FLOW}(t) = \alpha \cdot g_r(t) + (1-\alpha)g_w(t)$ is derived.

For the second approach to clarify absolute values such as K and Y:

11. $Y(t) = y(t) \cdot L_{POPUL}(t)$, where $L_{POPUL}(t) = L_{POPUL}(0) \cdot L(t)$.
12. $K(t) = L_{POPUL}(t) \cdot k(t)$.
13. $Y(t) = A(t) \cdot K(t)^{\alpha} \cdot L_{POPUL}(t)^{1-\alpha}$, where $A(t)$ remain unchanged.
14. $W(t) = w(t) \cdot L_{POPUL}(t)$.
15. $\Pi(t) = Y(t) - W(t)$.
16. Elasticity ob substitution, *sigma*: $\sigma_3 = 1.0000$ by time/year holds, where each denominator is weighted average of the two periods: $\sigma_3 = -\Delta k / \Delta(r/w)$.
17. Relative price level, $p = 1.0000$ by time/year holds: $p(t) = (r(t)K(t) + w(t)L_{POPUL}(t)) / Y(t)$.

For the approach to clarify absolute values at convergence such as K^* and Y^*:

1. $A^* = A_0(1+g_A^*)^{1/\lambda^*}$, where $1/\lambda^*$ is the speed years for convergence. The assumption of a constant rate of technological progress is required during the speed years for convergence.
2. $L^* = L_0(1+n)^{1/\lambda^*}$, where the rate of change in population, $n_E = n$, is constant.
3. $k^* = (A^* \cdot \Omega^*)^{\frac{1}{1-\alpha}}$, where the assumption of $\Omega^* = \Omega_0$ is required, as stated already above.
4. $y^* = A^* \cdot k^{*\alpha}$.
5. $K^* = k^* \cdot L^*$.
6. $Y^* = A^* \cdot K^{*\alpha} \cdot L^{*1-\alpha}$.

The above approach is related to the main discussion by Yoshiomi Furuta in this paper. Up to date, there is no way in the literature to measure 'values at convergence,' except for the above approach.

2.3 *Problems to be examined in recursive programming*

A few problems hidden in recursive programming are reviewed in this section. These are shown using Figures in Appendix at the end: (1) Time-series analysis of main variables, (2) the relationship between the capital-output ratio, $\Omega(t)$, and $1 = \Omega(t) \cdot B(t)^{1-\delta(t)}$, where $B(t) = (1-\beta(t)) / \beta(t)$, (3) the relationship between the capital-output ratio, $\Omega(t)$, and the growth rate of output per capita, $g_y(t)$, and (4) the capital-output ratio, $\Omega(t)$, and the capital-labor ratio, $k(t)$.

There is no empirical research of the capital-output ratio in the literature. Neo-classicists have used the capital-labor ratio but no empirical work for capital after 1995, due to some problems, which Kamiryo confirmed directly from PWT researchers. Kamiryo clarifies the four problems as follows:

First, for time series analysis, Kamiryo erased the assumption of diminishing returns to capital (DRC) perceived in the literature. When the transitional path shows increasing returns to capital (IRC) at the initial time/year, the capital-output ratio first increases, and hits the maximum. This point of time corresponds with the capital-output ratio at convergence theoretically. In recursive programming by country, this matching does not precisely occur due to the assumption of $\Omega^{*}=\Omega_{0}$. When the transitional path shows DRC at the initial time/year, the capital-output ratio first decreases, and hits the minimum. This point of time corresponds with the capital-output ratio at convergence theoretically. In recursive programming by country, this matching does not precisely occur due to the assumption of $\Omega^{*}=\Omega_{0}$.[2)] After convergence, DRC turns to IRC or the capital-output ratio turns towards zero in infinite time/year while IRC turns to DRC or the capital-output ratio rises up/disverges towards infinity. Furuta presents a new approach to decrease this inconsistency as shown below, from the aspect of the capital-output ratio.

Second, for $1=\Omega(t)\cdot B(t)^{1-\delta(t)}$, there is some problem to be examined. In recursive programming, this condition does not hold by time/year. It is theoretically true that this condition holds only at convergence. The purpose of the condition is traced back to the endogenous measurement of $delta_0$ at the initial time/year.

Instead of using A as a stock, using $B^{*}=(1-\beta^{*})/\beta^{*}$ as a flow, first define B as $B_{TFP}^{*}\equiv(B^{*})^{1-\delta_0}$. Since $\Omega=\dfrac{k^{1-\alpha}}{A}$ holds (as proved in Kamiryo (Note 19, 38, 2003)) in the C-D production function, this capital-output ratio is expressed as $\Omega=\dfrac{k^{1-\alpha}}{B_{TFP}\cdot k^{1-\delta_0}}$ or $\Omega=\dfrac{k^{\delta_0-\alpha}}{B_{TFP}}$.

At convergence, $\alpha=\delta_0$ holds under constant returns to capital (CRC), resulting in

2) This assumption corresponds with the law of conservation of the capital-output ratio applied to von Neumann (1945–46) turnpike theory and proved by Samuelson (1477–79, 1970). 'The constant capital-output ratio was the reciprocal of the von Neumann interest rate or of the equivalent maximal rate of balanced growth.'

$1 = k^{\delta_0 - \alpha}$. Then, $\Omega^* = \frac{1}{B^*_{TFP}}$ or $\Omega^* = \frac{1}{(B^*)^{1-\delta_0}}$ holds, resulting in $(B^*)^{1-\delta_0} = \frac{1}{\Omega^*}$. Therefore, $1 = \Omega^* \cdot B^{*1-\delta_0}$ holds at convergence and $\delta_0 = 1 - \frac{LN(1/\Omega^*)}{LN(B^*)}$, or $\delta_0 = 1 + \frac{LN(\Omega^*)}{LN(B^*)}$ are derived. In other words, if $\Omega^* = 1/B(t)^{1-\delta(t)}$ holds, there is no problem at all.

In short, $y = A \cdot k^{\alpha}$ is not consistently connected with $B_{TFP} \equiv B^{1-\delta_0}$ in the transitional path over years, except for one point of time/year at convergence. The purpose of B_{TFP}: $TFP_B \equiv B_{TFP} \cdot k^{1-\delta_0}$ is to derive the value of *delta*$_0$. The capital-output ratio and *delta*$_0$ or *beta* are tightly related. For this reason, Kamiryo (151, *JES*, Sep 2006, after revise) assumed that $\Omega^* = \Omega_0$ held. Without *delta*$_0$, DRC, IRC, and CRC are not specified.

Third, for the relationship between $\Omega(t)$ and $g_y(t)$, the patterns differ by country. Nevertheless, it is true that the lower the $g_y(t)$ the higher the $g_y(t)$. This evidence is important to interpret the results of deficit since the higher the deficit to government output the higher the $\Omega_G(t)$.

Fourth, for the relationship between $\Omega(t)$ and $k(t)$, the patterns differ by country. It is true that the capital-labor ratio cannot directly be connected with technology. Kamiryo finds that beyond some level of $k(t)$ remains roughly unchanged. This implies that we can take either $\Omega(t)$ or $k(t)$ after $\Omega(t)$ reaches a constant. Yet, when we observe more precisely, the relationship between $\Omega(t)$ or $k(t)$ is complicated. This implies that it may be impossible to directly formulate the equation of the capital-labor ratio. A fact remains unchanged that we cannot formulate the endogenous model without using the capital-output ratio.

2.4 *Mechanics of the data-sets: endogenous versus actual*

KEWT data-sets differ from one year recursive programming so that direct comparison is inappropriate, although both have 1.0 for the relative price level; $p = 1.0$. KEWT measures variables at convergence by using the endogenous speed years between the initial/current period and at convergence. As a result, the current growth rate of the level of technology as a stock fluctuate over years in 1990–2008 while the endogenous rate of technology as a flow is measured steadily over years. In statistics, actual variables are published yet unstably by year. Endogenous theoretical variables are stable in recursive programming and accordingly in KEWT by year.

Over years (not by year), actual data and endogenous data march in parallel. As a result, actual data cannot be far apart from theoretical data over years. This is another reason why actual current data fluctuate by year. The fluctuation of actual data comes from the change in net investment by year while endogenous data are based on smooth change in net investment in endogenous equilibrium. Actual data result in business cycle. Endogenous data show sustainable robustness by year, smoothening business cycle. And, nine endogenous parameters change by year inconspicuously. Policy-makers must watch these changes underlying in actual data. If policy-makers do not pay attention to these changes of endogenous parameters, some of endogenous parameters such as $delta_0$ suddenly change and the current situation gets into disequilibrium.

For example, each range of g_A^* / g_Y^*, $g_{A(G)}^* / g_{Y(G)}^*$, and $g_{A(PRI)}^* / g_{Y(PRI)}^*$ by country and sector change over years. Yet, for a certain short periods, g_A^* / g_Y^*, $g_{A(G)}^* / g_{Y(G)}^*$, and $g_{A(PRI)}^* / g_{Y(PRI)}^*$ show abnormal values, reflecting sudden unstable speed years for convergence, and this is a signal to disequilibrium. Unstable speed years often occur due to fiscal policy failure. Fiscal policy exists as a clue of real, financial, and market policies.

3. Mathematical new approach to the capital-output ratio by Furuta

3.1 *Purpose of mathematical approach*

As stated above, Kamiryo's recursive programming to the transitional path assumes that the initial capital-output ratio equals the capital-output ratio at convergence: $\Omega^* = \Omega_0$. This is a kind of handy method in order to avoid difficulties for active treatment of his endogenous model and to advance his argument.

The purpose of this section is to present a mathematical method without the handy one and to have a reasonable capital-output ratio $\Omega(t)$. The point of the method is as follows.

In order to have the growth rates of $\beta(t)$ and others necessary for determination of $\Omega(t)$, we need the value $\Omega(t^*)$ and other values related t^*, where t^* is the time/year in the transitional path such that $\Omega(t)$ is maximal (or minimal). This causes a cycle argument, because we could not know t^* in advance. By this reason, we propose the following method, which we call "the approximately convergent method".

Let at first arbitrarily the value of t^* be designated, and calculate the growth rates by means of this t^*. Then the growth rates decide a recursive function $\Omega(t)$, and this $\Omega(t)$ gives a new t^* such that $\Omega(t^*)$ is maximal. The new t^* decides a new $\Omega(t)$ in the same way as above. We continue this procedure, and want to have, if exist, t^* convergent in this procedure. Then, for a fixed country by year, we will have many $\Omega(t)$ depending on t^* designated at first.

However, by testing the BAO condition defined exactly later in **3.4**, it happens that $\Omega(t)$ coincides even if the value of t^* designated at first is different. Then by virtue of the BAO condition, the number of $\Omega(t)$ will become smaller.

The BAO condition is the condition that $1 = B^{*(1-\alpha)}\Omega^*$ is satisfied. This is fundamental to have the relation $\Omega^* = \dfrac{i \cdot \beta^* \cdot (1-\alpha)}{i \cdot (1-\beta^*)(1+n) + n \cdot (1-\alpha)}$ cited in Introduction. We sometimes denote $B^{*(1-\alpha)}\Omega^*$ by BAO.

3.2 *Fundamental data and equations*

In the following, we repeat some of definitions and relations in the previous section for the convenience. $A(t)$, $K(t)$, $L(t)$, $Y(t)$, $I(t)$ are the level of technology, the capital, the labor, the output, the net investment respectively, where t is discrete time/year of the transitional path of recursive programming. We sometimes treat that $\Omega(t)$ is continuous function by interpolation in a suitable way. The initially given data in the model are $K(0)$, $L(0)$, $Y(0)$, $I(0)$, and the constant α as the relative share of capital, n as the rate of change in population. We assume that the Cobb-Douglas production function

(CD) $\quad Y(t) = A(t)K(t)^{\alpha} L(t)^{1-\alpha}.$

holds at each stage t of the transitional path. Let

(1) $\quad \Omega(t) = \dfrac{K(t)}{Y(t)}$ and $k(t) = \dfrac{K(t)}{L(t)}$.

The growth rates $g(A(t))$, $g(K(t))$ of $A(t)$ and $K(t)$ are defined by

(2) $\quad g(A(t)) = i_{A(t)} k(t)^{\alpha-\delta(t)}$, where $i_{A(t)} = \dfrac{I(0)}{Y(0)}(1-\beta(t))$,

(3) $\quad g(K(t)) = i_{K(t)} Y(t) / K(t)$, where $i_{K(t)} = \dfrac{I(0)}{Y(0)}\beta(t)$.

Here, $\beta(t)$ is the quantitative net investment per the sum of quantitative and qualitative net investment, and $\delta(t)$ is defined in **3.4** later as a parameter related with $\beta(t)$ and $\Omega(t)$. Let $g(\beta)$ and $g(\delta)$ be the (discrete) growth rates of $\beta(t)$ and $\delta(t)$ respectively, which are assumed constant rate. If $\beta(0)$, $\delta(0)$, $g(\beta)$ and $g(\delta)$ are given, then $\beta(t)$ and $\delta(t)$ are determined by

(4) $\quad \beta(t) = \beta(0)(1+g(\beta))^t.$

(5) $\delta(t) = \delta(0)(1+g(\delta))^t$.

Moreover, $g(A(t))$ and $g(K(t))$ are determined by (2) and (3). Then we have $\Omega(t)$ by the following recursive procedure:

$$K(t+1) = K(t)(1+g(K(t))).$$
$$A(t+1) = A(t)(1+g(A(t))).$$
$$L(t+1) = L(t)(1+n).$$
$$Y(t+1) = A(t+1)K(t+1)^{\alpha} L(t+1)^{1-\alpha}.$$
$$\Omega(t+1) = \frac{K(t+1)}{Y(t+1)}.$$

Thus, our aim hereafter is how to determine $\beta(0)$, $\delta(0)$, $g(\beta)$ and $g(\delta)$.

3.3 $\Omega(t)$ *and* $\beta(t)$

The Cobb-Douglas production function (CD) implies

$$\Omega(t) = \frac{K(t)}{Y(t)} = \frac{K(t)}{A(t)K(t)^{\alpha} L(t)^{1-\alpha}} = \frac{1}{A(t)} \frac{K(t)^{1-\alpha}}{L(t)^{1-\alpha}} = \frac{k(t)^{1-\alpha}}{A(t)}.$$

Hence

(6) $\Omega(t)A(t) = k(t)^{1-\alpha}$.

In general, the logarithmic derivative $\frac{d(logX(t))}{dx} = \frac{\frac{d(X(t))}{dt}}{X(t)}$ of a function $X(t)$ is equal to the (continuous) growth rate $g(X(t))$ of $X(t)$. Then, (6) implies

(7) $g(\Omega(t)) + g(A(t)) = (1-\alpha)g(k(t))$.

Note that this regards with a relation of discrete growth rates. Because, the discrete growth rate is approximately the same as the continuous growth rate when their values are small.

We have

$$k(t+1) = \frac{K(t+1)}{L(t+1)} = \frac{K(t) + i_{K(t)} Y(t)}{L(t)(1+n)} = \frac{k(t) + i_{K(t)}\ y(t)}{1+n}.$$

by (3). Hence

$$k(t+1) - k(t) = \frac{i_{K(t)} y(t) - nk(t)}{1+n},$$

and we have

(8) $$g(k(t)) = \frac{k(t+1)-k(t)}{k(t)} = \frac{i_{K(t)}y(t)-nk(t)}{(1+n)k(t)} = \frac{1}{1+n}\left(\frac{i_{K(t)}}{\Omega(t)}-n\right).$$

Denote $i = \frac{I(0)}{Y(0)}$. Then it follows from (7), (2), (8) that

$$g(\Omega(t)) + i\cdot(1-\beta(t))k(t)^{\alpha-\delta(t)}.$$

$$= (1-\alpha)\frac{1}{1+n}\left(\frac{i\beta(t)}{\Omega(t)}-n\right).$$

Multiplying $(1+n)\Omega(t)$ to the both side, we have

(9) $$\begin{aligned} &g(\Omega(t))(1+n)\Omega(t) \\ &+i\cdot(1-\beta(t))k(t)^{\alpha-\delta(t)}(1+n)\Omega(t) \\ &=(1-\alpha)(i\beta(t)-n\Omega(t)). \end{aligned}$$

This implies

(10) $$\beta(t) = \frac{g(\Omega(t))(1+n)\Omega(t) + i\cdot k(t)^{\alpha-\delta(t)}(1+n)\Omega(t) + (1-\alpha)n\Omega(t)}{i\cdot k(t)^{\alpha-\delta(t)}(1+n)\Omega(t) + (1-\alpha)\cdot i}.$$

Let us call this the $(\Omega-\beta)$ relation.

We denote by t^* the value t satisfying $g(\Omega(t)) = 0$. This means that t^* is a point at which the slope of $\Omega(t)$ is equal to 0:

$$\left[\frac{d\Omega(t)}{dt}\right]_{t=t^*} = 0.$$

We call t^* the pole or the turning point of $\Omega(t)$. Let $\Omega^* = \Omega(t^*)$, which is called the extremum (the maximal value in many cases) of $\Omega(t)$.

We have $g(\Omega(t)) = g(K(t)) - g(Y(t))$.

And $g(\Omega(t)) = g(k(t)) - g(y(t))$.

Hence t^* coincides with the value t satisfying

(11) $g(K(t)) = g(Y(t))$ or $g(k(t)) = g(y(t))$.

Set $\beta^* = \beta(t^*)$ and $B^* = \frac{1-\beta^*}{\beta^*}$.

3.4 *Definition of $\delta(t)$ and BAO condition*

We define $\delta(t)$ by

(12) $1 = B^{*(1-\delta(t))}\Omega(t)$,

and we call that the BAO condition is satisfied when

(13) $\delta(t^*) = \alpha$,

that is that

(14) $1 = B^{*(1-\alpha)}\Omega^*$.

Let the BAO condition be satisfied. Then the $(\Omega^* - \beta^*)$ relation (10) at $t = t^*$ implies

(15) $$\beta^* = \frac{\Omega^* \cdot (i \cdot (1+n) + (1-\alpha) \cdot n)}{i \cdot (1+n)\Omega^* + (1-\alpha) \cdot i},$$

since $g(\Omega(t^*)) = 0$. We have also

(16) $$\Omega^* = \frac{i \cdot \beta^* \cdot (1-\alpha)}{i \cdot (1-\beta^*)(1+n) + n \cdot (1-\alpha)}.$$

Let us call (15) and (16) the $(\beta^* - \Omega^*)$ formula and the $(\Omega^* - \beta^*)$ formula respectively. Note that these relations are satisfied when the BAO condition is fulfilled.

We defined $\delta(t)$ by (12) $1 = B^{*(1-\delta(t))}\Omega(t)$, where $B^* = (1-\beta^*)/\beta^*$, $\beta^* = \beta(t^*)$. In order to have t^*, we need $\Omega(t)$, and $\Omega(t)$ is defined using $g(A(t))$, which is defined by using $\delta(t)$. Thus the way of definition is cyclic. Hence, we could not calculate them in usual way. We propose now a special method using the BAO condition. We call it "the approximately convergent method".

3.5 *Framework of the approximately convergent method*

(i) Method to determine $\beta(0)$ and $\delta(0)$. (cf. **3.6** below)

(ii) The pole t^* of $\Omega(t)$ and $\beta^* = \beta(t^*)$ are determined after $\Omega(t)$ is given. If t^* and β^* are given previously, what is the method to have the growth rates $g(\beta)$ and $g(\delta)$ and then $\Omega(t)$. (cf. **3.7** below)

(iii) Method to have the most suitable β^* which satisfy the BAO condition, if t^* is given previously.(cf. the first step of **3.8** below)

(iv) Method to have the most suitable t^* which satisfy the BAO condition, if β^* is given previously.(cf. the second step of **3.8** below)

(v) Let β^* be the value determined by the method (iii) from arbitrarily designated t^*, and let t_1^* be the value determined by the method (iv) from this β^*. Then, if $t_1^* \neq t^*$, let t_2^* be the value determined by the method (iii) and (iv) from t_1^* in the same way. Continue this process. If the subscript number i such that $t_i^* = t_{i+1}^*$ can be fined, then set $t_\#^* = t_i^*$ and let $\beta_\#^*$ be β^*, which is used to determine t_{i+1}^* in the method (iv).

(vi) Let t^* designated at first in (iii) change from 1 to 100 by step 1. Then each t^* determines $t_\#^*$ as in (v). Note that $t_\#^*$ is not necessarily different even if t^* is different. However, many number of $t_\#^*$ may be determined, and also many number of $\Omega(t)$ by $t_\#^*$ will be determined. In order to decide the most reasonable one among them, it seems that we need more useful condition related economics. In the present paper, we choose, as a reasonable one, $\Omega(t)$ which appear most frequently in the above procedure.

3.6 *Determination of* $\beta(0)$ *and* $\delta(0)$

Let $t=0$ in (10). Then we have

$$(17)\quad \beta(0) = \frac{g(\Omega(0))(1+n)\Omega(0) + i\cdot k(0)^{\alpha-\delta(0)}(1+n)\Omega(0) + (1-\alpha)\cdot n\cdot \Omega(0)}{i\cdot k(0)^{\alpha-\delta(0)}(1+n)\Omega(0) + (1-\alpha)\cdot i}.$$

In order to get $\beta(0)$, we need $\Omega(1)$, since

$$g(\Omega(0) = [g(\Omega(t))]_{t=0} = (\Omega(1) - \Omega(0)) / \Omega(0).$$

However, we need $\beta(0)$ in order to calculate $\Omega(1)$. This means that the procedure is cyclic. Thus, we assume here in (17) temporarily

$$g(\Omega(0)) = [g(\Omega)]_{t=0} = 0 \text{ and } \delta(0) = 0.$$

Then, later at the stage of $t=1$, we decide the value $\beta(0)$ again by (17) using the above assumption. This temporary assumption is only established here through the section **3** as an unavoidable handy method.

3.7 *Determination of* $g(\beta)$ *and* $g(\delta)$ *by given* t^* *and* β^*

Let t^* be a temporarily designated value of a pole, and let β^* be a temporarily designated value at a pole. We denote them here by *tk*, and *betak* respectively. The growth rates $g(\beta)$ and $g(\delta)$ depending on tk, and betak are determined by

$$g(\beta) = (betak - \beta(0)) / (tk\cdot\beta(0)).$$
$$g(\delta) = (\alpha - \delta(0)) / (tk\cdot\delta(0)).$$

Then $\Omega(t)$ depending on the above *tk*, and *betak* is decided by the recursive programming in

3.2. We denote the pole of this $\Omega(t)$ by $tkk = t(tk, betak)$, that is

$$g(\Omega(tkk)) = 0.$$

Note that tk is used in order to determine the growth rates, but tk is not equals the pole of the obtained $\Omega(t)$, namely $tkk \neq tk$ in general.

3.8 *Application of the BAO condition*

We want to have a pair $t^* = tk$ and $\beta^* = betak$ in the previous section **3.7**, so that the BAO condition (14) is satisfied: $1 = B^{*(1-\alpha)}\Omega^*$, where $\beta^* = \beta(t^*) = \beta(tk)$, $B^* = (1-\beta^*)/\beta^*$, and $\Omega^* = \Omega(t^*) = \Omega(tk)$. However, owing to the inherent calculation error by machine, it is almost impossible to have exactly $1 = B^{*(1-\alpha)}\Omega^*$. Thus we make to have a pair $t^* = tk$ and $\beta^* = betak$, by which the value $B^{*(1-\alpha)}\Omega^*$ becomes as possible as near to 1. It is done by the following procedure:

The first step

(1-1) For a given value of tk, the value of $betak$ make change from 0.01 to 1 by step 0.01. Then for each tk and $betak$, we have $g(\beta)$, $\Omega(t)$ and the pole $tkk = t(tk, betak)$ of $\Omega(t)$ by **3.7**.

(1-2) We calculate $\beta(tkk) = \beta(0)(1+g(\beta))^{tkk}$ and $B^{*(1-\alpha)}\Omega^*$, where $B^* = \dfrac{1-\beta(tkk)}{\beta(tkk)}$, $\Omega^* = \Omega(tkk)$.

(1-3) For a given value of tk, we choose the value of $betak$ among 0.01 to 1 by step 0.01, for which the value of $B^{*(1-\alpha)}\Omega^*$ in (1-2) is nearest to 1.

The second step

(2-1) For the value of $betak$ obtained by the above first step, the value of the renewal tk makes change from 1 to 100 by step 1. Then for each $betak$ and the renewal tk, we have $g(\beta)$, $\Omega(t)$ and the pole $tkk = t(tk, betak)$ of $\Omega(t)$ by **3.7**.

(2-2) We calculate $\beta(tkk) = \beta(0)(1+g(\beta))^{tkk}$ and $B^{*(1-\alpha)}\Omega^*$, where $B^* = \dfrac{1-\beta(tkk)}{\beta(tkk)}$, $\Omega^* = \Omega(tkk)$.

(2-3) For the value of $betak$ obtained by the above first step, we choose the value of the renewal tk among 1 to 100 by step 1, so that the value of $B^{*(1-\alpha)}\Omega^*$ in (2-2) is nearest to 1.

If the given value of tk in (1-1) does not coincide with the value of tk chosen in (2-3), then we replace the value of tk in (1-1) by the value of tk chosen in (2-3), and continue the step 1 and the step 2. We continue this procedure until the both *tk* coincides. We have the coincident *tk* at most 4 times of repeating in experience. We denote the coincident *tk* by $t_{\#}^{*}$, and set $\beta_{\#}^{*} = betak$ which is used to calculate $t_{\#}^{*}$ in (2-1). More precisely, $t_{i+1}^{*} = t(t_i^{*}, \beta_{\#}^{*})$ when $t_{\#}^{*} = t_{i+1}^{*} = t_i^{*}$ is set by the notation of (v) in **3.5**. Then $\Omega(t)$ depending on $t_{\#}^{*}$ and $\beta_{\#}^{*}$ is decided by the recursive programming in **3.2**.

Note that $t_{\#}^{*}$ is not necessarily equal to the pole of $\Omega(t)$ determined by means of $t_{\#}^{*}$ and $\beta_{\#}^{*}$, as stated in **3.7**.

3.9 *Remark for the determination of* $\Omega(t)$

We proposed first to present a mathematical method without the assumption $\Omega^{*} = \Omega_0$, and consider the approximately convergent method. Then we know now that there are many number of possibilities of reasonable $\Omega(t)$, the capital-output ratio in the endogenous model by Hideyuki Kamiryo. More precisely as follows:

(i) We have set the period of the recursive programming be from 1 to 100 by step 1. Then the number of *tk* designated at first in (1-1) is equal to 100, and for each country by year, the pair $t_{\#}^{*}$ and $\beta_{\#}^{*}$ is determined by the way of **3.8**. Hence, the possibility of the number of pair $t_{\#}^{*}$ and $\beta_{\#}^{*}$ may be 100. Thus the number of possibility of $\Omega(t)$ determined in the way **3.8** may also be 100. However, the application of the BAO condition (14) make the number of $\Omega(t)$ smaller, but not equal to 1 in general.

(ii) As stated in (vi) of **3.5**, in order to decide the most reasonable one among them, we need more useful condition probably related in economics. Now, we only propose that to choose $\Omega(t)$ which appear most frequently in the above procedure, and present a part of the main data table at the last of the paper.

3.10 *Data of the approximately convergent method*

We have now data table related to **3.9**. It is indispensable to use of computer for the calculation of the capital-output ratio $\Omega(t)$ because of complicated process. Running time to compute by Excel Macro Program is about 6 minutes a country by year. Thus, it needs about 100 hours to have all data for 60 countries and period from 1990 to 2008, and the size of data file is over ten thousand KB.

The data is separated 3 Excel files as follows:

(1) kmodel explicite data Euro (3200 KB)

(2) kmodel explicite data Non-Euro (3400 KB)
(3) kmodel explicite data Non-Euro-31 (5100 KB)

These files are obtained by Excel Macro Program. The Macro Program Soft is presented in the following file, which is complicated and difficult to read. But it will be useful to make data after 2009 in future.
(4) kmodel macro (150 KB)

For the only calculation to have $\Omega^* = \Omega(t^*)$ and $B^{*(1-\alpha)}\Omega^*$ from the pair $t_{\#}^*$ and $\beta_{\#}^*$, the following Excel Calculation File is prepared independently to the above file: kmodel macro:
(5) kmodel excel calculation (470 KB)

The main part of the kmodel data is simply represented in the following data table:
(6) kmodel data table (200 KB)

The only first part (Euro sector) of this data table is presented at the last of this paper. For all above other data, please ask, with the above number of files, using the author's email address: furuta@forest.ocn.ne.jp

Explanation of items of the data table presented at last of this paper

Items L, n, Y, I, K, α are the initially given data as in Introduction.

For each row, namely each country and year, the initially given data are copies from KEWT.

$\Omega(0) = K/Y$ by the initially given data K and Y.

$t*$ the pole of $\Omega(t)$ decided finally in the way of **3.9**: $t* = t(t\,\#,\ \beta\,\#)$.

$\Omega(t*)$ the extremum of $\Omega(t)$ decided finally in the way of **3.9**.

$\beta(t*) = \beta(0)(1+g(\beta))^{t*}$. by using $g(\beta)$ below.

$\beta\,\#$ is decided finally in the way of **3.9**.

$t\,\#$ is decided finally in the way of **3.9**. Note that $t* \neq t\,\#$ in general.

BAO $= B^{*(1-\alpha)}\Omega^*$, where $\beta^* = \beta(t*)$, $B^* = (1-\beta^*)/\beta^*$, and $\Omega^* = \Omega(t*)$.

$g(\beta) = (\beta\,\# - \beta(0))/((t\,\#)\cdot\beta(0))$: the growth rate of β decided finally in the way of **3.9**.

4. Conclusions

This paper focused the review of the capital-output ratio in terms of the assumption of $\Omega_0 = \Omega^*$, by introducing Furuta's *approximately convergent method* into the endogenous model and its recursive programming. The assumption of $\Omega_0 = \Omega^*$ has been used since 2004 at *JES* 7 (Feb, 2): 51–80, as one of the backbones of the endogenous model. The assumption has been justified by two justifications that (1) the model and its data-sets could connect endogenous data with actual data such as currency supply stock *M*2, ten year debt yield, and the exchange rate financial markets and (2) the model and its data-sets could avoid falling into the tautology between and among endogenous parameters in endogenous equilibrium such as λ^*, Ω^*, α, β^*, δ_0 and, n, i, by sector (the G and PRI sectors).

The above *approximately convergent method* is expressed as an Excel Macro Program and tests the relationship between the capital-output ratio and the initial/current capital-output ratio, Ω_0 and Ω^*, by time/year in recursive programming. Excel Macro Program sets the following two conditions:

1. The pole as the maximum/minimum point convergent time (convergence point of time/year) is within 100 years.
2. The BAO condition, $1 = B^{*(1-\alpha)}\Omega^*$, is satisfied. Accordingly, the $(\Omega^* - \beta^*)$ relation is satisfied; $\beta^* = \dfrac{\Omega^* \cdot (i \cdot (1+n) + (1-\alpha) \cdot n)}{i \cdot (1+n)\Omega^* + (1-\alpha) \cdot i}$.

The above results are summarized by (1) kmodel-explicit-Euro, (2) kmodel-explicit-NonEuro, (3) kmodel-explicit-NonEuro-31. The mathematical conclusion is that there are many number of possibilities of reasonable $\Omega(t)$. This conclusion, however, remains an aspect, when a selected $\Omega(t)$ is not connected with the whole presumption consistency of system to match stable endogenous equilibrium. Yet, mathematical proofs and resultant characteristics are invaluable within the Macro Application. We hope that Furuta's method in this paper is not a final one. The capital-output ratio is the most difficult aspect in the Cobb-Douglas production function. The literature has only used the capital-labor ratio, instead of using the capital-output ratio: There is no paper that sets the capital-output ratio a main aspect in the literature hitherto.

At the endogenous model and its recursive programming, the BAO condition of $1 = B^{*(1-\alpha)}\Omega^*$ only exists at the convergence time/year, while Furuta's Macro Application much more soaks into the whole system. Keynesian models use no production function but their equations are partial. Neo classicists' model use the continuous C-D production function but with differentials. The endogenous model has already conquered each defects and will be strengthened by the help of Furuta's Macro Application in teh future. *beta* and *Omega* supports $delta_0$ in two kinds of recursive programming in parallel. These endogenous parameters continue to hold by time/year with speed years in endogenous equilibrium, in the endogenous model and its data-sets of KEWT series by country and sector, without using recursive programming by time/year between the initial and at convergence time/year. We hope that more device by Furuta will further cultivate the relationship between Ω_0 and Ω^*, in the endogenous model.

We are grateful to the corporation of Dr. Susumu Tokimasa and Dr. Toshimi Fujimoto hereto.

For the formulation of endogenous equations, starting with **the first appearance**:

Kamiryo, Hideyuki. (2003). Furthering the Role of Corporate Finance in Economic Growth. PhD. Thesis at the University of Auckland.

Kamiryo, Hideyuki. (2004). Basics of an Endogenous Growth Model: the Optimum CRC Situation and Conditional Convergence, *Journal of Economic Sciences* 7 (Feb, 2), 51–80. (First appearance to *beta* and *Omega*).

Kamiryo, Hideyuki. (2005). Empirics of A Consumption Function Consistent with A Technology-Golden Rule: Using Three Dimensional Graphs, *Papers of the Research Society of Commerce and Economics* 46 (1), 159–212. (First appearance to *national taste* which integrates utility with time preference at the macro level).

Kamiryo, Hideyuki. (2006). Towards the Relationship between Constant Returns to Scale and Diminishing/Increasing Returns to Scale Using Two Production Functions: with Recursive Programming, *Journal of Economic Sciences* 10 (1), 73–104. (First appearance to *delta* and *lambda;* after revised).

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(see www@riee.tv, www.megaegg.ne.jp/˜kamiryo/, and http://ci.nii.ac.jp/).

country	year	L	n	Y	I	K	α	Ω(0)	t*	Ω(t*)	β(t*)	β#	t#	BAO	g(β)
E1. Austri	1990	7.73	0.009138	1531.105	196.805	1570.9	0.103934	1.025991	86	4.403909	0.837971	0.76	43	1.010117	0.00096
E1. Austri	1991	7.8	0.009056	1637.525	223.425	1794.325	0.103619	1.095754	78	4.454529	0.841472	0.77	39	0.997668	0.000868
E1. Austri	1992	7.82	0.002564	1740.12	221.92	2016.245	0.099828	1.158682	25	2.379678	0.727763	0.71	11	0.981986	0.000157
E1. Austri	1993	7.84	0.002558	1805.485	215.785	2232.03	0.094572	1.23625	28	1.665069	0.637152	0.56	65	1.00009	−0.0024
E1. Austri	1994	7.86	0.002551	1923.465	263.865	2495.895	0.098017	1.297604	29	2.84034	0.763897	0.74	13	0.984961	0.000222
E1. Austri	1995	7.88	0.002545	2053.005	204.105	2700	0.095597	1.315145	11	1.521418	0.614359	0.58	15	0.99849	−0.00231
E1. Austri	1996	7.92	0.005076	2127.21	204.31	2904.31	0.100141	1.365314	41	1.946902	0.677021	0.59	97	1.00024	−0.00249
E1. Austri	1997	7.97	0.006313	2165.46	206.26	3110.57	0.094224	1.436448	13	1.693671	0.641338	0.61	17	1.000484	−0.00227
E1. Austri	1998	7.98	0.001255	2250.205	213.505	3324.075	0.092423	1.477232	9	1.629764	0.63109	0.61	11	1.001161	−0.00204
E1. Austri	1999	7.99	0.001253	172	22.8	274	0.096975	1.593023	21	1.865749	0.666112	0.63	38	0.999987	−0.00133
E1. Austri	2000	8.01	0.002503	180.944	25.944	299.944	0.102631	1.657662	35	2.083124	0.696646	0.64	94	0.987891	−0.00143
E1. Austri	2001	8.04	0.003745	182.75	20.85	320.794	0.092891	1.755371	25	2.101192	0.694101	0.66	43	0.999254	−0.00127
E1. Austri	2002	8.08	0.004975	188.168	15.668	336.462	0.095566	1.788094	49	2.300087	0.715421	0.67	97	0.999186	−0.00138
E1. Austri	2003	8.14	0.007426	192.038	16.638	353.1	0.092995	1.838699	44	2.41836	0.725788	0.69	74	1.000251	−0.0013
E1. Austri	2004	8.19	0.006143	200.208	22.008	375.108	0.10929	1.873591	25	2.311878	0.719231	0.69	37	1.000213	−0.00135
E1. Austri	2005	8.23	0.004884	210.27	24.17	399.278	0.112985	1.898882	21	2.282732	0.717015	0.69	30	1.000714	−0.00135
E1. Austri	2006	8.27	0.00486	221.278	26.178	425.456	0.120272	1.922722	31	2.456736	0.735313	0.69	57	0.999972	−0.00147
E1. Austri	2007	8.31	0.004837	232.888	29.288	454.744	0.139359	1.95263	20	2.378234	0.732477	0.7	29	0.999499	−0.00154
E1. Austri	2008	8.34	0.00361	242.778	31.178	485.922	0.143856	2.001508	30	2.577464	0.751329	0.7	56	1.000157	−0.0016
E2. Belgiu	1990	9.97	0.003018	5503.75	354.75	3615.07	0.100218	0.656838	73	2.411061	0.7289	0.63	26	0.990189	0.000799
E2. Belgiu	1991	9.98	0.001003	5763	278	3893.07	0.10581	0.675528	65	1.934467	0.675276	0.62	23	1.005168	0.000457
E2. Belgiu	1992	10.05	0.007014	6285.84	481.84	4374.91	0.092431	0.695994	12	0.84811	0.454841	0.39	19	0.999641	−0.00443
E2. Belgiu	1993	10.08	0.002985	6365.79	274.79	4649.7	0.09336	0.73042	72	1.86388	0.666881	0.63	27	0.993371	0.000334
E2. Belgiu	1994	10.09	0.000992	6526.3	132.3	4782	0.100065	0.732728	93	1.448194	0.600782	0.61	34	1.002493	-9.7E-05
E2. Belgiu	1995	10.08	−0.00099	7090	218	5000	0.092513	0.705219	6	0.737362	0.417246	0.4	7	0.998508	−0.00361
E2. Belgiu	1996	10.11	0.002976	7192	168	5168	0.095089	0.718576	81	1.356506	0.584233	0.61	32	0.997091	−0.00029
E2. Belgiu	1997	10.13	0.001978	7553	279	5447	0.092459	0.72117	75	1.764097	0.652084	0.62	27	0.997515	0.000277
E2. Belgiu	1998	10.14	0.000987	7823	390	5837	0.095331	0.746133	87	2.498357	0.735681	0.65	31	0.989635	0.000682
E2. Belgiu	1999	10.17	0.002959	202	9	155	0.093638	0.767327	11	0.825653	0.447264	0.41	16	1.000324	−0.00294
E2. Belgiu	2000	10.19	0.001967	212	11	166	0.092623	0.783019	6	0.821381	0.445746	0.42	8	1.000926	−0.00261
E2. Belgiu	2001	10.23	0.003925	227.92	18.92	184.92	0.108421	0.811337	7	0.886011	0.466102	0.43	10	1.000051	−0.00292
E2. Belgiu	2002	10.27	0.0003	237.448	19.448	204.368	0.113085	0.860685	4	0.912665	0.469964	0.45	5	1.015416	−0.00255
E2. Belgiu	2003	10.31	0.003895	229	2	206.368	0.10023	0.90117	5	0.908387	0.473319	0.12	21	1.000033	−0.01865
E2. Belgiu	2004	10.36	−0.005	255.2	20.2	226.568	0.106174	0.887806	39	1.893299	0.672549	0.59	13	0.995013	0.000631
E2. Belgiu	2005	10.42	−0.005	259.72	18.72	245.288	0.094613	0.944432	44	1.915638	0.675048	0.59	14	0.988188	0.000607
E2. Belgiu	2006	10.47	−0.005	276.66	26.66	271.948	0.104464	0.982968	48	2.436034	0.726881	0.63	17	1.013865	0.00075
E2. Belgiu	2007	10.53	0.005731	284.3958	23.39577	295.3438	0.095463	1.038496	74	2.651892	0.744393	0.69	37	1.008423	0.000744
E2. Belgiu	2008	10.59	0.005698	294.12	30.12	325.4638	0.092861	1.106568	37	1.434663	0.598302	0.53	95	0.999531	−0.00209
3. Finland	1990	4.99	0.006048	438.1155	67.5955	278.8458	0.102097	0.636466	22	0.886779	0.466547	0.37	69	1.000169	−0.00367
3. Finland	1991	5.01	0.004008	408.7395	18.4395	297.2853	0.146728	0.727322	31	0.951219	0.485149	0.39	57	1.000693	−0.00496
3. Finland	1992	5.04	−0.0004	405.263	8.313	305.5983	0.14836	0.754074	38	0.874653	0.46118	0.41	54	0.998583	−0.00412
3. Finland	1993	5.07	0.005952	419.688	6.258	311.8563	0.104282	0.743067	38	0.833248	0.449253	0.29	77	1.000024	−0.00887
3. Finland	1994	5.09	0.003945	455.8685	24.94848	336.8048	0.096101	0.73882	81	2.143006	0.697438	0.62	32	1.007365	0.000769
3. Finland	1995	5.11	0.003929	501.8552	53.1952	390	0.115094	0.777117	14	0.997826	0.485366	0.42	24	1.050892	−0.00371
3. Finland	1996	5.13	−0.0004	519.3408	45.0208	435.0208	0.104059	0.83764	5	0.881725	0.468381	0.45	6	0.987666	−0.00286
3. Finland	1997	5.14	−0.005	562.8656	54.7056	489.7264	0.133725	0.870059	5	0.933493	0.480848	0.46	6	0.997577	−0.00324
3. Finland	1998	5.15	−0.008	612.48	70.04	559.7664	0.169306	0.913934	26	2.263761	0.724857	0.7	11	1.012423	0.000171
3. Finland	1999	5.16	0.001942	107.9672	10.8472	83	0.19459	0.768752	30	1.09854	0.529235	0.41	79	0.999689	−0.00434
3. Finland	2000	5.17	−0.008	116.336	13.216	96.216	0.226181	0.827053	4	0.87936	0.469042	0.44	5	0.967912	−0.00404
3. Finland	2001	5.19	−0.01	123.0152	13.3652	109.5812	0.228703	0.890794	16	1.161851	0.532618	0.46	27	1.050471	−0.00386
3. Finland	2002	5.2	−0.008	126.5528	11.1328	120.714	0.189529	0.953863	59	2.941963	0.793633	0.7	23	0.987482	0.000732
3. Finland	2003	5.21	0.001923	128.304	12.264	132.978	0.137311	1.036429	66	2.955427	0.775906	0.71	31	1.012287	0.000748
3. Finland	2004	5.23	0.003839	130.849	7.629	140.607	0.111215	1.074575	75	2.296989	0.718438	0.69	39	0.999051	0.000421
3. Finland	2005	5.24	0.001912	135.0802	10.9802	151.5872	0.103859	1.122201	80	2.963256	0.770225	0.7	36	1.002337	0.000761
3. Finland	2006	5.26	0.003817	143.6286	12.2686	163.8558	0.11139	1.14083	36	1.467263	0.60612	0.54	79	1.000378	−0.00223
3. Finland	2007	5.28	0.003802	154.5076	16.4976	180.3534	0.131073	1.167279	12	1.359416	0.587191	0.55	17	1.000875	−0.00239
3. Finland	2008	5.3	0.003788	160.0976	17.3176	197.671	0.109182	1.234691	59	3.092291	0.780034	0.73	29	1.001256	0.000606
4. France	1990	56.73	0.005495	5533.075	543.175	7393.29	0.097756	1.336199	12	1.55998	0.620246	0.59	16	1.00204	−0.00214
4. France	1991	57.05	0.005641	5759.77	479.87	7873.16	0.101598	1.366923	14	1.604884	0.627855	0.6	18	1.00317	−0.00217
4. France	1992	57.37	0.005609	5949.66	384.16	8257.32	0.109032	1.387864	19	1.655132	0.637968	0.61	24	0.999097	−0.00227
4. France	1993	57.65	0.004881	6015.535	208.135	8465.455	0.129926	1.407266	37	1.747035	0.654986	0.67	33	1.000175	−0.00187
4. France	1994	57.9	0.004337	6281.245	273.545	8739	0.118456	1.391285	47	1.805001	0.66148	0.61	71	1.000016	−0.00248
4. France	1995	58.2	0.005181	6601.6	261	9000	0.134344	1.363306	26	1.65565	0.641825	0.67	21	0.999261	−0.00182
4. France	1996	58.41	0.003608	6782.2	157.3	9157.3	0.142758	1.350196	55	1.680214	0.646995	0.65	54	0.999557	−0.0023
4. France	1997	58.59	0.003082	7029.6	142.3	9299.6	0.122148	1.32292	49	1.583641	0.627817	0.64	45	1.000729	−0.00215
4. France	1998	58.75	0.002731	7369.8	272.1	9571.7	0.10767	1.298773	99	2.523661	0.737686	0.74	54	1.003066	−5E−05
4. France	1999	58.94	0.003234	1174.9	50.6	1600	0.098954	1.361818	50	1.664504	0.637841	0.6	79	0.999532	−0.00173
4. France	2000	59.19	0.004242	1224.1	57.9	1657.9	0.106345	1.354383	29	1.592514	0.627524	0.61	35	0.999177	−0.00173
4. France	2001	59.49	0.005068	1326.1	111.8	1769.7	0.092419	1.334515	21	1.565028	0.621105	0.59	31	0.999341	−0.00168
4. France	2002	59.85	0.006051	1355.9	96.9	1866.6	0.09495	1.37665	48	1.793408	0.655871	0.6	98	1.000408	−0.00182
4. France	2003	60.23	0.006349	1400.6	96.1	1962.7	0.097876	1.401328	40	1.789263	0.656031	0.61	69	0.99934	−0.0018
4. France	2004	60.63	0.006641	1386.267	37.567	2000.267	0.146187	1.442916	72	1.774385	0.724786	0.69	98	0.776221	−0.0019
4. France	2005	61.01	0.006268	1441.294	55.0935	2055.361	0.149133	1.426053	85	2.103575	0.711592	0.7	97	0.9755	−0.00137
4. France	2006	61.37	0.005901	1508.344	70.544	2125.905	0.143874	1.409429	43	1.861826	0.674364	0.67	45	0.998308	−0.00157
4. France	2007	61.71	0.00554	1663.442	168.8424	2294.747	0.095593	1.379517	17	1.628413	0.631316	0.6	25	1.001155	−0.00169
4. France	2008	62.04	0.005348	1710.064	189.2637	2484.011	0.096356	1.452584	29	1.822803	0.660345	0.61	58	0.999604	−0.00167
5. German	1990	79.36	0.008643	2028.549	214.749	2943.851	0.098592	1.45121	22	1.795576	0.656851	0.62	34	1.00005	−0.00173
5. German	1991	79.98	0.007813	2382.756	227.656	3171.507	0.100543	1.331024	32	1.738948	0.649107	0.59	64	1.00001	−0.002
5. German	1992	80.57	0.007377	2568.126	217.926	3389.433	0.104538	1.319808	3	1.364392	0.585955	0.59	3	0.999745	−0.00207
5. German	1993	81.19	0.007695	2634.342	162.5415	3551.974	0.11533	1.348335	20	1.627091	0.634156	0.64	19	1.000147	−0.00167
5. German	1994	81.41	0.00271	2772.451	214.2505	3766.225	0.101612	1.358446	35	1.679422	0.640518	0.59	66	0.999531	−0.00183
5. German	1995	81.66	0.003071	3018.776	233.7755	4000	0.106294	1.325041	72	3.017578	0.773466	0.74	37	1.007021	0.000445
5. German	1996	81.91	0.003061	3064.033	188.5325	4188.533	0.113321	1.367	19	1.565259	0.623668	0.6	24	1.00015	−0.00196
5. German	1997	81.95	0.000488	3128.328	199.8275	4388.36	0.109553	1.402782	17	1.564837	0.622997	0.6	22	1.00052	−0.00175
5. German	1998	82	0.00061	3209.657	236.0565	4624.417	0.103805	1.440782	68	3.029694	0.774232	0.74	32	1.004032	0.000377
5. German	1999	82.03	0.000366	1673.6	115.5	2570	0.112769	1.535612	13	1.770734	0.657179	0.68	8	0.994048	−0.0006
5. German	2000	82.08	0.00061	1713.2	119.1	2689.1	0.116661	1.569636	33	1.844952	0.666709	0.63	54	1.000001	−0.00152
5. German	2001	82.15	0.000853	1775.5	95.2	2784.3	0.113548	1.568178	48	1.875839	0.670493	0.63	83	0.999308	−0.00153

5. German	2002	82.23	0.000974	1812.647	66.147	2850.447	0.105066	1.572533	24	1.715125	0.646246	0.64	26	1.000218	−0.00135
5. German	2003	82.32	0.001094	1843.957	71.657	2922.104	0.103981	1.584692	29	1.758566	0.652453	0.64	34	1.000152	−0.00137
5. German	2004	82.38	0.000729	1922.838	69.738	2991.842	0.092464	1.555951	30	1.706826	0.643032	0.63	36	1.000508	−0.00128
5. German	2005	82.41	0.000364	1929.152	37.352	3029.194	0.094452	1.57022	71	1.742995	0.650234	0.63	94	0.994122	−0.00133
5. German	2006	82.39	−0.00024	1996.49	43.59	3072.784	0.092378	1.539093	2	1.546333	0.617775	0.62	2	1.000122	−0.00121
5. German	2007	82.34	−0.00061	2043.353	21.75271	3094.537	0.092793	1.514441	26	1.579259	0.623246	0.65	12	1.000315	−0.00038
5. German	2008	82.26	−0.00097	2139.68	90.58	3185.117	0.100586	1.488595	11	1.540617	0.616157	0.61	12	1.00654	−0.00133
6. Greece	1990	10.16	0.0003	11828.79	1324.69	9192.349	0.178318	0.777117	18	1.234796	0.56018	0.42	36	1.01222	−0.00607
6. Greece	1991	10.25	0.0003	14607.45	1971.25	11163.6	0.159397	0.76424	29	1.415365	0.615217	0.42	98	0.95399	−0.00572
6. Greece	1992	10.32	0.0003	16810.2	1908.1	13071.7	0.169339	0.777605	94	5.952308	0.895117	0.81	40	1.002755	0.000665
6. Greece	1993	10.38	0.0003	18995.58	2317.18	15388.88	0.180619	0.810129	39	3.211885	0.802387	0.79	18	1.018852	3.16E−05
6. Greece	1994	10.43	−0.005	21617.78	3340.178	18729.06	0.162643	0.866373	23	2.693877	0.80908	0.78	9	0.803967	0.000123
6. Greece	1995	10.66	0.022052	25328.64	1270.943	20000	0.13112	0.78962	54	1.24076	0.561855	0.59	47	0.999639	−0.00327
6. Greece	1996	10.74	−0.005	26941.68	2096.18	22096.18	0.172357	0.820149	17	1.136028	0.538513	0.44	27	0.999786	−0.00577
6. Greece	1997	10.81	−0.005	34134.76	6756.16	28852.34	0.116941	0.845248	40	4.941705	0.856127	0.75	15	1.023046	0.000715
6. Greece	1998	10.86	−0.016	37116.76	7792.456	36644.8	0.119532	0.987284	40	6.087367	0.877562	0.77	14	1.074757	0.000611
6. Greece	1999	10.91	0.004604	39548.41	9291.108	45935.9	0.132025	1.161511	64	8.064739	0.91635	0.85	29	1.009824	0.000538
6. Greece	2000	10.94	−0.016	125.396	20.496	45956.4	0.172755	0.85	0	0	0	0.02	99	0	−0.03971
6. Greece	2001	10.97	0.002742	134.688	38.488	100	0.11294	0.742457	19	2.37746	0.680674	0.58	8	1.214877	0.001075
6. Greece	2002	11	−0.016	136.242	33.542	133.542	0.095157	0.980182	34	3.345118	0.744877	0.61	13	1.268696	0.001099
6. Greece	2003	11.02	0.001818	149.118	40.118	173.66	0.093325	1.164581	5	1.200817	0.593809	0.54	15	0.851041	−0.00153
6. Greece	2004	11.04	0.001815	161.733	19.333	192.993	0.210725	1.193282	29	1.641841	0.652117	0.56	67	0.999871	−0.00284
6. Greece	2005	11.06	0.001812	171.912	18.712	211.705	0.226021	1.231473	37	2.477895	0.763476	0.76	22	1.000438	−2E−05
6. Greece	2006	11.09	0.002712	185.484	22.684	234.389	0.220002	1.263662	29	1.753471	0.672657	0.58	64	0.999822	−0.00286
6. Greece	2007	11.11	0.001803	198.534	28.334	262.723	0.22396	1.323315	53	3.699872	0.842864	0.81	29	1.004798	0.000385
6. Greece	2008	11.14	0.0027	211.323	27.623	290.346	0.227145	1.373944	22	1.851601	0.688984	0.61	42	1.001342	−0.0027
7. Ireland	1990	3.5	−0.00285	23.79125	5.36925	3.92558	0.121539	0.165001	0	0	0	0.09	1	0.965228	−0.00573
7. Ireland	1991	3.52	0.005714	24.696	4.788	8.71358	0.102579	0.352834	19	0.406857	0.269272	0.21	58	0.996624	−0.00397
7. Ireland	1992	3.55	0.008523	26.2325	4.3505	13.06408	0.098336	0.498011	13	0.582619	0.349408	0.28	36	1.020499	−0.00373
7. Ireland	1993	3.56	0.002817	28.19075	4.31875	17.38283	0.114907	0.616615	16	0.729676	0.411661	0.35	42	1.000917	−0.00284
7. Ireland	1994	3.57	0.002809	31.01116	5.19016	22.57299	0.128389	0.727899	17	0.886972	0.465593	0.4	44	1.000206	−0.00269
7. Ireland	1995	3.61	−0.016	36.85401	7.42701	30	0.200282	0.814023	16	1.861321	0.669811	0.61	7	1.057197	0.000527
7. Ireland	1996	3.64	−0.025	40.61426	8.62526	38.62526	0.229949	0.951027	38	3.86625	0.826054	0.7	16	1.164876	0.000944
7. Ireland	1997	3.67	0.008242	46.9564	11.4354	50.06066	0.315456	1.066109	31	3.085697	0.836226	0.81	19	1.010749	0.000261
7. Ireland	1998	3.71	0.010899	53.00925	14.29425	64.35491	0.340587	1.214032	21	2.001031	0.738997	0.58	68	1.007398	−0.00377
7. Ireland	1999	3.75	0.010782	79.2855	22.8455	89	0.414372	1.122526	36	3.917128	0.913152	0.89	22	0.987604	7.91E−05
7. Ireland	2000	3.8	0.013333	91.72625	27.11525	116.1153	0.424244	1.265889	24	2.406015	0.801299	0.61	84	1.078011	−0.00408
7. Ireland	2001	3.87	0.018421	102.3146	29.82363	145.9389	0.428921	1.426374	22	2.484232	0.827439	0.66	70	1.014857	−0.0035
7. Ireland	2002	3.94	0.018088	113.9758	33.92275	179.8616	0.444949	1.578069	21	2.635667	0.849522	0.7	63	1.008457	−0.00308
7. Ireland	2003	4.02	0.020305	122.2926	34.84463	214.7063	0.446665	1.755676	21	2.783176	0.864251	0.74	56	0.999341	−0.00262
7. Ireland	2004	4.1	0.0199	130.4608	38.73175	253.438	0.454483	1.942638	18	2.8504	0.872394	0.77	42	0.998815	−0.0023
7. Ireland	2005	4.19	0.021951	141.8296	46.61763	300.0556	0.454273	2.115606	20	3.208458	0.894337	0.79	53	1.000211	−0.00209
7. Ireland	2006	4.27	0.019093	154.6641	50.62312	350.6788	0.447888	2.267357	27	3.752311	0.916469	0.8	95	0.999889	−0.00199
7. Ireland	2007	4.36	0.021077	166.0321	54.94513	405.6239	0.410468	2.443045	5	2.759522	0.850393	0.81	7	0.990682	−0.00184
7. Ireland	2008	4.44	0.018349	159.089	43.31	448.9339	0.258364	2.821904	34	4.502399	0.883767	0.82	77	1.000129	−0.00141
8. Italy 34	1990	57.66	0.002086	1179.63	162.83	662.24	0.093261	0.561396	12	0.663717	0.38462	0.33	27	1.016385	−0.003
8. Italy 34	1991	56.76	−0.01561	1284.84	176.44	838.68	0.092453	0.652751	15	0.769031	0.393474	0.38	21	1.138946	−0.00143
8. Italy 34	1992	56.86	0.001762	1352.25	142.85	981.53	0.093077	0.72585	9	0.820434	0.435908	0.4	14	1.036523	−0.00262
8. Italy 34	1993	57.05	0.003342	1395.27	107.27	1088.8	0.092462	0.780351	8	0.854302	0.456622	0.42	12	1.000394	−0.0027
8. Italy 34	1994	57.2	0.002629	1474.83	118.63	1207.43	0.092378	0.818691	21	0.965012	0.490385	0.44	40	0.999296	−0.00241
8. Italy 34	1995	57.3	0.0002	1608.57	192.57	1400	0.112851	0.870338	31	1.109027	0.53764	0.46	96	0.970116	−0.00246
8. Italy 34	1996	57.38	−0.003	1674.024	149.724	1549.724	0.099112	0.925748	51	2.353073	0.719087	0.62	18	1.008982	0.000787
8. Italy 34	1997	57.1	−0.00488	1787.016	162.516	1712.24	0.096747	0.958156	52	2.483372	0.723211	0.62	18	1.042989	0.00079
8. Italy 34	1998	57.04	−0.00105	1842.679	158.6795	1870.919	0.092659	1.015326	62	2.599544	0.744464	0.65	23	0.985225	0.00078
8. Italy 34	1999	57.03	−0.00018	961.722	65.622	1000	0.099135	1.039802	59	2.132871	0.69993	0.64	24	0.994485	0.000588
8. Italy 34	2000	57.12	0.001578	1010.707	75.107	1075.107	0.104537	1.063718	8	1.146405	0.538387	0.52	10	0.998863	−0.0019
8. Italy 34	2001	57.31	0.003326	1067.166	83.566	1158.673	0.098135	1.085748	70	2.511998	0.735593	0.68	33	0.998301	0.000678
8. Italy 34	2002	57.59	0.004886	1101.809	90.409	1249.082	0.099545	1.133665	21	1.33919	0.580637	0.54	34	0.999069	−0.002
8. Italy 34	2003	57.93	0.005904	1134.129	85.829	1334.911	0.107611	1.177036	79	2.687206	0.751585	0.72	45	1.000553	0.000547
8. Italy 34	2004	58.29	0.006214	1184.023	89.923	1424.834	0.103651	1.203384	34	1.522536	0.614955	0.56	64	1.000716	−0.00209
8. Italy 34	2005	58.65	0.006176	1215.561	86.36137	1511.195	0.112884	1.243208	15	1.424766	0.598387	0.58	18	1.000272	−0.00201
8. Italy 34	2006	58.98	0.005627	1263.153	101.353	1612.548	0.111065	1.276606	24	1.545185	0.619916	0.58	37	1.000283	−0.00199
8. Italy 34	2007	59.31	0.005595	1306.49	108.89	1721.438	0.107757	1.317606	4	1.370374	0.587561	0.59	4	0.999326	−0.00188
8. Italy 34	2008	59.6	0.00489	1327.547	111.2474	1832.686	0.117299	1.380505	38	1.777199	0.657412	0.6	75	0.999709	−0.00194
9. Luxemb	1995	0.4134	0.0003	542.544	17.644	400	0.166634	0.737267	18	0.883358	0.462866	0.4	24	0.99999	−0.00624
9. Luxemb	1996	0.4175	0.009918	554.364	15.664	415.664	0.145854	0.749803	26	0.903383	0.47038	0.36	40	0.99971	−0.00795
9. Luxemb	1997	0.4224	0.011737	549.6	20.5	436.164	0.092952	0.793603	68	1.369832	0.58595	0.64	39	0.999717	−0.00121
9. Luxemb	1998	0.427	0.0003	562	34.8	470.964	0.069997	0.838014	21	1.344635	0.57779	0.59	7	1.004384	−0.00012
9. Luxemb	1999	0.432	−0.007	16.716	2.516	14	0.184402	0.837521	39	3.081207	0.799372	0.7	16	0.99786	0.000816
9. Luxemb	2000	0.436	−0.19	18.04	3.64	17.64	0.190457	0.977827	0	0	0	0.02	99	0	−0.02936
9. Luxemb	2001	0.44	0.009174	18.532	1.732	19.372	0.137873	1.045327	91	3.320143	0.800715	0.76	54	1.000987	0.000739
9. Luxemb	2002	0.444	0.009091	19.68	1.38	20.752	0.137398	1.054472	27	1.387707	0.593531	0.52	46	1.001086	−0.00333
9. Luxemb	2003	0.4488	0.010811	21.156	1.156	21.908	0.18597	1.035545	99	2.277814	0.733544	0.74	85	0.998865	−0.00057
9. Luxemb	2004	0.453	0.009358	23.65	2.05	23.958	0.229056	1.013023	89	3.235296	0.821541	0.81	59	0.997032	0.000223
9. Luxemb	2005	0.4572	0.009272	25.368	1.868	25.826	0.247765	1.018054	84	2.775334	0.795519	0.8	59	0.998845	−0.00019
9. Luxemb	2006	0.4622	0.010936	28.476	1.276	27.102	0.317329	0.951749	91	1.852144	0.711425	0.71	92	1.000362	−0.00213
9. Luxemb	2007	0.4668	0.009952	30.94	1.84	28.942	0.354398	0.935423	45	1.480785	0.648571	0.46	96	0.996975	−0.00667
9. Luxemb	2008	0.4716	0.010283	31.195	2.395	31.337	0.298592	1.004552	91	2.94005	0.82282	0.83	68	1.001366	−0.00033
10. Nether	1990	14.95	0.006734	467.973	67.073	317.1746	0.178519	0.677763	23	1.01684	0.505034	0.37	69	1.000159	−0.00497
10. Nether	1991	15.07	0.0002	497.112	71.912	389.0866	0.182617	0.782694	20	1.110522	0.531843	0.42	50	1.000576	−0.00421
10. Nether	1992	15.18	−0.007	518.672	71.272	460.3586	0.160294	0.887572	19	1.275833	0.518064	0.46	32	1.200695	−0.00319
10. Nether	1993	15.29	0.007246	526.698	57.598	517.9566	0.140702	0.983403	79	3.404198	0.807669	0.74	41	0.992007	0.000911
10. Nether	1994	15.36	0.004578	511.68	23.28	541.2366	0.092473	1.057764	14	1.162272	0.5413	0.52	17	1.000111	−0.00243
10. Nether	1995	15.46	0.00651	569.3634	58.7634	600	0.150137	1.053809	82	3.515087	0.814741	0.76	44	0.998318	0.00077
10. Nether	1996	15.56	0.006468	593.5571	63.55707	663.5571	0.143927	1.117933	86	3.763938	0.826186	0.77	46	0.991029	0.000776
10. Nether	1997	15.64	0.005141	616.0667	56.46667	720.0237	0.126885	1.168743	22	1.464067	0.607011	0.55	37	1.001618	−0.00256
10. Nether	1998	15.74	0.006394	650.6885	56.68846	776.7122	0.123635	1.193678	16	1.437431	0.602056	0.56	23	1.000007	−0.00252
10. Nether	1999	15.83	0.005718	331.5527	29.3527	400	0.114197	1.206445	29	1.524658	0.616627	0.56	55	1.000788	−0.00214
10. Nether	2000	15.92	0.005685	358.853	23.953	423.953	0.121064	1.181411	21	1.415467	0.597988	0.56	30	0.998444	−0.0023
10. Nether	2001	16	0.005025	375.3069	20.40691	444.3599	0.099426	1.183991	22	1.376836	0.587384	0.56	29	1.001742	−0.00208
10. Nether	2002	16.08	0.005	399.3742	21.4742	465.8341	0.105193	1.16641	87	2.385717	0.726261	0.71	51	0.996412	0.000306

10. Nether	2003	16.16	0.004975	409.4187	19.11865	484.9528	0.099862	1.184491	34	1.434924	0.59913	0.56	50	0.9994	−0.00219
10. Nether	2004	16.24	0.00495	431.6174	20.61744	505.5702	0.128017	1.171339	28	1.407249	0.596648	0.56	38	1.00024	−0.00251
10. Nether	2005	16.32	0.004926	440.7539	26.3539	531.9241	0.122119	1.206851	15	1.375935	0.590335	0.57	18	0.998402	−0.00225
10. Nether	2006	16.39	0.004289	474.4101	28.41013	560.3342	0.154873	1.181118	25	1.443406	0.60676	0.56	36	1.000462	−0.00274
10. Nether	2007	16.46	0.004271	498.3108	27.61077	587.945	0.161938	1.179876	33	1.504373	0.619467	0.56	52	1.000001	−0.00287
10. Nether	2008	16.53	0.004253	522.475	50.47502	638.42	0.171197	1.221915	17	1.526189	0.624407	0.57	26	1.001497	−0.00278
11. Portug	1990	9.9	−0.00402	8147.335	1325.235	1312.632	0.178209	0.161112	2	0.183271	0.120627	0.1	3	0.937731	−0.01172
11. Portug	1991	9.87	−0.00303	9587.113	1547.513	2860.144	0.185214	0.298332	0	0	0	0.02	99	0	−0.033
11. Portug	1992	9.86	−0.00101	10935.94	1835.436	4695.58	0.159643	0.429372	0	0	0	0.26	1	1.0338	−0.00812
11. Portug	1993	9.87	0.001014	11097.96	2054.96	6750.54	0.131452	0.608269	43	4.06528	0.832009	0.69	16	1.012949	0.001019
11. Portug	1994	9.92	0.005066	13332.3	2608.5	9359.04	0.101504	0.701982	2	0.847221	0.626256	0.62	1	0.532811	2.42E−05
11. Portug	1995	10.03	−0.008	15485.96	3540.96	12900	0.097964	0.833013	3	0.936921	0.483029	0.45	4	0.99611	−0.00357
11. Portug	1996	10.06	−0.008	16136.64	3427.64	16327.64	0.092423	1.011836	42	5.340131	0.851724	0.73	15	1.092681	0.000806
11. Portug	1997	10.09	0.002982	16982.2	3704.2	20031.84	0.092477	1.179579	5	1.676081	0.737887	0.73	2	0.655182	1.34E−05
11. Portug	1998	10.13	0.003964	16840.25	2695.25	22727.09	0.176233	1.34957	80	7.267282	0.918389	0.89	40	0.989385	0.000238
11. Portug	1999	10.18	0.004936	99918.88	17468.88	115000	0.120845	1.150934	46	5.121905	0.86247	0.83	21	1.019626	0.000262
11. Portug	2000	10.23	0.004912	106986.3	18576.25	133576.3	0.131462	1.248537	77	7.64292	0.912693	0.87	36	0.995356	0.000361
11. Portug	2001	10.28	0.004888	113145.4	18867.38	152443.6	0.12783	1.347325	42	4.871564	0.858279	0.85	20	1.012658	2.99E−05
11. Portug	2002	10.35	0.006809	118504.8	17231.75	169675.4	0.129964	1.431802	82	6.796828	0.899743	0.88	42	1.007296	0.00019
11. Portug	2003	10.42	0.006763	121259.3	14392.25	184067.6	0.138264	1.517968	75	5.525449	0.879679	0.88	40	0.995046	−4.3E−05
11. Portug	2004	10.49	0.006718	126112	15302	199369.6	0.154373	1.580893	69	5.436309	0.880934	0.89	38	1.000742	−0.00017
11. Portug	2005	10.55	0.00572	130483.5	15010.5	214380.1	0.182502	1.642967	41	2.950467	0.798022	0.65	97	0.95958	−0.00367
11. Portug	2006	10.6	0.004739	136015.3	15050.25	229430.4	0.17771	1.686799	21	2.417405	0.745678	0.66	33	0.998166	−0.00349
11. Portug	2007	10.64	0.003774	142781.6	15799.63	245230	0.163768	1.717518	27	2.599836	0.758302	0.66	47	0.999309	−0.00338
11. Portug	2008	10.68	0.003759	145447.8	16243.75	261473.8	0.201434	1.797716	26	2.721238	0.777655	0.68	44	1.001243	−0.0034
12. Sloven	1995	1.96	0.005644	2340.864	392.464	1100	0.172505	0.469912	2	0.529958	0.345365	0.29	3	0.89961	−0.00801
12. Sloven	1996	1.967	0.003571	2690.784	461.984	1561.984	0.182764	0.580494	59	5.004566	0.878643	0.77	25	0.99254	0.000817
12. Sloven	1997	1.974	0.003559	3156.27	703.37	2265.354	0.232472	0.717731	0	0	0	0.39	1	1.053215	−0.00771
12. Sloven	1998	1.978	−0.05	3521.554	847.8542	3113.208	0.257721	0.884044	3	1.15079	0.514357	0.46	4	1.102752	−0.0064
12. Sloven	1999	1.982	0.002022	3902.408	980.3083	4093.517	0.217603	1.048972	69	9.429076	0.946869	0.9	33	0.990237	0.000262
12. Sloven	2000	1.9846	0.001312	4282.102	1059.402	5152.918	0.219856	1.203362	0	0	0	0.56	1	1.108078	−0.00481
12. Sloven	2001	1.9884	0.001915	4763.892	1028.892	6181.81	0.21446	1.297639	4	1.512808	0.622432	0.58	5	1.021519	−0.00453
12. Sloven	2002	1.9925	0.002062	5290.1	1096.4	7278.21	0.223766	1.375817	4	1.608899	0.642584	0.6	5	1.020419	−0.00435
12. Sloven	2003	1.997	0.002258	5731.057	1275.157	8553.367	0.219847	1.492459	50	7.303946	0.92765	0.92	26	0.998141	−5E−05
12. Sloven	2004	2.002	0.002504	6153.506	1520.506	10073.87	0.241321	1.637095	59	9.088552	0.948717	0.94	31	0.993405	−5.5E−05
12. Sloven	2005	2.008	0.002997	6542.514	1584.014	11657.89	0.259655	1.781867	4	2.06523	0.720579	0.68	5	1.024175	−0.00351
12. Sloven	2006	2.014	0.002988	7154.684	1945.984	13603.87	0.324284	1.901394	88	12.82947	0.9775	0.97	48	1.003304	−0.00011
12. Sloven	2007	2.0184	−0.05	32399.08	9447.182	23051.05	0.330666	0.711472	3	1.028658	0.512269	0.38	5	0.995411	−0.00937
12. Sloven	2008	2.0207	−0.056	34894.6	10564.4	33615.46	0.309074	0.963343	0	0	0	0.02	99	0	−0.03947
13. Spain	1990	38.84	0.001806	45130.5	8159.5	34024.73	0.099901	0.753919	23	1.238336	0.546801	0.42	77	1.045788	−0.00407
13. Spain	1991	38.92	−0.008	52180.65	11311.65	45336.38	0.144074	0.868835	5	1.041009	0.515545	0.46	7	0.987037	−0.00467
13. Spain	1992	39.01	0.002312	52299.08	7280.075	52616.46	0.094902	1.006069	65	4.802635	0.848658	0.75	26	1.008711	0.0008
13. Spain	1993	39.08	0.001794	53621.92	5341.92	57958.38	0.100264	1.080871	87	4.81669	0.850361	0.77	36	1.008893	0.000684
13. Spain	1994	39.15	0.001791	55736.63	5153.625	63112	0.106784	1.132325	77	4.317564	0.836659	0.78	33	1.003564	0.000506
13. Spain	1995	39.39	0.00613	65003	6888	70000	0.092465	1.076873	24	2.131775	0.697201	0.71	11	1.000068	−0.00018
13. Spain	1996	39.47	0.002031	68600	6870	76870	0.092447	1.120554	88	4.873108	0.851445	0.77	36	0.999163	0.000683
13. Spain	1997	39.6	0.003294	72767	7422	84292	0.092504	1.158382	87	4.82767	3.82767	0.78	37	0.988271	0.000638
13. Spain	1998	39.73	0.003283	75542	8139	92431	0.092375	1.223571	67	4.302489	3.302489	0.78	29	1.007125	0.000475
13. Spain	1999	39.94	0.005286	487	52	610	0.098394	1.252567	22	1.493126	0.493126	0.57	39	1.000692	−0.00162
13. Spain	2000	40.26	0.008012	521	57	667	0.108838	1.28023	27	1.610949	0.610949	0.58	52	1.000419	−0.00184
13. Spain	2001	40.71	0.011177	554	53	720	0.114254	1.299639	25	1.654912	0.654912	0.6	38	1.000913	−0.0019
13. Spain	2002	41.26	0.01351	590	56	776	0.111643	1.315254	23	1.731749	0.731749	0.64	26	0.999512	−0.00143
13. Spain	2003	41.87	0.014784	625	57	833	0.118398	1.3328	45	1.931843	0.931843	0.62	85	1.000056	−0.002
13. Spain	2004	42.49	0.014808	672.8	69.8	902.8	0.126688	1.341855	86	3.067963	2.067963	0.78	77	0.998658	0.000336
13. Spain	2005	43.06	0.013415	736.29	96.29	999.09	0.113682	1.356925	37	1.908855	0.908855	0.6	94	1.000251	−0.00204
13. Spain	2006	43.58	0.012076	805.24	126.24	1125.33	0.103082	1.397509	35	2.733506	1.733506	0.74	22	1.001274	0.000258
13. Spain	2007	44.05	0.010785	863.922	141.922	1267.252	0.101487	1.466859	15	1.788112	0.788112	0.62	24	0.999787	−0.00164
13. Spain	2008	44.49	0.009989	900.09	129.09	1396.342	0.107764	1.551336	18	1.933903	0.677364	0.64	29	0.997785	−0.0016

Appendix

Figure Recur1 Convergences with the capital-output ratio and the capital-labor ratio: the US and Canada

Figure Recur2 Convergences with the capital-output ratio and the capital-labor ratio: Australia and New Zealand

Figure Recur3 Convergences with the capital-output ratio and the capital-labor ratio: Mexico and Brazil

Figure Recur4 Convergences with the capital-output ratio and the capital-labor ratio: China and India

Figure Recur5 Convergences with the capital-output ratio and the capital-labor ratio: Indonesia and Japan

Figure Recur6 Convergences with the capital-output ratio and the capital-labor ratio: Korea and Malaysia

Figure Recur7 Convergences with the capital-output ratio and the capital-labor ratio: Philippines and Singapore

Figure Recur8 Convergences with the capital-output ratio and the capital-labor ratio: Sri Lanka and Thailand

Figure Recur9 Convergences with the capital-output ratio and the capital-labor ratio: Vietnam and Chile

Figure Recur10 Convergences with the capital-output ratio and the capital-labor ratio: Finland and France

Figure Recur11 Convergences with the capital-output ratio and the capital-labor ratio: Germany and Greece

Figure Recur12 Convergences with the capital-output ratio and the capital-labor ratio: Ireland and Italy

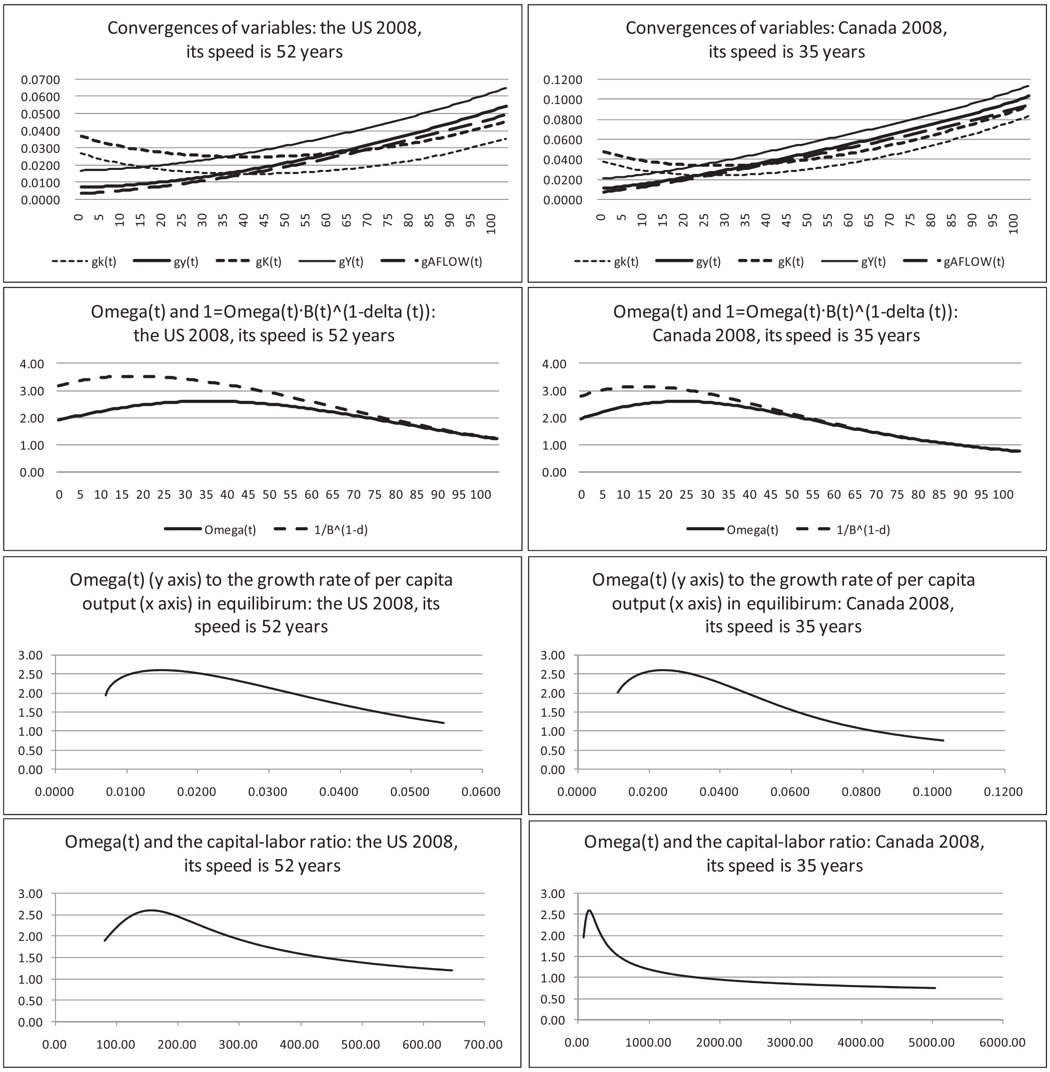
Figure Recur13 Convergences with the capital-output ratio and the capital-labor ratio: Netherlands and Spain

Figure Recur14 Convergences with the capital-output ratio and the capital-labor ratio: Czech Rep and Denmark

Figure Recur15 Convergences with the capital-output ratio and the capital-labor ratio: Iceland and Norway

Figure Recur16 Convergences with the capital-output ratio and the capital-labor ratio: Romania and Russia

Figure Recur17 Convergences with the capital-output ratio and the capital-labor ratio: Sweden and the UK



Data source: KEWT 4.10 of 59 countries by sector, 1990–2008, whose ten original data for the real assets come from *International Financial Statistics Yearbook*, IMF (the following figures are the same).

Figure Recur1 Convergences with the capital-output ratio and the capital-labor ratio: the US and Canada

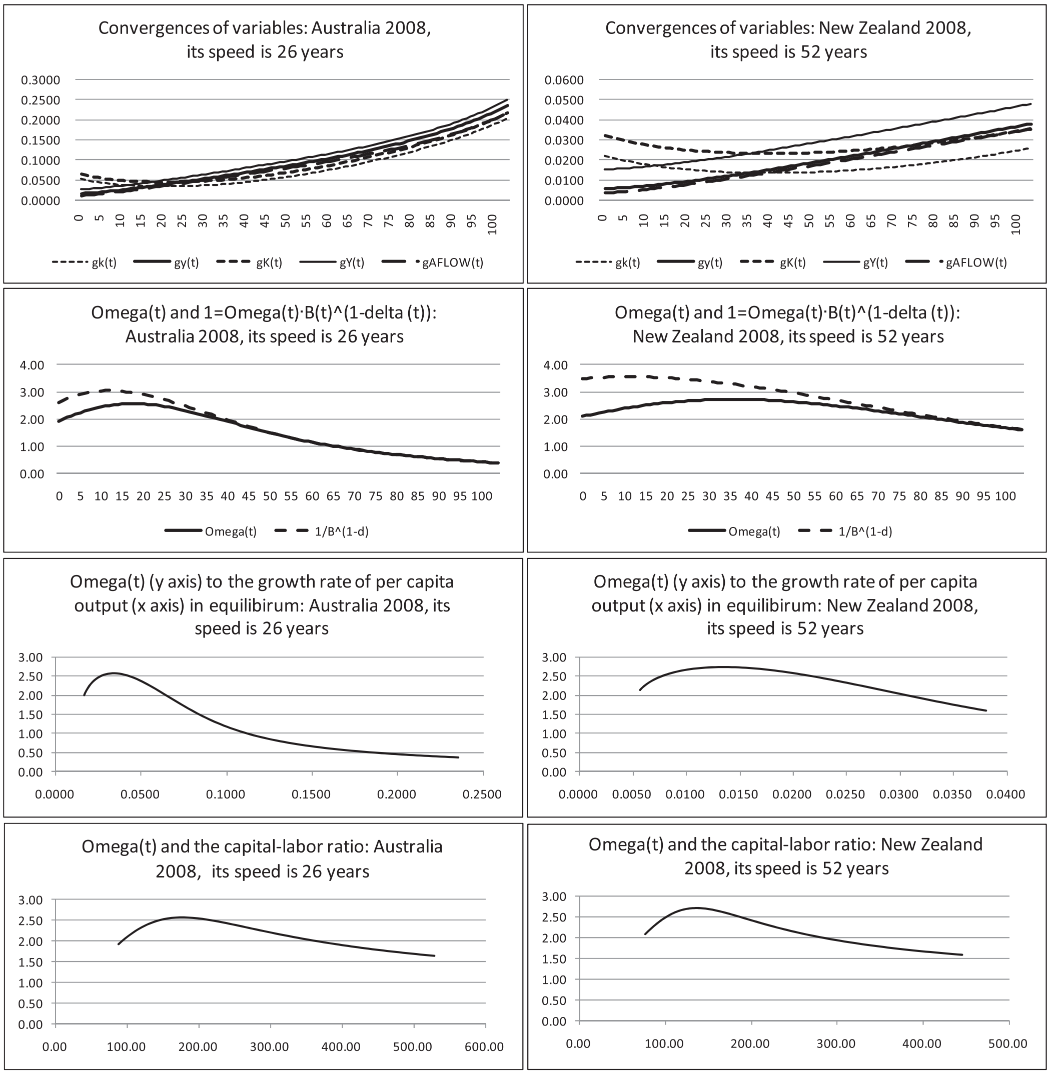


Figure Recur2 Convergences with the capital-output ratio and the capital-labor ratio: Australia and New Zealand

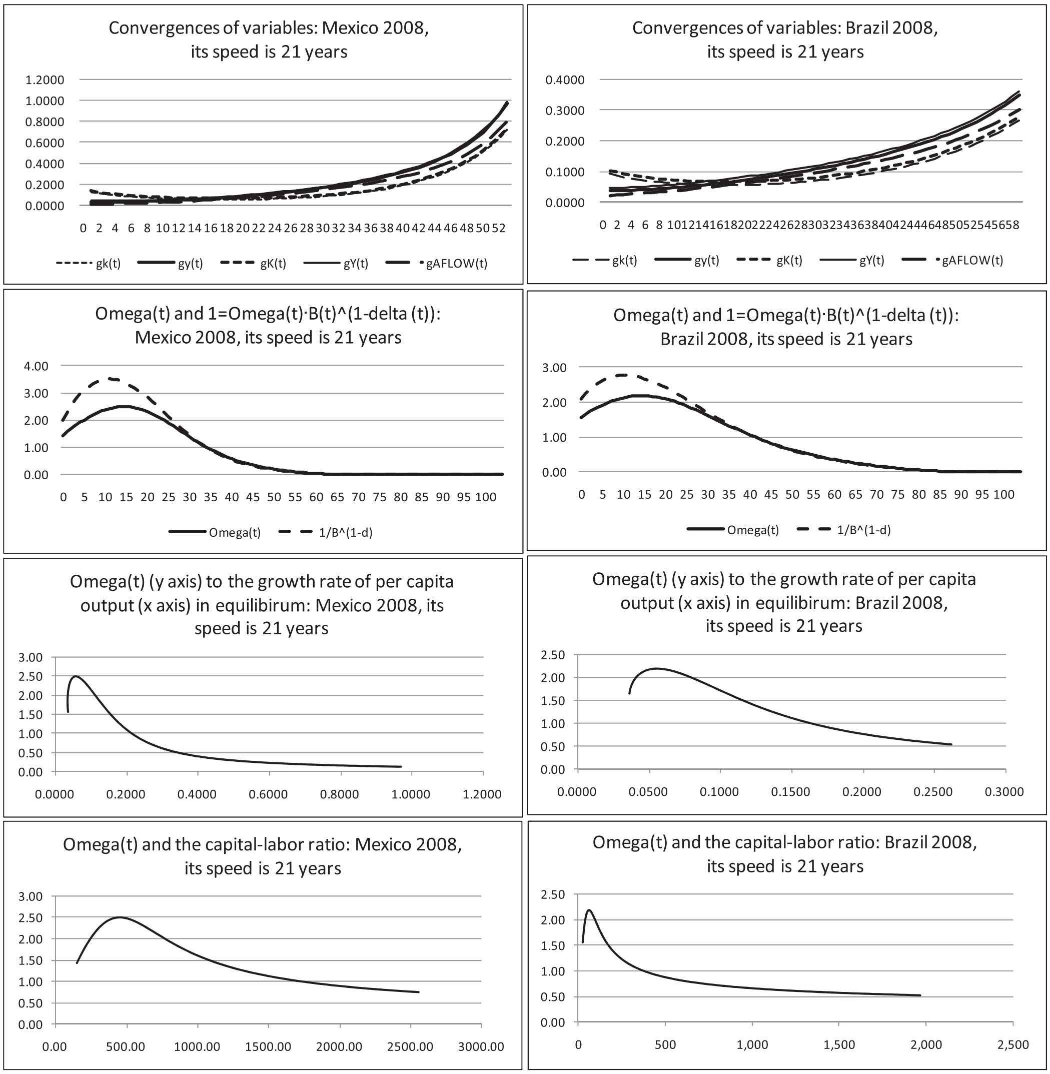


Figure Recur3 Convergences with the capital-output ratio and the capital-labor ratio: Mexico and Brazil

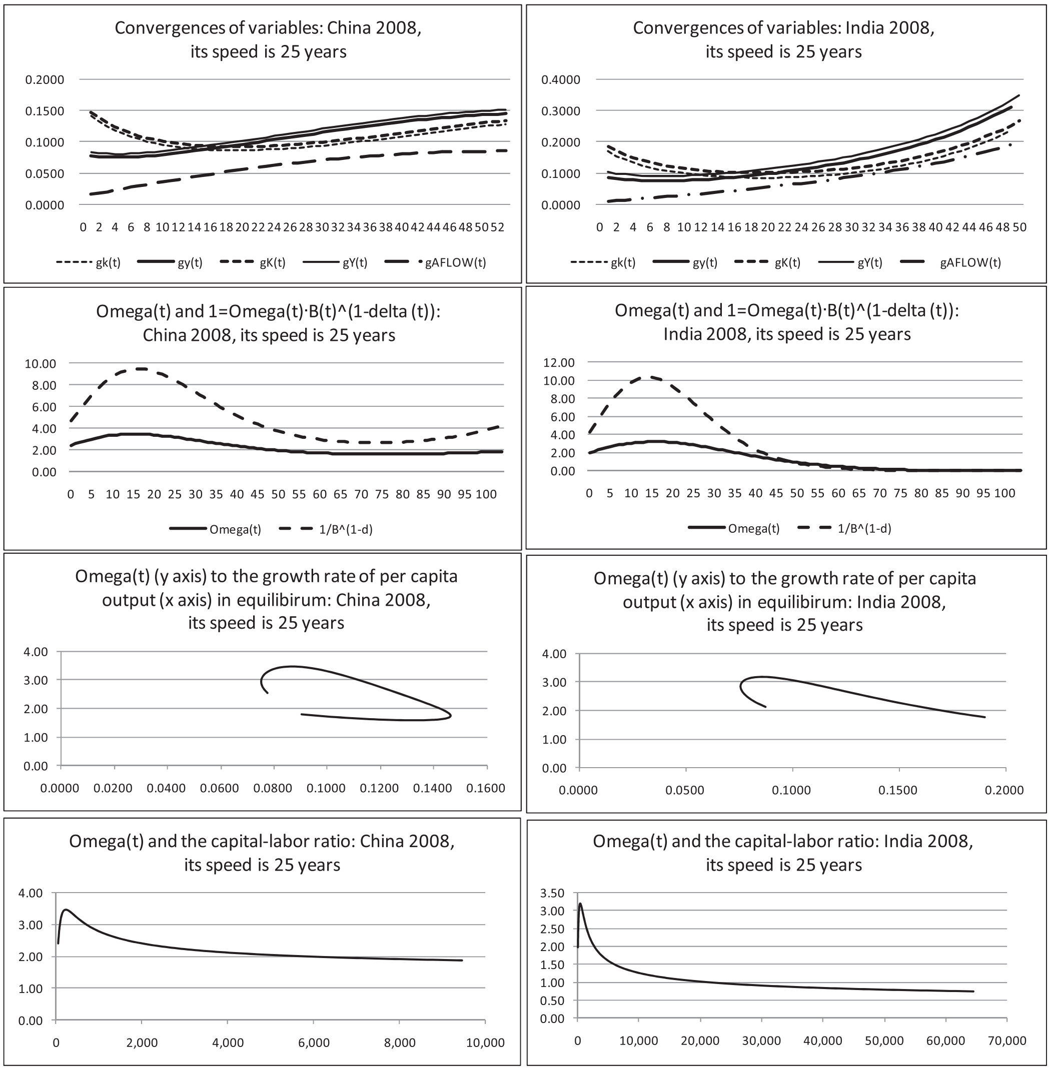


Figure Recur4 Convergences with the capital-output ratio and the capital-labor ratio: China and India

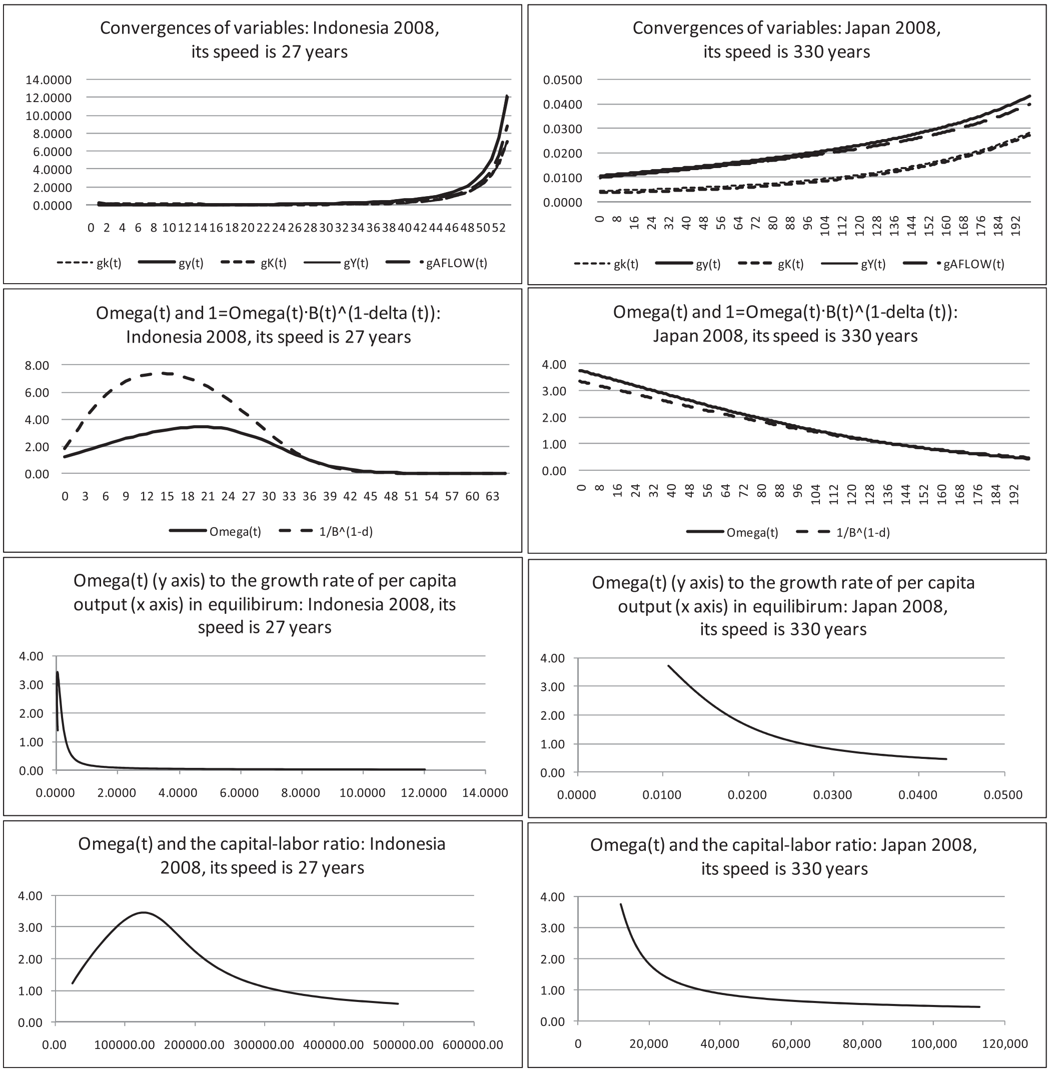


Figure Recur5 Convergences with the capital-output ratio and the capital-labor ratio: Indonesia and Japan

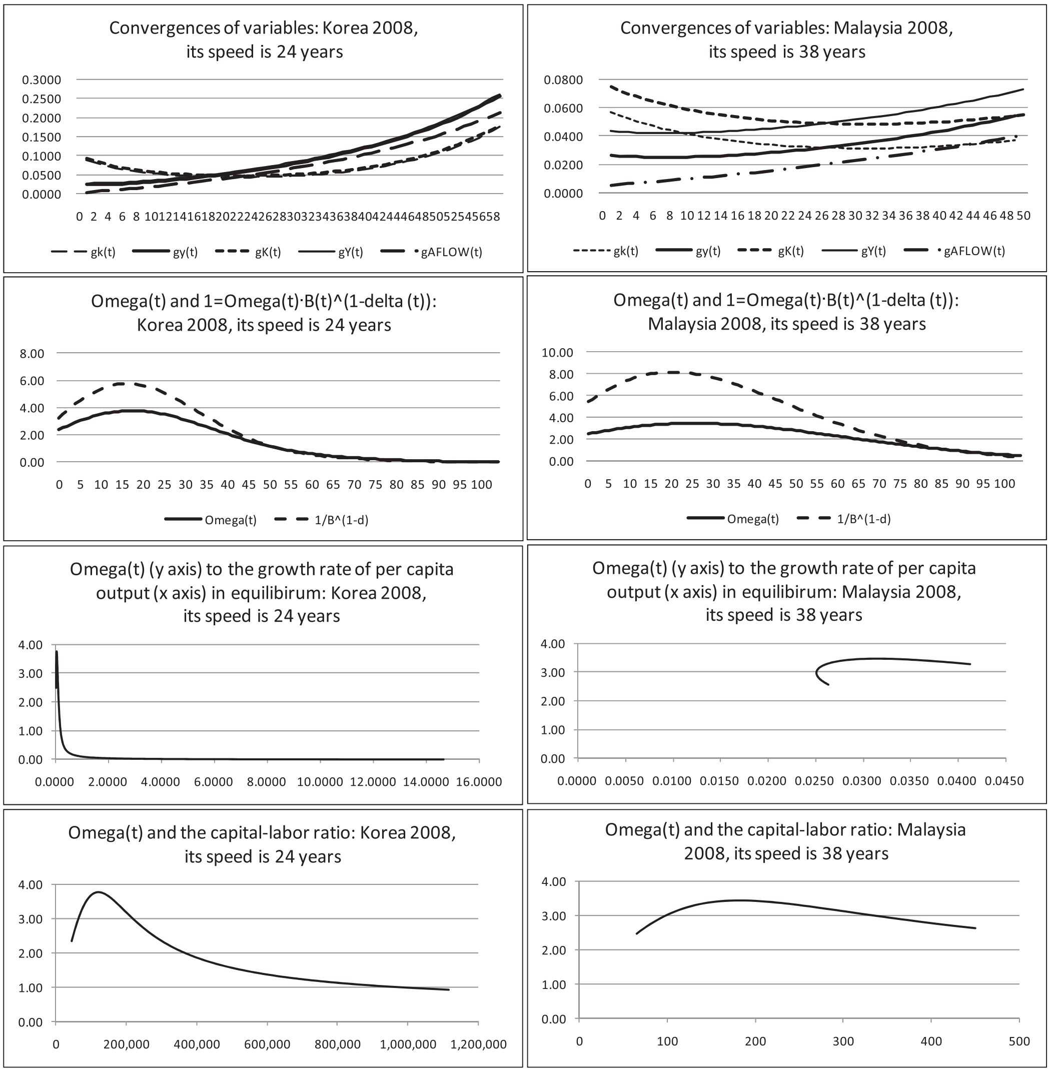


Figure Recur6 Convergences with the capital-output ratio and the capital-labor ratio: Korea and Malaysia

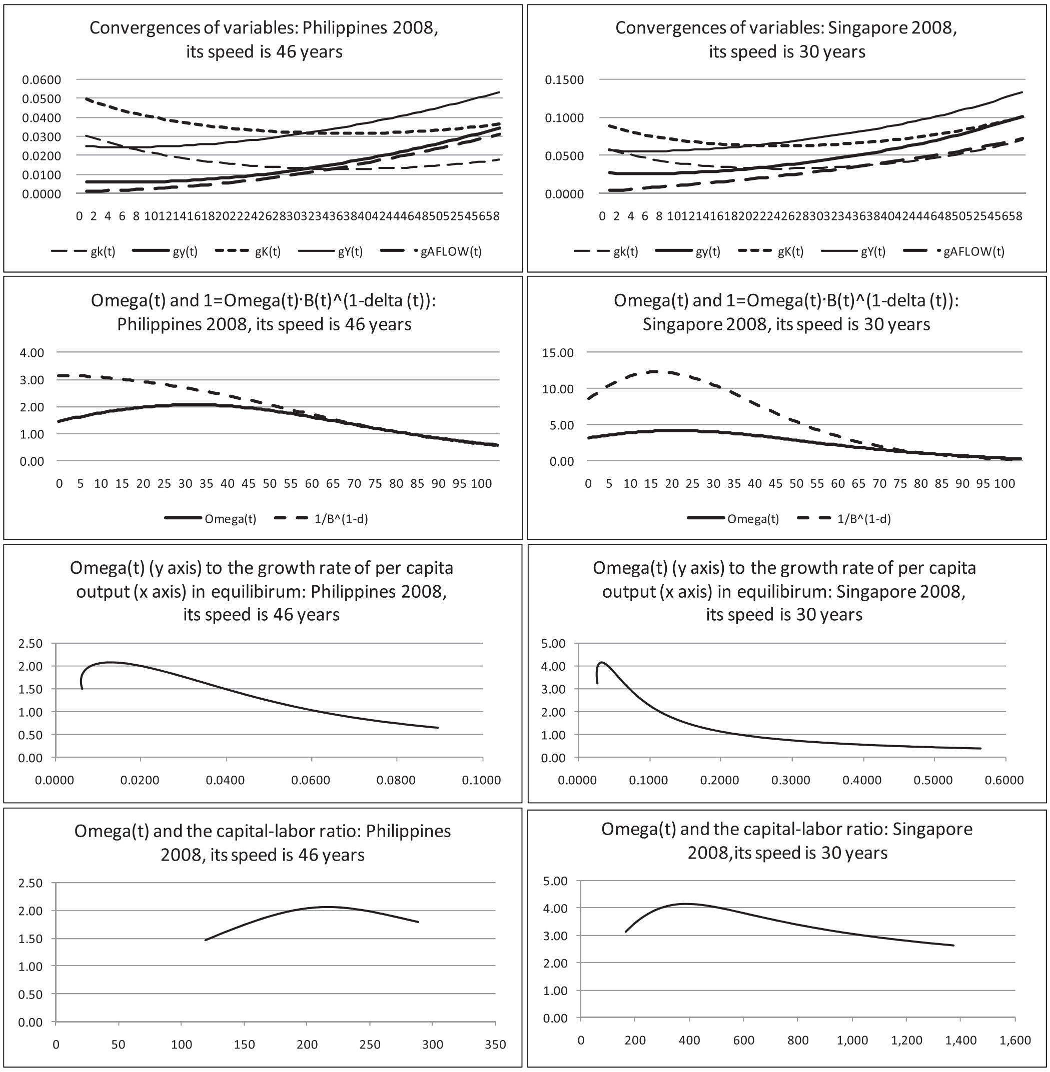


Figure Recur7 Convergences with the capital-output ratio and the capital-labor ratio: Philippines and Singapore

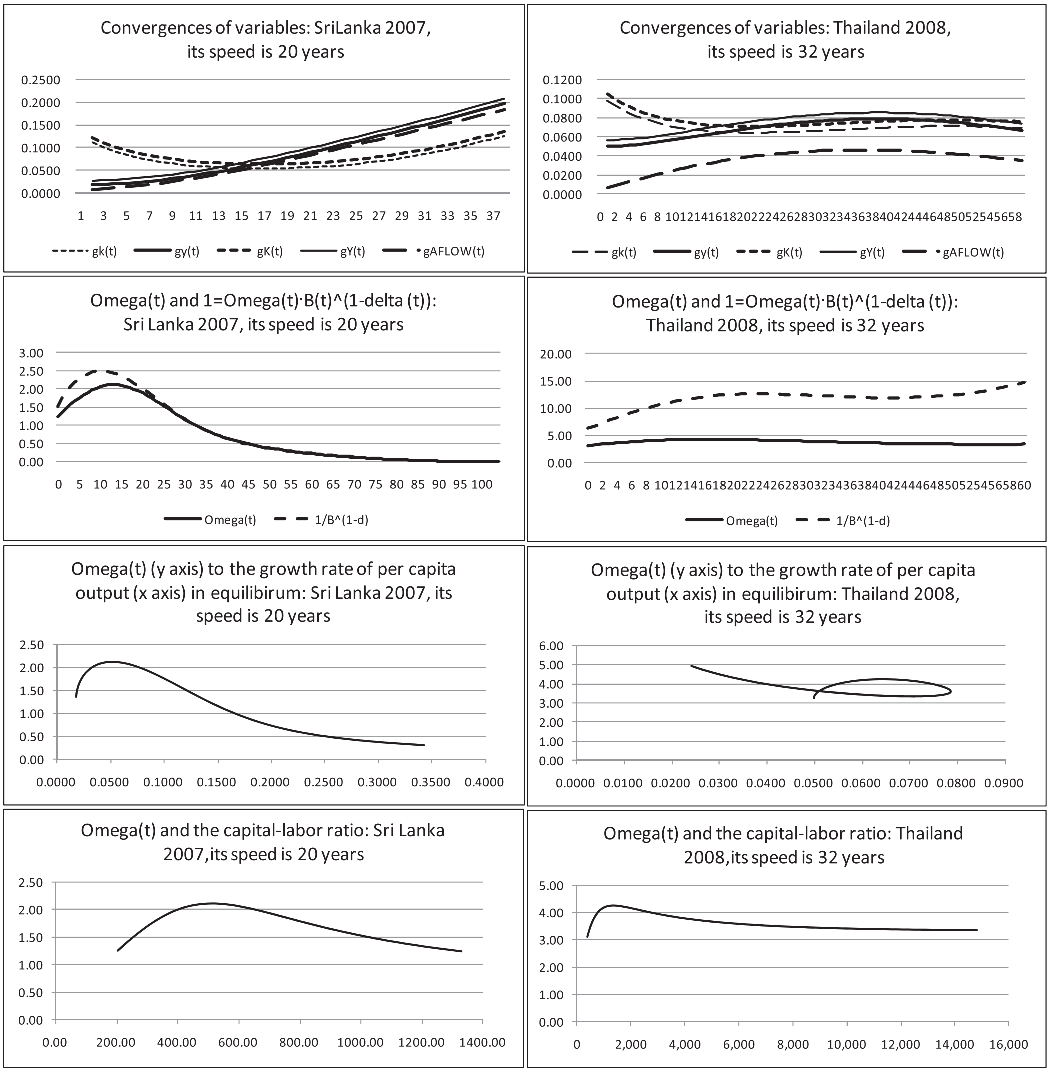


Figure Recur8 Convergences with the capital-output ratio and the capital-labor ratio: Sri Lanka and Thailand

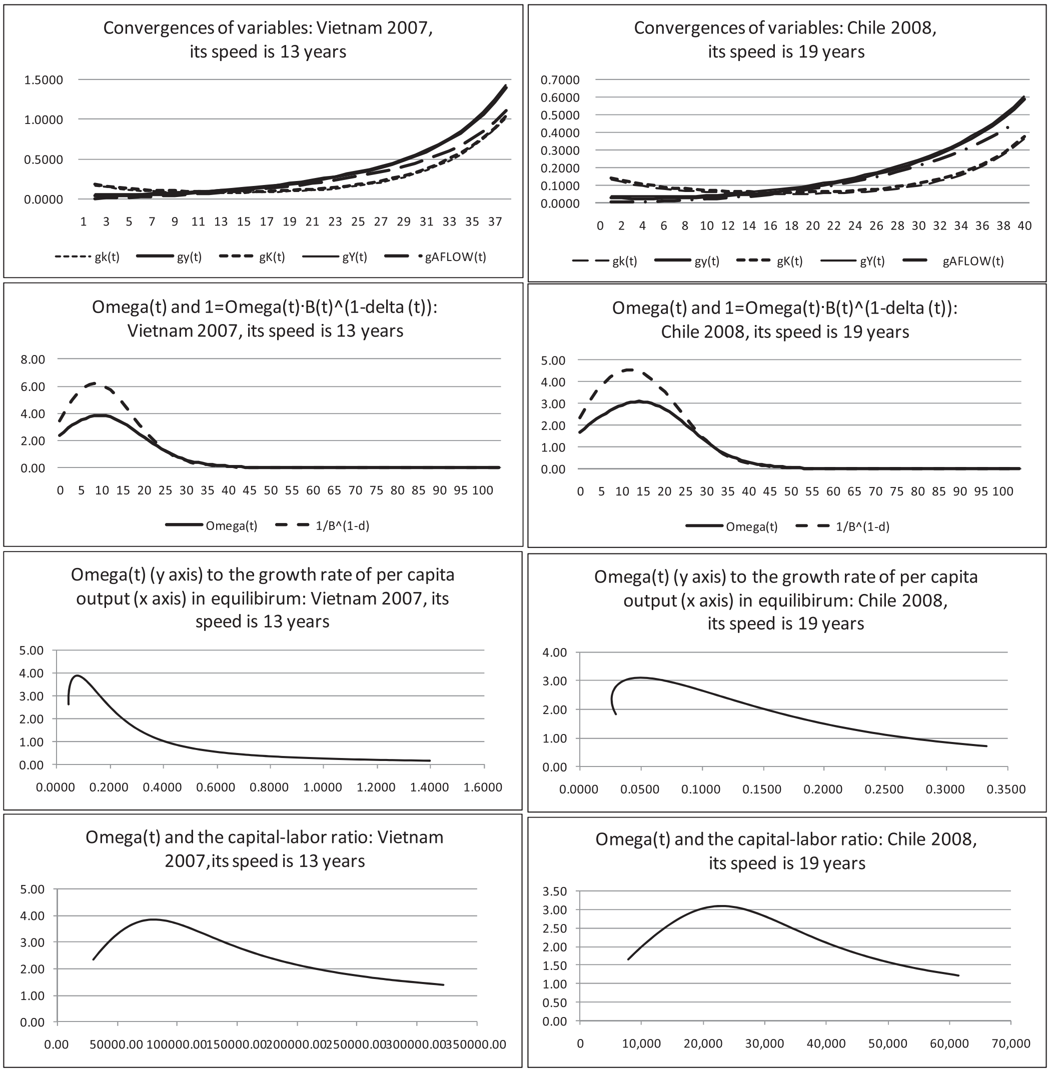


Figure Recur9 Convergences with the capital-output ratio and the capital-labor ratio: Vietnam and Chile

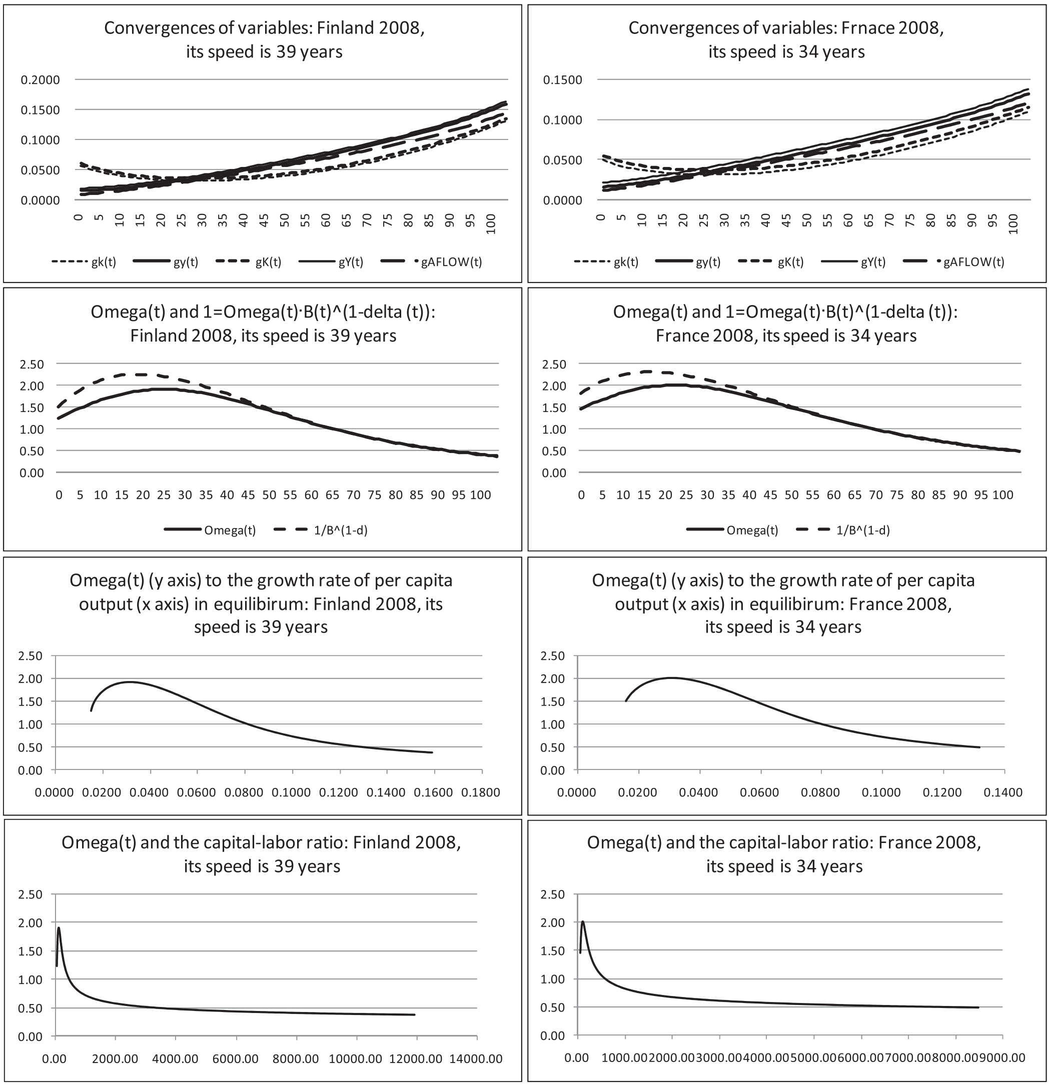


Figure Recur10 Convergences with the capital-output ratio and the capital-labor ratio: Finland and France

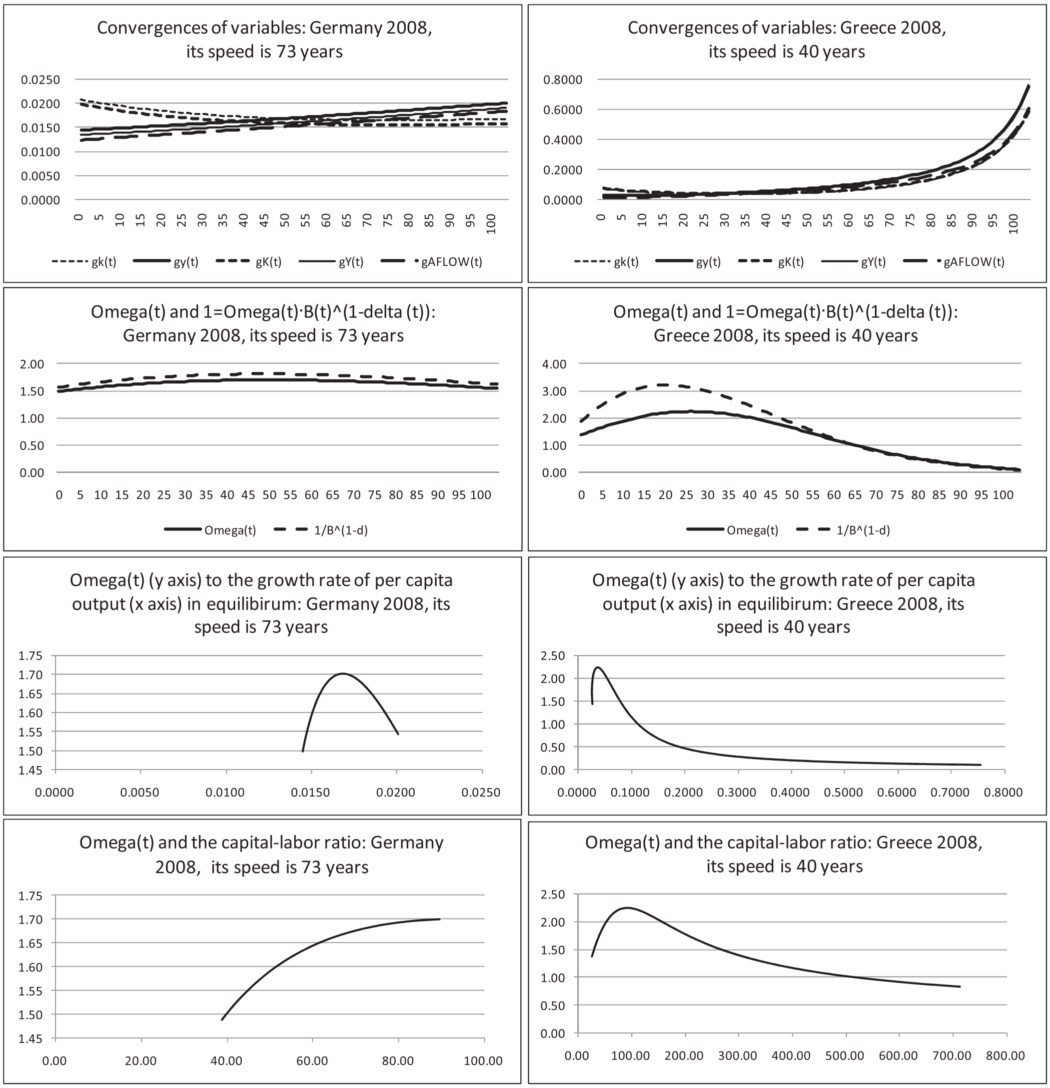


Figure Recur11 Convergences with the capital-output ratio and the capital-labor ratio: Germany and Greece

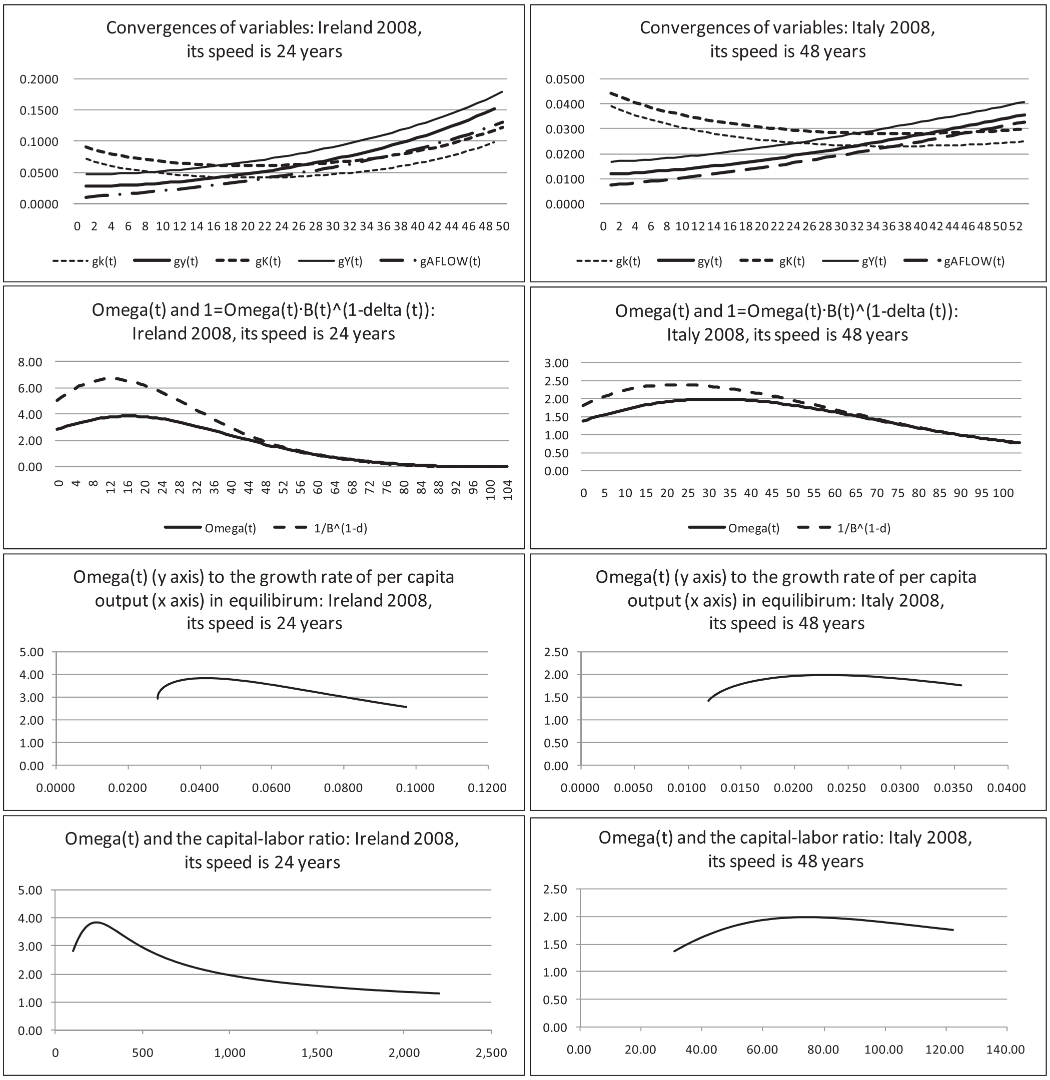


Figure Recur12 Convergences with the capital-output ratio and the capital-labor ratio: Ireland and Italy

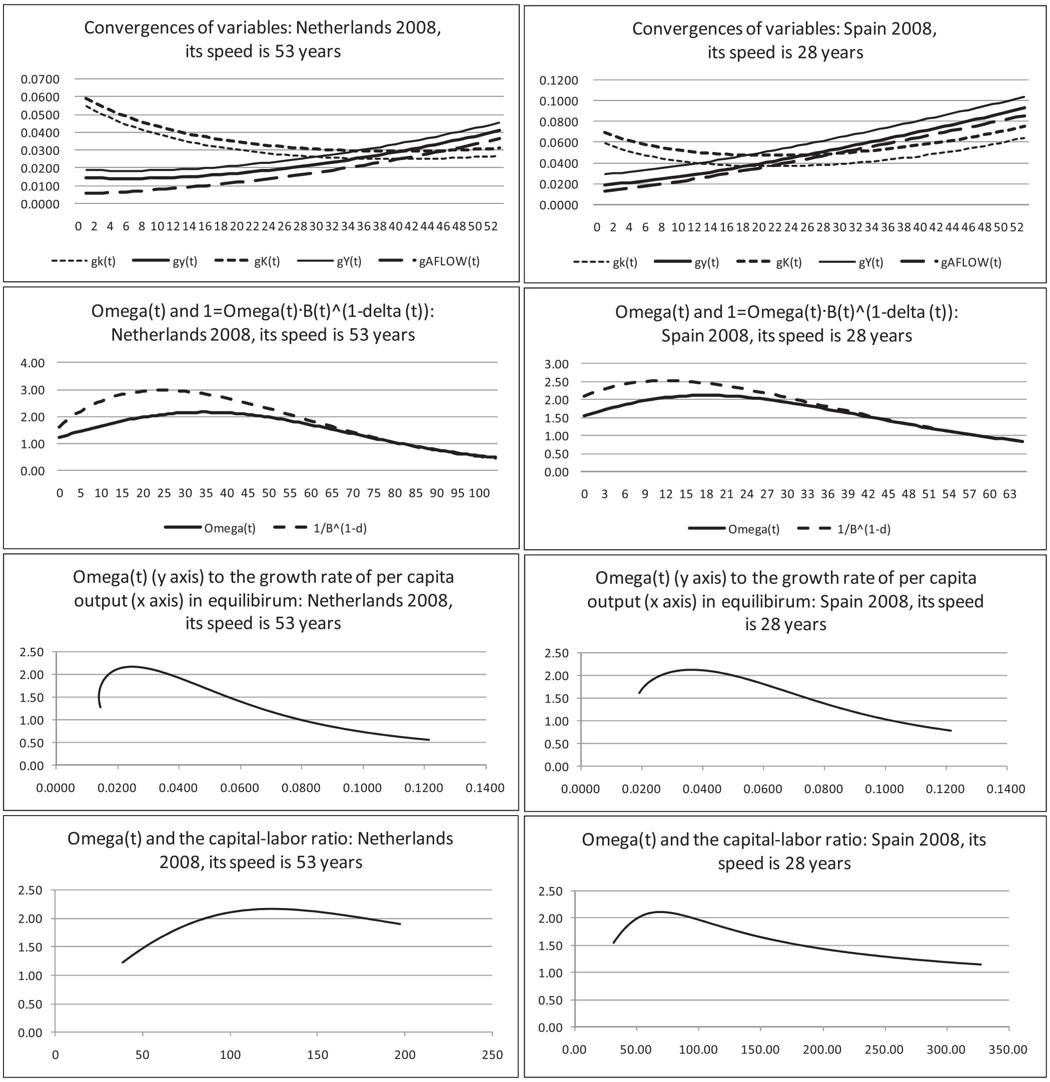


Figure Recur13　Convergences with the capital-output ratio and the capital-labor ratio: Netherlands and Spain

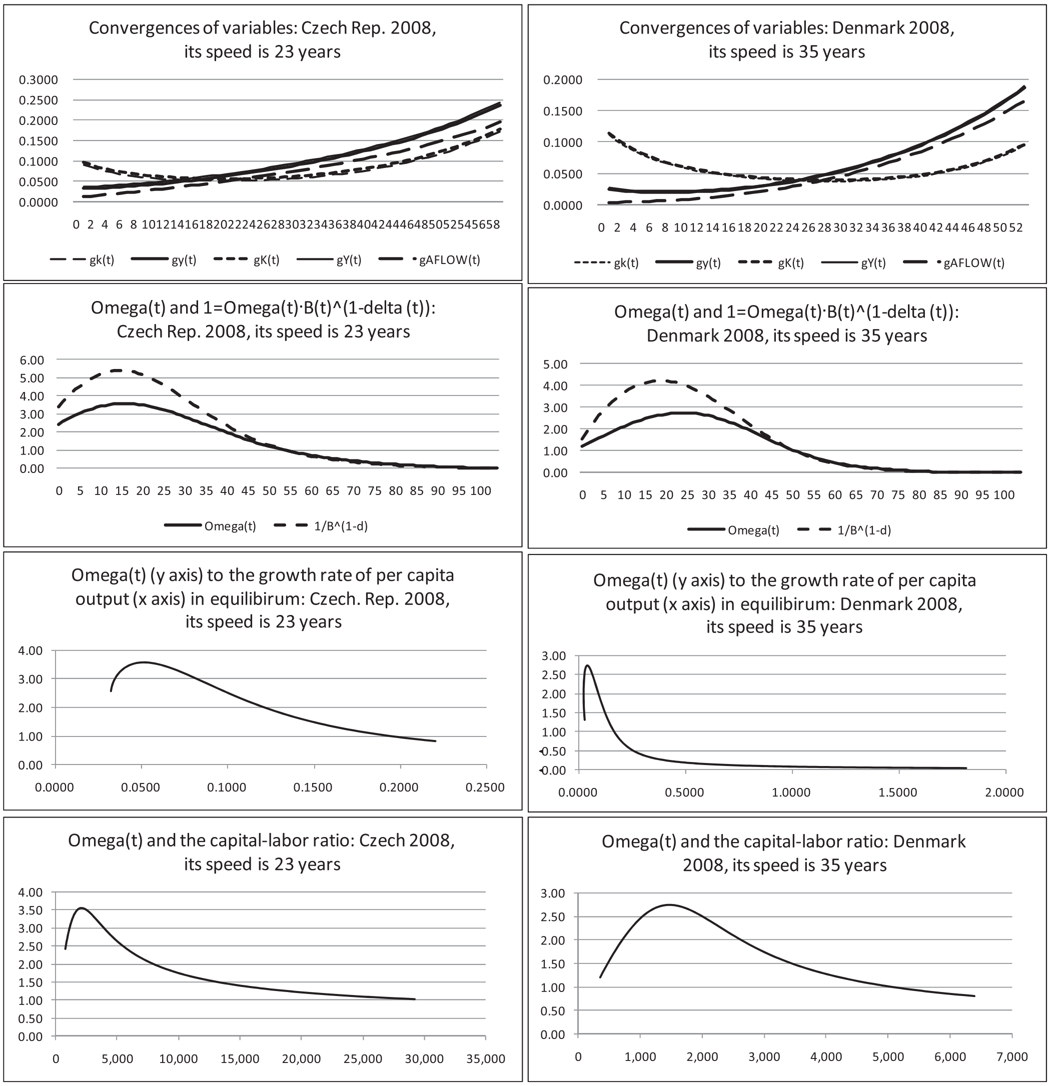


Figure Recur14 Convergences with the capital-output ratio and the capital-labor ratio: Czech Rep and Denmark

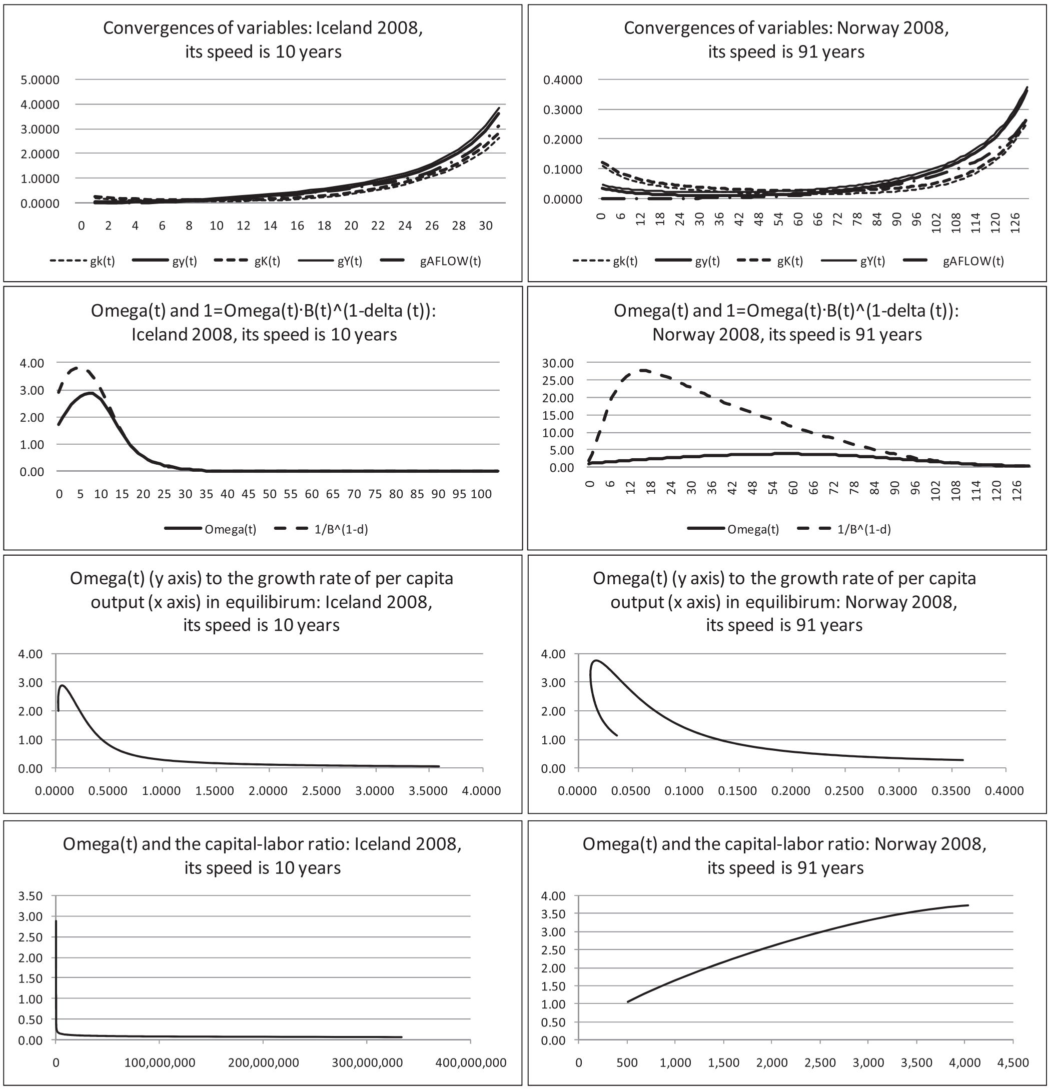


Figure Recur15 Convergences with the capital-output ratio and the capital-labor ratio: Iceland and Norway

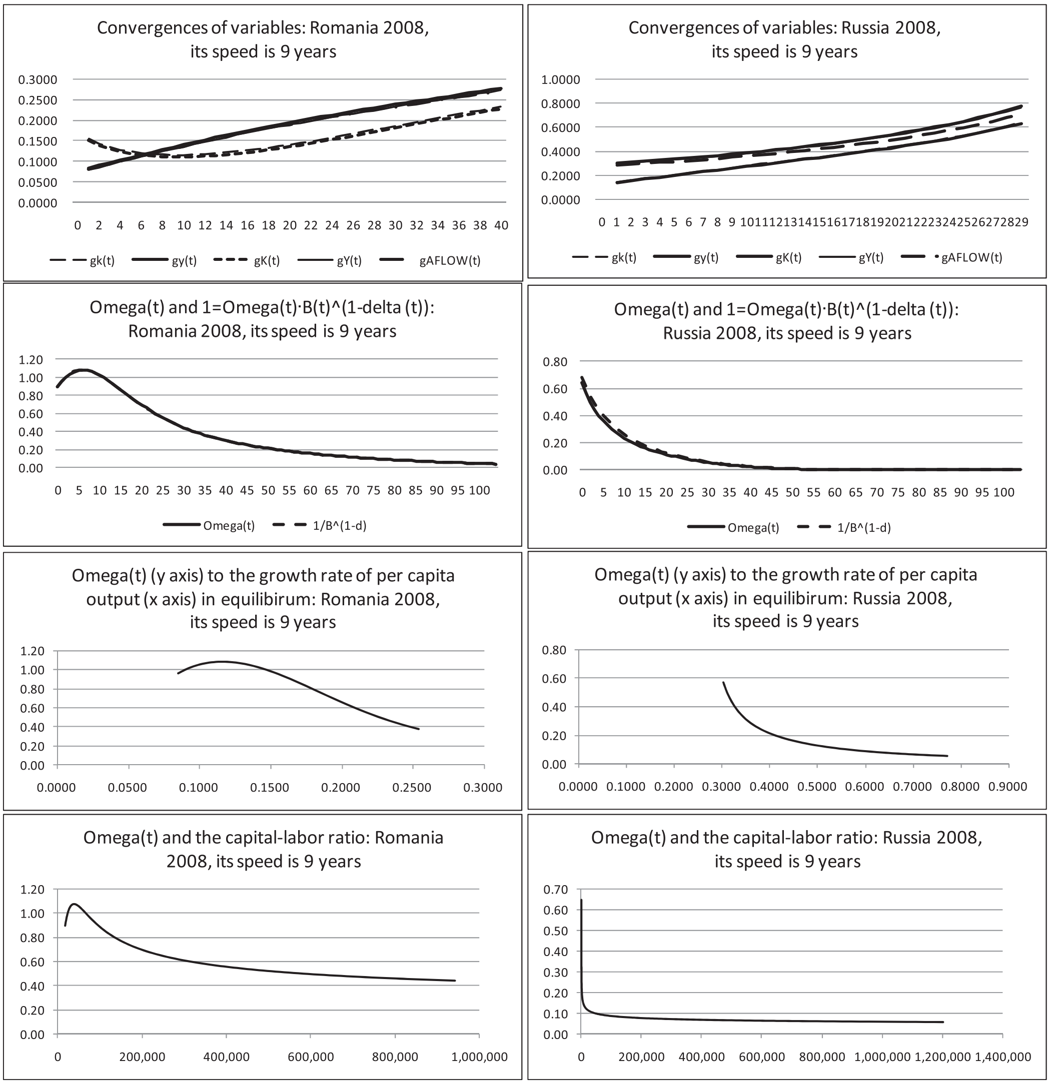


Figure Recur16 Convergences with the capital-output ratio and the capital-labor ratio: Romania and Russia

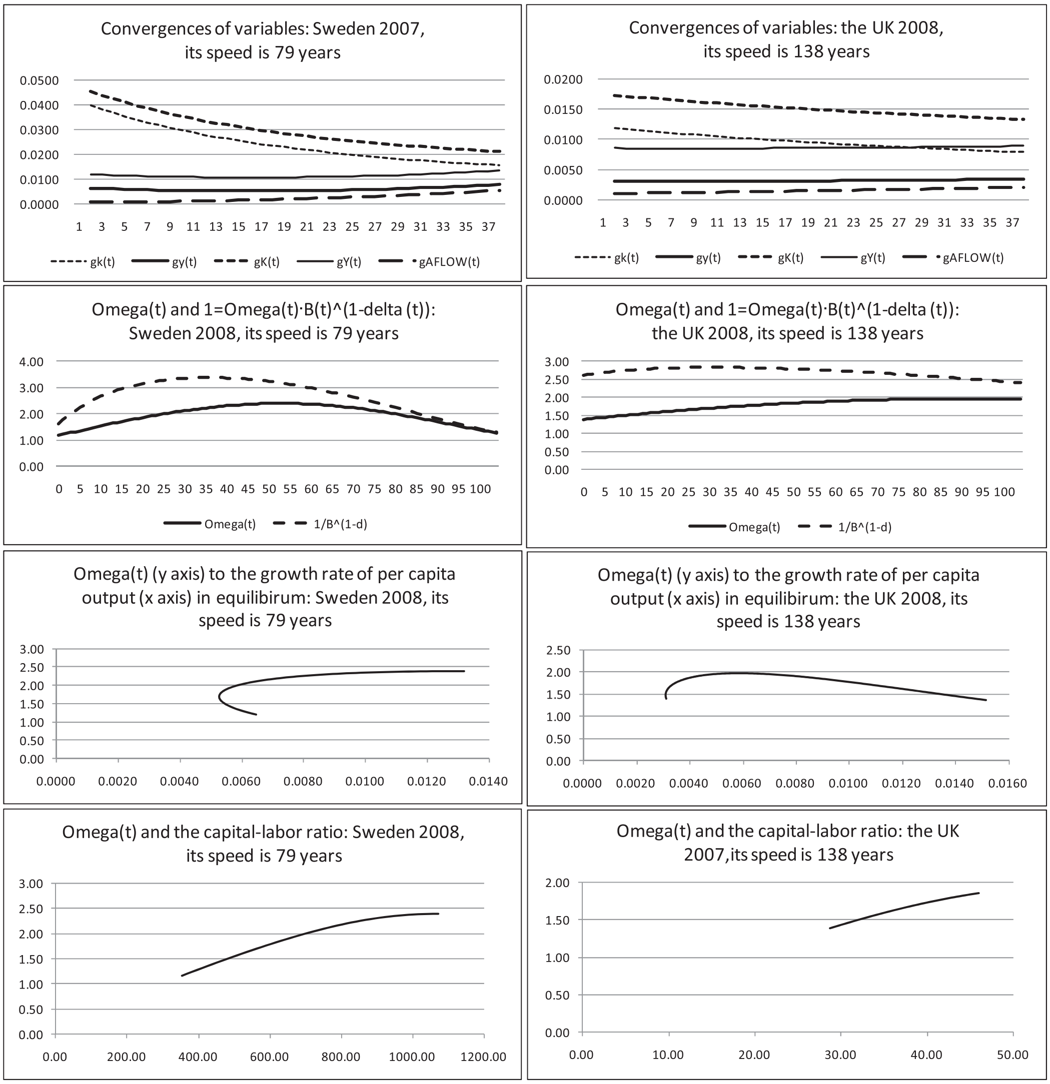


Figure Recur17 Convergences with the capital-output ratio and the capital-labor ratio: Sweden and the UK