GLOBAL SOCIAL STATUS, NATIONAL SPIRITS OF CAPITALISM, AND ECONOMIC DEVELOPMENT

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***Abstract**: This paper constructs a global economic growth model with endogenous social status, endogenous preferences, and wealth accumulation. The economic system is based the Solow model, the Uzawa two-sector model, and the Oniki-Uzawa trade model. We base our approach to measuring social status on some ideas in the literature of economic growth with endogenous growth. The model is specially based on a model proposed by Zhang (2016). This study considers relative social status as a function of a country's relative wealth per household with the global average per household wealth. It treats time distribution between leisure and work as endogenous variables. The world economy is composed of any number of national economies and each national economy consists of one capital goods sector and one consumer goods sector. National economies differ in social status, preferences, spirits of capitalism, and productivities. We build the model for J -country world economy and express the dynamics with J differential equations. We simulate the movement of a 3-country global economy and carried out comparative dynamic analysis with regard to some parameters.*

***Keywords**: economic growth; social status; spirit of capitalism; global income inequality; global wealth distribution.*

JEL: F43, 041.

1. Introduction

Conspicuous consumption, social status and spirit of capitalism have been considered as important determinants of modern economic growth. *The Theory of the Leisure Class* by Veblen (1899) first comprehensively examined economic consequences of conspicuous consumption and social status. According to Veblen people are interested in conducting conspicuous consumption because it shows social status. According to Duesenberry (1949) people try to imitate consumption standards of social or classes above them in order to enhance social status. Rege (2008: 240) observes that "By investing in social status a person can thus improve his chance of engaging in a complementary interaction with a high ability person. The idea that status can serve as a signal of abilities is not new and has been captured in several models. It has, for example, been demonstrated that workers can signal their ability to employers by undertaking some seemingly irrelevant but costly activity interpreted as status consumption (Frank, 1985a) or social culture (Fang, 2001)… ." In the contemporary literature of economic growth with endogenous social status there are some studies which emphasize the role of social status in explaining economic growth processes (see, for instance, Cole *et al*., 1992; Konrad, 1992; Fershtman et al., 1996; Rauscher, 1997). Nevertheless, except a recent paper by Zhang (2016) issues related to possible effects of endogenous social status are seldom examined in formal economic growth theory with international trade. This study is to explicitly introduce social status into formal trade theory.

We build a model which not only deals with inequalities in income, wealth and economic structures between (any number of) countries, but also introduces endogenous preferences and social status. The economic system is built on the basis of the Solow model (1956), the Uzawa two-sector model (1961), and the Oniki-Uzawa trade model (1965). The way that social status is introduced into the trade model is influenced by some ideas in research on macroeconomic effects of consumers' wealth-induced preferences for social status (Kurz, 1968; Zou, 1994; Bakshi and Chen, 1996; Chang, 2006; Corneo and Jeanne, 2001; Clemens, 2004; Fisher and Hof, 2005; Chen and Guo, 2011). This study applies an alternative approach to consumer behavior by Zhang (1993, 2005). The model in this study is a further development of a model by Zhang (2016). The paper is organized as follows. Section 2 develops an international trade model of endogenous growth, social status and preferences. In section 3 we deal with dynamic properties of the model and simulate the model with three national economies. Section 4 carries out comparative dynamic analysis. Section 5 concludes the study.

2. The global growth model with free trade and endogenous social status

The model in this study is an extension of Zhang's model (2016). The main deviations from Zhang's model is that this study considers relatively global social status as a function of a country's relative wealth per household with the global average per household wealth as the basis, while Zhang's model considers a country's per household wealth as the determinant of social status. Another important extension is that this study treats time distribution between leisure and work as endogenous variables, while Zhang's model does not consider issues related to endogenous time distribution. We now build the model on the basis of Zhang's model. The world economy is composed of any number of national economies, indexed by $j = 1, ..., J$. Each national economy has a fixed population, $\bar{N}_j$. As in Uzawa's analytical framework (Uzawa, 1961), each national economy has two sectors: one capital goods sector and one consumer goods sector. We follow neoclassical growth theory in describing each national economy's economic production (e.g., Burmeister and Dobell, 1970; Azariadis, 1993; Barro and Sala-i-Martin, 1995). With regard to determination of international trade, we follow the Oniki-Uzawa trade model (Oniki and Uzawa, 1965). All national economies produce homogenous capital goods. As reviewed by Ikeda and Ono (1992), most of trade models with endogenous capital is structured like the Oniki-Uzawa model and its extensions. Each national economy's consumer goods (and service) sector supplies goods and services. Consumer goods are not tradable in international markets. Households own assets and distribute their disposable incomes to consume and save. There are two input factors in production, capital and labor. Factor markets work well; factors are inelastically supplied and the available factors are fully utilized at every moment. Markets are perfectly competitive. Let prices be measured in terms of capital goods and the price of capital goods be unit. We introduce following variables:

subscript indices i and s - capital goods sector and consumer goods sector, respectively;

$w_j(t)$ - wage rate per unit of human capital and per unit of time in country j;

$r(t)$ - rate of interest in global markets;

$p_j(t)$ - price of consumer goods in country j;

$K_j(t)$ and $\bar{K}_j(t)$ - total capital stock employed by and total value of wealth owned by country j;

$c_j(t)$ and $\bar{k}_j(t)$ - consumption level of consumer goods and wealth owned by the representative household in country j;

$T_j(t)$ and $\bar{T}_j(t)$ - work hours and leisure hours of the representative household in country j;

$N_j(t)$ and $K_j(t)$ - total labor force of and capital stocks employed by country j;

$N_{jm}(t)$ and $K_{jm}(t)$ - labor force and capital stocks employed by sector m in country j;

$F_{jm}(t)$ - output level of sector m in country j;

h_j and δ_{jk} - fixed human capital and depreciation rate of physical capital in country j.

National total labor supply

The total labor supply is the sum of qualified labor supply of all the households in a country

$$N_j(t) = h_j T_j(t) \bar{N}_j . \tag{1}$$

The capital goods sectors

We use the following Cobb-Douglass function with capital and labor as factor inputs

$$F_{ji}(t) = A_{ji} K_{ji}^{\alpha_{ji}}(t) N_{ji}^{\beta_{ji}}(t), \;\; A_{ji}, \alpha_{ji}, \beta_{ji} > 0, \;\; \alpha_{ji} + \beta_{ji} = 1, \tag{2}$$

where A_{ji}, α_{ji}, and β_{ji} are positive parameters. The marginal conditions of the capital goods sectors are

$$r(t) + \delta_{jk} = \frac{\alpha_{ji} F_{ji}(t)}{K_{ji}(t)}, \;\; w_j(t) = \frac{\beta_{ji} F_{ji}(t)}{N_{ji}(t)}. \tag{3}$$

The consumer goods sectors

The production function of the consumer goods sector are

$$F_{js}(t) = A_{js} K_{js}^{\alpha_{js}}(t) N_{js}^{\beta_{js}}(t), \;\; \alpha_{js} + \beta_{js} = 1, \;\; \alpha_{js}, \beta_{js} > 0, \tag{4}$$

where A_{js}, α_{js}, and β_{js} are the technological parameters of the consumer goods sector. The marginal conditions are

$$r(t) + \delta_{kj} = \frac{\alpha_{js} \, p_j(t) F_{js}(t)}{K_{js}(t)}, \;\; w_j(t) = \frac{\beta_{js} \, p_j(t) F_{js}(t)}{N_{js}(t)}. \tag{5}$$

Current income and disposable income

In this study, we use an approach to modeling behavior of households proposed by Zhang (1993, 2005). Per household current income from the interest payment $r(t)\bar{k}_j(t)$ and the wage payment $h_j T_j(t) w_j(t)$ is

$$y_j(t) = r(t)\bar{k}_j(t) + h_j T_j(t) w_j(t). \tag{6}$$

Per household disposable income is the sum of the current disposable income and the value of wealth. That is

$$\hat{y}_j(t) = y_j(t) + \bar{k}_j(t). \tag{7}$$

Budgets

The disposable income is distributed between saving and consuming consumer goods. Representative household j distributes the distributes saving $s_j(t)$ and consumer goods $c_j(t)$. The budget constraint is

$$p_j(t)c_j(t) + s_j(t) = \hat{y}_j(t). \tag{8}$$

The total available time T_0 is used for leisure and work

$$T_j(t) + \bar{T}_j(t) = T_0 . \tag{9}$$

Insert (9) in (7)

$$\hat{y}_j(t) = \bar{y}_j(t) - h_j \bar{T}_j(t) w_j(t), \tag{10}$$

where we use (6) and

$$\bar{y}_j(t) \equiv (1 + r(t))\bar{k}_j(t) + h_j T_0 w_j(t).$$

Insert (10) in (8)

$$h_j \bar{T}_j(t) w_j(t) + p_j(t)c_j(t) + s_j(t) = \bar{y}_j(t). \tag{11}$$

Utility functions and optimal decisions

The representative choose three variables $\bar{T}_j(t)$, $c_j(t)$ and $s_j(t)$. We specify utility functions as follows

$$U_j(t) = \bar{T}_j^{\sigma_{j0}(t)}(t) c_j^{\xi_{j0}(t)}(t) s_j^{\lambda_{j0}(t)}(t), \ \ \sigma_{j0}(t), \xi_{j0}(t), \lambda_{j0}(t) > 0, \tag{12}$$

where $\sigma_{j0}(t)$ is the propensity to use leisure time, $\xi_{j0}(t)$ the propensity to consume consumer goods, and $\lambda_{j0}(t)$ the propensity to save. The propensities are changeable. We will specify how the propensities are related to national social status. In traditional approaches to growth with social status, social status directly enter utility functions. This study considers that it is through social status the propensities are affected. Changes in propensities lead to changes in macroeconomic conditions and thus social status distribution. Through conducting conspicuous consumption (which may be reflected in increases in the propensity to consume some kinds of services or commodities) or enhancing spirit of capitalism (which may be reflected in enhancing the propensity to save) that social status affects households' behavior.

Relative wealth

The average wealth of the global economy is

$$\bar{k}(t) = \frac{1}{\bar{N}} \sum_{j=1}^{J} \bar{k}_j(t) \bar{N}_j. \tag{13}$$

Country $j's$ per household relative wealth $\tilde{k}_j(t)$ is given by

$$\tilde{k}_j(t) = \frac{\bar{k}_j(t)}{\bar{k}(t)}. \tag{14}$$

National relative social status

In order to illustrate our approach, we introduce two popular approaches to growth with endogenous social status. For instance, Chen and Guo (2009) assume social status as a function of wealth. They use the following utility function

$$U = \int_0^\infty \left[\frac{c^{1-\sigma}(t) - 1}{1-\sigma} + \beta \frac{k^{1-\sigma}(t) - 1}{1-\sigma} \right] e^{\rho t} \, dt,$$

where $c(t)$ and $k(t)$, denote the household's consumption and capital stock, ρ is the time discount rate, and β measures the degree for the spirit of capitalism. Chen and Guo (2011) specifies another utility function as follows

$$U = \int_0^\infty \frac{\left[c(t)(k(t)/K(t))^\beta\right]^{1-\sigma} - 1}{1-\sigma} e^{-\rho t} \, dt,$$

where $\beta > 0$ measures the degree of the spirit of capitalism. In this approach the wealth-based social status is represented by its physical-capital ownership $k(t)$ relative to the economy-wide level of physical capital stock $K(t)$. Corneo and Jeanne (1999) use the following utility function

$$U = \int_0^\infty [u(c(t)) + v(t)] e^{\rho t} \, dt,$$

where $v(t)$ is social esteem.

Inspirited by the literature, we assume social status of the representative household in country j a function of relative wealth as follows

$$\omega_j(t) = \omega_{0j} + \omega_{kj} \tilde{k}_j^{\omega_j}(t), \tag{15}$$

where ω_j, ω_{0j} and ω_{kj} are positive parameters. Equations (15) imply that national social status are positively related to national relative wealth. Parameters ω_{0j} and ω_{kj} vary between countries. For instance, if a country has a long respectable history ω_{0j} might be higher than another country which has been characterized of social disorder and poverty. It is obvious that this is a simplified of social status. National social status can be dependent on many other variables such as relative education, relative human capital, history, and the like.

Social status and propensities

This study considers that it is through affecting propensities to consume, to use leisure time, and to save that social status affect growth and inequality. This study assumes the propensities to consume and to save to be related to social status in the following way

$$\sigma_{j0}(\omega_j(t)) = \bar{\sigma}_{j0} + \tilde{\sigma}_{j0}\,\omega_j(t), \;\; \xi_{j0}(\omega_j(t)) = \bar{\xi}_{j0} + \tilde{\xi}_{j0}\,\omega_j(t), \;\; \lambda_{j0}(\omega_j(t)) = \bar{\lambda}_{j0} + \tilde{\lambda}_{j0}\,\omega_j(t), \quad (16)$$

where $\bar{\sigma}_{j0}$, $\bar{\xi}_{j0}$ and $\bar{\lambda}_{j0}$ are positive parameters, and $\tilde{\sigma}_{j0}$, $\tilde{\xi}_{j0}$, and $\tilde{\lambda}_{j0}$ are parameters which may be either positive, zero, or negative. The propensity to consume may be enhanced by social status, for instance, through the so-called conspicuous consumption. The propensity to save is influenced by social status as higher relative wealth tends to enhance social status. In our approach we consider the spirit of capitalism affects the propensity to save. Although social status may interact with propensities through many channels in nonlinear relations, this study accepts the above linear forms for convenience of analysis.

Optimal household behavior

Maximizing (10) subject to (11) yields

$$h_j\, w_j(t)\bar{T}_j(t) = \sigma_j(t)\bar{y}_j(t), \;\; p_j(t)c_j(t) = \xi_j(t)\bar{y}_j(t), \;\; s_j(t) = \lambda_j(t)\bar{y}_j(t), \qquad (17)$$

where

$$\sigma_j(t) \equiv \rho_j(t)\sigma_{j0}(t), \;\; \xi_j(t) \equiv \rho_j(t)\xi_{j0}(t), \;\; \lambda_j(t) \equiv \rho_j(t)\lambda_{j0}(t),$$
$$\rho_j(t) \equiv \frac{1}{\sigma_{j0}(t) + \xi_{j0}(t) + \lambda_{j0}(t)}.$$

Wealth accumulation

The change in wealth is equal to saving minus dissaving. According to the definition of $s_j(t)$, the change in the household's wealth is

$$\dot{\bar{k}}_j(t) = s_j(t) - \bar{k}_j(t). \tag{18}$$

Demand and supply

The total capital stock employed by country j is allocated between the country's two sectors. Full employment of labor and capital implies

$$K_{ji}(t) + K_{js}(t) = K_j(t), \; N_{ji}(t) + N_{js}(t) = N_j(t). \tag{19}$$

Clearing conditions of the global capital markets

The total capital stocks employed by the world is equal to the wealth owned by the world. That is

$$K(t) = \sum_{j=1}^{J} K_j(t) = \sum_{j=1}^{J} \bar{K}_j(t) = \sum_{j=1}^{J} \bar{k}_j(t) \bar{N}_j . \tag{20}$$

Demand and supply for consumer goods

The clearing condition for consumer goods in each country is

$$c_j(t) N_j = F_{js}(t), \quad j = 1, \ldots, J . \tag{21}$$

Trade balances

The world production of capital goods is equal to the world net savings. That is

$$S(t) - K(t) + \sum_{j=1}^{J} \delta_{kj} K_j(t) = F(t), \tag{22}$$

where

$$S(t) \equiv \sum_{j=1}^{J} s_j(t) \bar{N}_j , \quad F(t) \equiv \sum_{j=1}^{J} F_{ji}(t).$$

We can also represent equation (22) in another form. The change in the global capital stock is the total output of all the capital goods sectors minus the total depreciations of capital goods

$$\dot{K}(t) = F(t) - \sum_{j=1}^{J} \delta_{kj} K_j(t). \tag{23}$$

We introduce trade balances of the economies as follows

$$B_j(t) = \left(\bar{K}_j(t) - K_j(t)\right) r(t). \tag{24}$$

When $B_j(t)$ is positive (negative), we say that country j is in trade surplus (deficit). When $B_j(t)$ is zero, country $j's$ trade is in balance.

We completed the model. Irrespective of the obvious strict assumptions in our model, from a structural point of view the model is quite general in the sense that some well-known models in economics can be considered as its special cases. For instance, our model is structurally similar to the neoclassical growth model by Solow (1956) and Uzawa (1961). Our model is also structurally similar to the Oniki-Uzawa trade model (Oniki and Uzawa, 1965). As mentioned before, our approach is influenced by some growth models in the literature of growth model with social status and spirit of capitalism.

3. Global economic dynamics

The global dynamic economic system is composed of any (finite) number of national economies. As nations vary in utility and production functions, the global system is nonlinear with many dimensions. The following lemma shows that the dimension of the dynamic system is the same as the number of countries. We provide a computational procedure for calculating all the variables at any point in time. We first introduce a new variable $z_1(t)$

$$z_1(t) \equiv \frac{r(t) + \delta_{k1}}{w_1(t)}.$$

Lemma

The dynamics of the world economy is governed by the following J dimensional differential equations system with $z_1(t)$, $\{\tilde{k}_j(t)\}$, where $\{\tilde{k}_j(t)\} \equiv \left(\tilde{k}_2(t), \cdots, \tilde{k}_J(t)\right)$ as the variables

$$\dot{z}_1(t) = \Omega_1\left(z_1(t), \{\tilde{k}_j(t)\}\right),$$
$$\dot{\tilde{k}}_j(t) = \Omega_j\left(z_1(t), \{\tilde{k}_j(t)\}\right), \quad j = 2, \ldots, J, \tag{25}$$

in which Ω_j are unique functions of $z_1(t)$ and $\{\tilde{k}_j(t)\}$ defined in the Appendix. For any given solution of $z_1(t)$ and $\{\tilde{k}_j(t)\}$ at any point in time, the other variables are uniquely determined by the following procedure: $z_j(t)$ by (A3) → $r(t)$ and $w_j(t)$ by (A2) → $\tilde{k}_1(t)$ by (A17) → $\omega_j(t)$ by (15) → $\sigma_{j0}(t)$, $\xi_{j0}(t)$, and $\lambda_{j0}(t)$ by (16) →

$\sigma_j(t)$, $\xi_j(t)$ and $\lambda_j(t)$ by (16) → $K(t)$ by (A20) → $\bar{k}(t) = K(t)/\bar{N}$ → $\bar{k}_j(t)$ by (14)→ $K_j(t)$ by (A14)→ $N_j(t)$ by (A10) → $N_{js}(t)$ by (A7) → $N_{ji}(t)$ by (A11) → $K_{js}(t)$ and $K_{ji}(t)$ by (A1) → $\bar{y}_j(t)$ by (A5) → $F_{ji}(t)$ and $F_{js}(t)$ by the definitions → $p_j(t)$ by (A4) → $\bar{T}_j(t)$, $c_j(t)$ and $s_j(t)$ by (13) → $T_j(t) = T_0 - \bar{T}_j(t)$.

The lemma provides a computational procedure for following the movement of global economy. We simulate the model to show dynamic properties of the system. We consider a 3-country world. We specify parameter values as follows

$$T_0 = 24,$$
$$\begin{pmatrix} N_1 \\ N_2 \\ N_3 \end{pmatrix} = \begin{pmatrix} 10 \\ 20 \\ 30 \end{pmatrix}, \ \begin{pmatrix} h_1 \\ h_2 \\ h_3 \end{pmatrix} = \begin{pmatrix} 6 \\ 3 \\ 1 \end{pmatrix}, \ \begin{pmatrix} A_{1i} \\ A_{2i} \\ A_{3i} \end{pmatrix} = \begin{pmatrix} 1.7 \\ 1 \\ 0.8 \end{pmatrix}, \ \begin{pmatrix} A_{1s} \\ A_{2s} \\ A_{3s} \end{pmatrix} = \begin{pmatrix} 1.5 \\ 0.9 \\ 0.7 \end{pmatrix}, \ \begin{pmatrix} \alpha_{1i} \\ \alpha_{2i} \\ \alpha_{3i} \end{pmatrix} = \begin{pmatrix} 0.31 \\ 0.31 \\ 0.31 \end{pmatrix}, \ \begin{pmatrix} \alpha_{1s} \\ \alpha_{2s} \\ \alpha_{3s} \end{pmatrix} = \begin{pmatrix} 0.33 \\ 0.33 \\ 0.33 \end{pmatrix},$$
$$\begin{pmatrix} \omega_1 \\ \omega_2 \\ \omega_3 \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}, \ \begin{pmatrix} \omega_{10} \\ \omega_{20} \\ \omega_{30} \end{pmatrix} = \begin{pmatrix} 0.15 \\ 0.1 \\ 0.05 \end{pmatrix}, \ \begin{pmatrix} \omega_{1k} \\ \omega_{2k} \\ \omega_{3k} \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}, \ \begin{pmatrix} \bar{\lambda}_{10} \\ \bar{\lambda}_{20} \\ \vec{\lambda}_{30} \end{pmatrix} = \begin{pmatrix} 0.8 \\ 0.7 \\ 0.6 \end{pmatrix}, \ \begin{pmatrix} \bar{\xi}_{10} \\ \bar{\xi}_{20} \\ \bar{\xi}_{30} \end{pmatrix} = \begin{pmatrix} 0.12 \\ 0.12 \\ 0.13 \end{pmatrix},$$
$$\begin{pmatrix} \bar{\sigma}_{10} \\ \bar{\sigma}_{20} \\ \bar{\sigma}_{30} \end{pmatrix} = \begin{pmatrix} 0.15 \\ 0.16 \\ 0.17 \end{pmatrix}, \ \begin{pmatrix} \tilde{\lambda}_{10} \\ \tilde{\lambda}_{20} \\ \tilde{\lambda}_{30} \end{pmatrix} = \begin{pmatrix} 0.1 \\ 0.1 \\ 0.1 \end{pmatrix}, \ \begin{pmatrix} \tilde{\xi}_{10} \\ \tilde{\xi}_{20} \\ \tilde{\xi}_{30} \end{pmatrix} = \begin{pmatrix} 0.05 \\ 0.05 \\ 0.05 \end{pmatrix}, \ \begin{pmatrix} \tilde{\sigma}_{10} \\ \tilde{\sigma}_{20} \\ \tilde{\sigma}_{30} \end{pmatrix} = \begin{pmatrix} 0.05 \\ 0.05 \\ 0.05 \end{pmatrix}, \ \begin{pmatrix} \delta_{1k} \\ \delta_{2k} \\ \delta_{3k} \end{pmatrix} = \begin{pmatrix} 0.05 \\ 0.04 \\ 0.04 \end{pmatrix}. \quad (17)$$

The population of country 3 is largest, while the population of country 2 is the next. Country 1's human capital is highest, country 2's human capital is the next. The capital goods and consumer goods sector's total productivities in country 1 highest, and the capital goods and consumer goods sector's total productivities in country are lowest. We specify the values of the parameters, α_j, in the Cobb-Douglas productions for the capital goods and consumer goods sectors approximately equal to 0.3. The depreciation rates of physical capital are approximately 0.05. Values of the parameters associated with social status and preference change are positive. We will examine how the system is affected as these parameters vary. We specify the initial conditions as follows

$$z_1(0) = 0.04, \ \tilde{k}_2(0) = 0.95, \ \tilde{k}_3(0) = 0.15.$$

The motion of the variables is plotted in Figure 1. In Figure 1, the global income is

$$Y(t) = Y_1(t) + Y_2(t) + Y_3(t), \ Y_j(t) = F_{ji}(t) + p_j(t) F_{js}(t),$$

The global output is slightly changed and global wealth rises over time from the initial conditions. All countries increase national wealth and employ more capital. Country 1 has trade surplus while country 3 has trade deficit over time. Country 2 initially has trade deficit but has trade surplus in the long term. Country 1's capital goods sector expands and employs more two inputs, while the other two countries' capital goods sector shrink and use less input factors. The three countries' consumer goods sectors expand and employ more inputs. The rate of interest falls in association with increases in the global capital. The prices of consumer goods fall. The wage rates rise. The preferences, wealth and consumption levels of the households are slightly changed in the three economies. Country 1's household works more hours while the other two countries' households work less hours. It should be noted that wealth and wage rates do not converge over time. In the theoretical literature of economic growth and income convergence much of discussions about income convergence is based on the insights from analyzing models of closed economies (Barro and Sala-i-Martin, 1995). This obvious invalid approach is due to the fact that the main streams in economics lack proper analytical tools of international economic interactions. The approach accepted in this study enables us to analyze many important economic issues which cannot be properly addressed in the other approaches in theoretical economics.

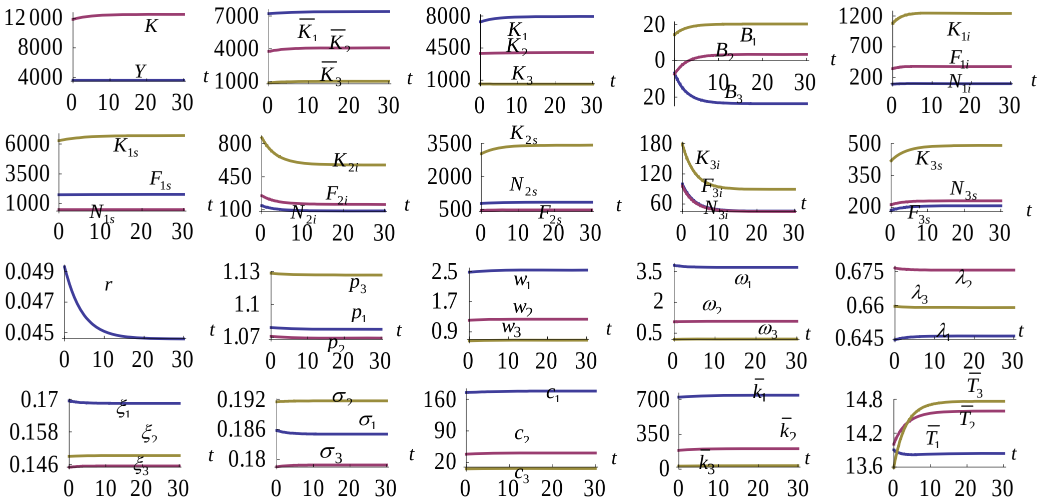

Figure 1. The Motion of the Economic System

We simulated the model with the initial conditions for longer periods. The system tends to be stationary after period 30. We also simulated the model with other initial conditions. The results show that all the variables tend to become stationary with different initial conditions. This demonstrates the existence of a stable equilibrium point. We identify the following equilibrium point

$$Y = 3615, \quad K = 12362, \quad r = 0.0458,$$

$$\begin{pmatrix} Y_1 \\ Y_2 \\ Y_3 \end{pmatrix} = \begin{pmatrix} 2312 \\ 1027 \\ 276 \end{pmatrix}, \quad \begin{pmatrix} \bar{K}_1 \\ \bar{K}_2 \\ \bar{K}_3 \end{pmatrix} = \begin{pmatrix} 7264 \\ 4069 \\ 1029 \end{pmatrix}, \quad \begin{pmatrix} K_1 \\ K_2 \\ K_3 \end{pmatrix} = \begin{pmatrix} 7878 \\ 3916 \\ 568 \end{pmatrix}, \quad \begin{pmatrix} B_1 \\ B_2 \\ B_3 \end{pmatrix} = \begin{pmatrix} -28 \\ 7 \\ 21 \end{pmatrix}, \quad \begin{pmatrix} p_1 \\ p_2 \\ p_3 \end{pmatrix} = \begin{pmatrix} 1.08 \\ 1.07 \\ 1.23 \end{pmatrix},$$

$$\begin{pmatrix} w_1 \\ w_2 \\ w_3 \end{pmatrix} = \begin{pmatrix} 2.52 \\ 1.23 \\ 0.67 \end{pmatrix}, \quad \begin{pmatrix} F_{1i} \\ F_{2i} \\ F_{3i} \end{pmatrix} = \begin{pmatrix} 422 \\ 150 \\ 43 \end{pmatrix}, \quad \begin{pmatrix} F_{1s} \\ F_{2s} \\ F_{3s} \end{pmatrix} = \begin{pmatrix} 1754 \\ 820 \\ 2017 \end{pmatrix}, \quad \begin{pmatrix} N_{1i} \\ N_{2i} \\ N_{3i} \end{pmatrix} = \begin{pmatrix} 115.4 \\ 84 \\ 44.2 \end{pmatrix}, \quad \begin{pmatrix} N_{1s} \\ N_{2s} \\ N_{3s} \end{pmatrix} = \begin{pmatrix} 501.8 \\ 478.3 \\ 231.7 \end{pmatrix},$$

$$\begin{pmatrix} K_{1i} \\ K_{2i} \\ K_{3i} \end{pmatrix} = \begin{pmatrix} 1365.9 \\ 540.9 \\ 84.2 \end{pmatrix}, \quad \begin{pmatrix} K_{1s} \\ K_{2s} \\ K_{3s} \end{pmatrix} = \begin{pmatrix} 6511.8 \\ 3375.5 \\ 483.4 \end{pmatrix}, \quad \begin{pmatrix} \tilde{k}_1 \\ \tilde{k}_2 \\ \tilde{k}_3 \end{pmatrix} = \begin{pmatrix} 3.53 \\ 0.99 \\ 0.17 \end{pmatrix}, \quad \begin{pmatrix} \omega_1 \\ \omega_2 \\ \omega_3 \end{pmatrix} = \begin{pmatrix} 3.68 \\ 1.08 \\ 0.22 \end{pmatrix}, \quad \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{pmatrix} = \begin{pmatrix} 0.65 \\ 0.68 \\ 0.66 \end{pmatrix},$$

$$\begin{pmatrix} \xi_1 \\ \xi_2 \\ \xi_3 \end{pmatrix} = \begin{pmatrix} 0.17 \\ 0.15 \\ 0.15 \end{pmatrix}, \quad \begin{pmatrix} \sigma_1 \\ \sigma_2 \\ \sigma_3 \end{pmatrix} = \begin{pmatrix} 0.19 \\ 0.18 \\ 0.19 \end{pmatrix}, \quad \begin{pmatrix} \bar{k}_1 \\ \bar{k}_2 \\ \bar{k}_3 \end{pmatrix} = \begin{pmatrix} 726.4 \\ 203.5 \\ 34.3 \end{pmatrix}, \quad \begin{pmatrix} c_1 \\ c_2 \\ c_3 \end{pmatrix} = \begin{pmatrix} 175.4 \\ 41 \\ 6.9 \end{pmatrix}, \quad \begin{pmatrix} \bar{T}_1 \\ \bar{T}_2 \\ \bar{T}_3 \end{pmatrix} = \begin{pmatrix} 13.7 \\ 14.6 \\ 14.8 \end{pmatrix}.$$

It is straightforward to calculate the three eigenvalues at the equilibrium point as follows

$$-0.37, \ -0.33, -0.24.$$

The equilibrium point is stable. This conclusion is important as it guarantees that we can effectively carry out comparative dynamic analysis.

4. Comparative dynamic analysis

We simulated the movement of the global economy. This section is concerned with how changes in parameters affect the global economy in transitory processes as well as in long-term economic growth. We introduce a variable $\overline{\Delta} x_j(t)$ which stands for the change rate of the variable, $x_j(t)$, in percentage due to changes in the parameter value.

4.1. More weights being given to relative wealth in determining social status

As mentioned before, social status may be affected by different factors and each factor may have different "weights" on determining social status. Although this study takes account of only relative wealth in endogenously determining social status, we can analyze other factor changes in terms of parameter change. We now examine what happen to the global economy if more weights are given to relative weight as follows:

$$\omega_{k1} = \omega_{k2} = \omega_{k3} : 1 \Rightarrow 1.05.$$

This implies that societies value more their relative economic positions in determining social status. The simulation result is given in Figure 2. If all countries raise the weights simultaneously, the global income and world capital stock fall. Although all the countries enhance their social status, the net results on the (relative) propensities to save fall in all the three economies. The falling propensities to save tend to reduce saving. Moreover, the changes in the weights enhance the propensities to consume consumer goods and to use leisure times. It should be noted that these changes in propensities are due to the presumed relations between social status and the propensities. If these functions vary, we may have opposite results on the propensities and thus macroeconomic behavior. The three national economies have less wealth and employ less capital stocks. Country 1's trade balance is deteriorated while the other two trade balances are improved in the long term. Country 1's representative household has less leisure hours, while the representative households in the other two economies have more leisure hours. All the households consume less and have less wealth in the long term. The rate of interest and prices of consumer goods rise. The wage rates fall. It should be noted that in their research on interaction between pecuniary emulation and inequality, Corneo and Jeanne (1999: 1667) conclude: "On the one hand, the presence of pecuniary emulation tends to underscore the conventional view that equality has a positive impact on growth. A more equal distribution of wealth, by reducing the distance between the wealth levels of classes, makes pecuniary emulation easier for the poor. Hence, equality strengthens the incentive to accumulate for status reasons, and is beneficial for economic growth. This mechanism has already been put forward by Cole et al. (1992) and Fershtman et al. (1996), and is thoroughly investigated in our companion paper Corneo and Jeanne (1997a)." It should be remarked that our simulation implies that as it is relatively easier for the poor to raise social status, the gaps between the poor and the rich in relative wealth are reduced.

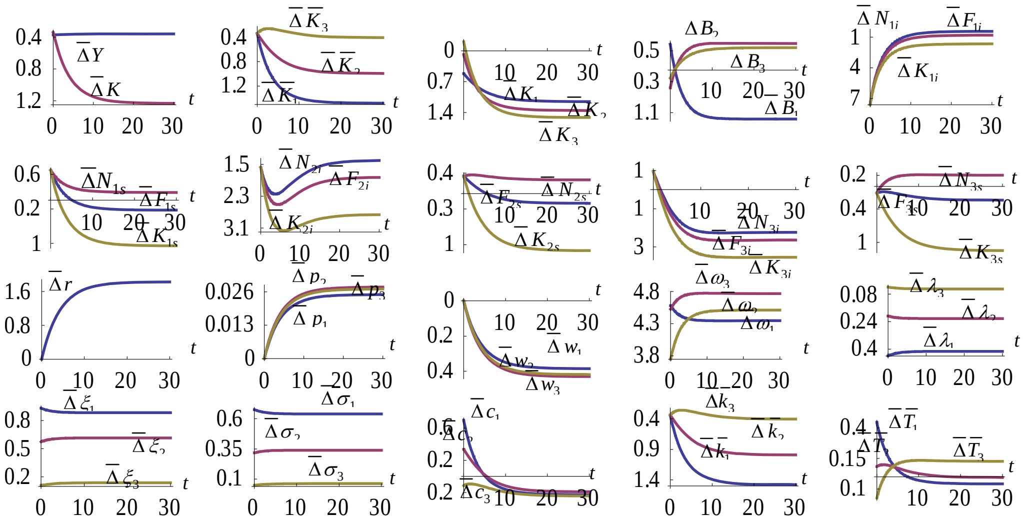

Figure 2. More Weights Being Given to Relative Wealth in Determining Social Status

4.2. The propensities to save being more strongly affected by social status

We now study a case that social status affects more strongly propensities to save:

$$\tilde{\lambda}_{10} = \tilde{\lambda}_{20} = \tilde{\lambda}_{30} : 0.1 \Rightarrow 0.11.$$

We narrowly interpret that this occurs because spirits of capitalism are enhanced. The simulation result is given in Figure 3. People put more weights on propensities to save. By narrow interpretations we mean that as spirit of capitalism is enhanced, attitudes to consumption and leisure are not affected. The global income and world capital stock rise. All the national economies have more wealth and employ more capital stocks in the long term. Country 1's propensity to save rises while the other two countries' propensities to save fall. Country 1's trade balance is deteriorated initially and improved in the long term. The other two countries' trade balances are improved initially and deteriorated in the long term. The capital goods sectors of the three economies expand and employ more inputs in the long term. All the consumer goods sectors expand and employ more capital inputs. The rate of interest and prices of consumer goods fall. The wage rates rise. Country 1's social status is enhanced, while the other two economies' social status are lowered. The propensities to save are enhanced. The propensities to consume and to use leisure are reduced. In the long term all the households consume more, have more wealth, and use more leisure hours. Hence, the global as well as national economies benefit from the preference change.

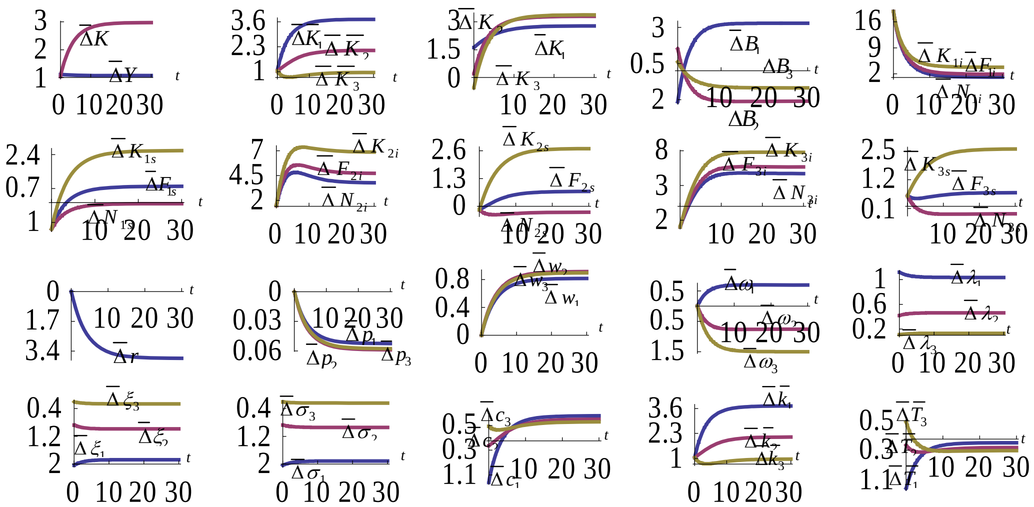

Figure 3. The Propensities to Save Being More Strongly Affected by Social Status

4.3. The propensities to consume being more strongly affected by social status

We now study a case that social status affects more strongly propensities to consume consumer goods:

$$\tilde{\xi}_{10} = \tilde{\xi}_{20} = \tilde{\xi}_{30} : 0.05 \Rightarrow 0.052.$$

We narrowly interpret that this occurs because conspicuous consumption is enhanced. The simulation result is given in Figure 4. The global income rises, while world capital stock falls. All the national economies have less wealth and employ less capital stocks in the long term. The economic structural changes are illustrated in Figure 4. The rate of interest and prices of consumer goods rise. The wage rates fall. Country 1's social status is lowered, while the other two economies' social status are enhanced. The propensities to save are reduced. The propensities to consume are reduced. The propensities to use leisure are augmented. The representative household's leisure time in country 3 rises, while the representative households' leisure hours in the other economies fall. Wealth level per household falls in the three economies.

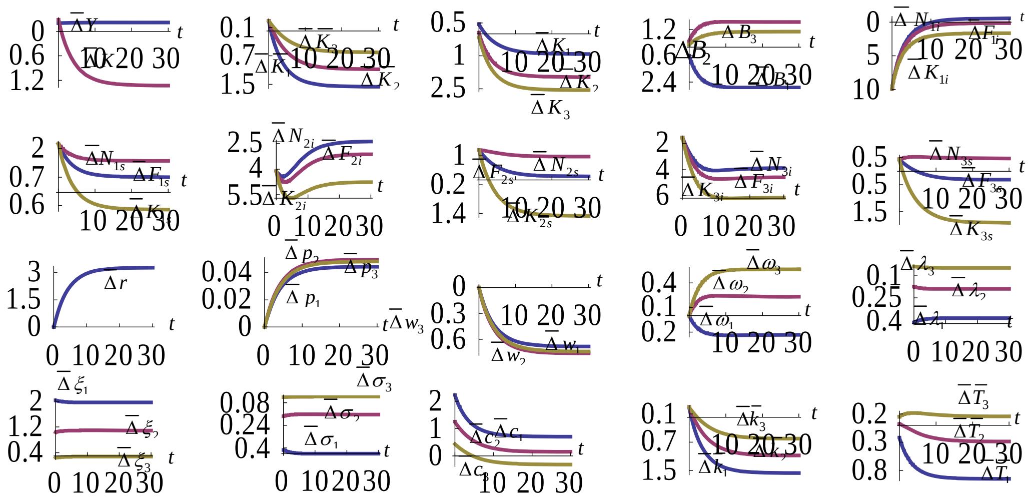

Figure 4. The Propensities to Consume Being More Strongly Affected by Social Status

4.4. Country 1's social status being reduced

We now study a case that country 1's social status is reduced as follows: $\omega_{01} : 0.15 \Rightarrow 0.12$. The simulation result is given in Figure 5. The global income and world capital stock rise. All the national economies have more wealth and employ more capital stocks in the long term. Country 1's trade balance is deteriorated initially and improved in the long term. The other two countries' trade balances are improved initially and deteriorated in the long term. The economic structural changes are illustrated in Figure 5. The rate of interest and prices of consumer goods fall. The wage rates rise. The countries' social statuses are lowered. The propensities to save are increased. The propensities to consume goods and to use leisure are reduced.

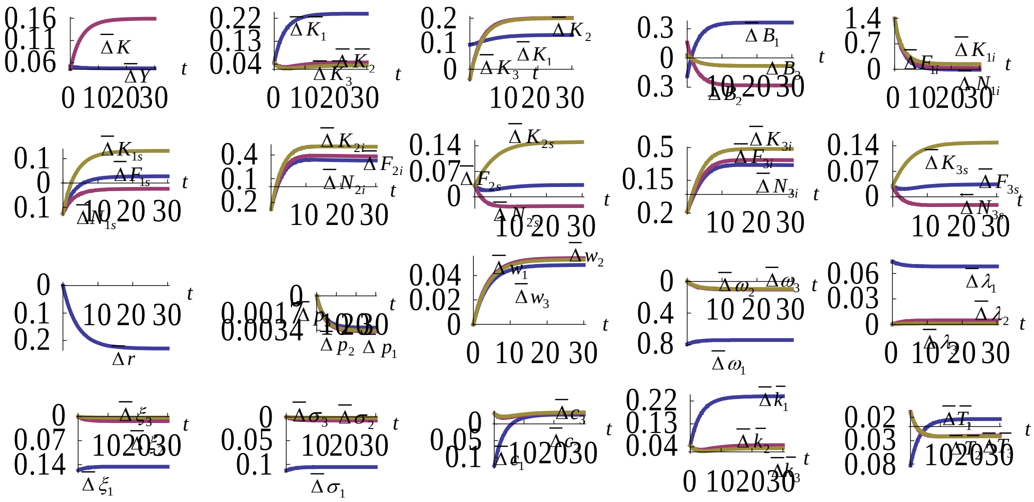

Figure 5. Country 1's Social Status Being Reduced

4.5. Country 1's human capital being enhanced

We now study a case that country 1's human capital is enhanced as follows: $h_1 : 6 \Rightarrow 6.1$. The simulation result is given in Figure 6. The global income and world capital stock rise. All the national economies have more wealth. Country 1 employs more capital stocks while the other two national economies employ less capital stocks. Country 1's trade balance is deteriorated while the other two countries' trade balances are improved. Country 1's two sectors expand and employ more inputs, while the other two countries' capital goods sectors shrink and employ less inputs. Country 1's social status is enhanced, while the other two countries' social statuses are lowered. Country 1's propensity to save falls, while the other two countries' propensities to save rise. Country 1's propensities to consume consumer goods and to use leisure rise, while the other two countries' propensities to consume consumer goods and to use leisure fall. The rate of interest and price of consumer goods rise. The wage rates fall. The time distributions are slightly affected in the long term. Country 1's representative household consumes more goods and owns more wealth, while the other two countries' consumption and wealth levels are changed slightly.

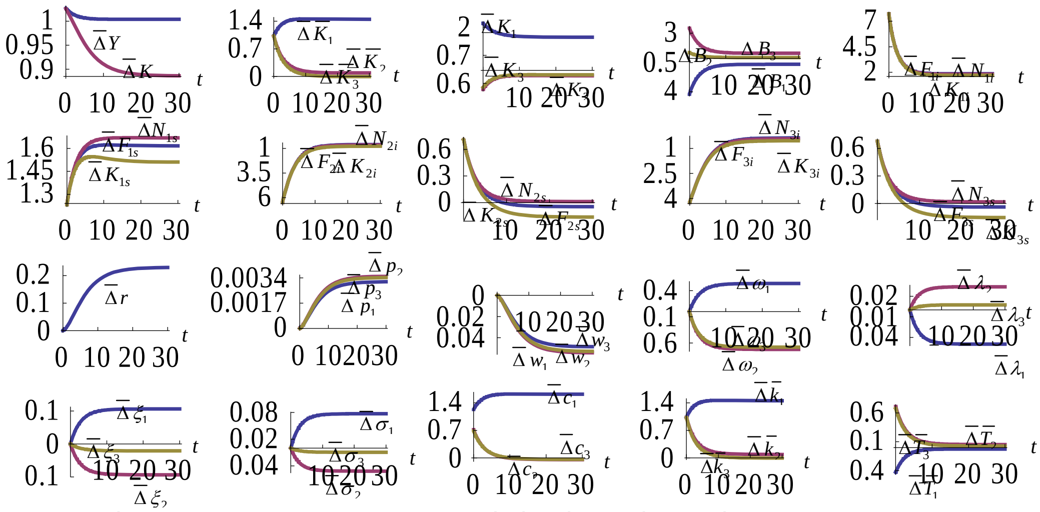

Figure 6. Country 1's Human Capital Being Enhanced

5. Conclusions

This paper built a global economic growth model with endogenous social status, endogenous preferences, and wealth accumulation. The economic system is based the Solow model (Solow, 1956), the Uzawa two-sector model (Uzawa, 1961), and the Oniki-Uzawa trade model (Oniki and Uzawa, 1965). We also based our approach to measuring social status on some ideas in the literature of economic growth with endogenous growth. The model is specially based on Zhang's model (2016). It is different from Zhang's model in that this study considered relative social status as a function of a country's relative wealth per household with the global average per household wealth, while Zhang's model considers a country's per household wealth as the determinant of social status. It is also different from Zhang's model in that this study treats time distribution between leisure and work as endogenous variables, while Zhang's model does not consider issues related to endogenous time distribution. The model deals with a world economy composed of any number of national economies. Each country consists of one capital goods sector and one consumer goods sector. Different from most of the growth models with social status which use the Ramsey approach to describe household behavior, we used the approach proposed by Zhang (1993, 2005) to model household behavior. The countries differ in social status, preferences, spirits of capitalism, and productivities. We built the model for J -country world economy and expressed the dynamics with J differential equations. We simulated the movement of a 3-country global economy and carried out comparative dynamic analysis with regard to some parameters. As our analytical framework is general, it is possible to generalize and extend the model in different aspects. For instance, it is important to introduce endogenous human capital and education as social status is influenced by human capital and education.

Appendix: Proving the lemma

By (3) and (5), we obtain

$$z_j \equiv \frac{r+\delta_{jk}}{w_j} = \frac{N_{jm}}{\bar{\beta}_{jm} K_{jm}}, \quad j = 1, ..., J, \ \ m = i, s, \tag{A1}$$

where $\bar{\beta}_{jm} \equiv \beta_{jm} / \alpha_{jm}$. Insert (A1) in (3)

$$r = \alpha_{jr} z_j^{\beta_{ji}} - \delta_{jk}, \ \ w_j = \alpha_j z_j^{-\alpha_{ji}}, \tag{A2}$$

where

$$\alpha_{jr} = \alpha_{ji} \bar{\beta}_{ji}^{\beta_{ji}} A_{ji}, \ \ \alpha_j = \frac{\beta_{ji} A_{ji}}{\bar{\beta}_{ji}^{\alpha_{ji}}}.$$

From (A2) we have

$$r = \alpha_{jr} z_j^{\beta_{ji}} - \delta_{jk} = \alpha_{1r} z_1^{\beta_{1i}} - \delta_{1k}, \ \ j = 1, ..., J.$$

The above equations imply

$$z_j(z_1) = \left(\frac{\alpha_{1r} z_1^{\beta_{1i}} + \delta_{jk} - \delta_{1k}}{\alpha_{jr}} \right)^{1/\beta_{ji}}, \quad j = 2, ..., J. \tag{A3}$$

Hence, we determine r, w_j, and z_j, as functions of z_1. From (4) and (5), we have

$$p_j(z_1) = \frac{\bar{\beta}_{js}^{\alpha_{js}} z_j^{\alpha_{js}} w_j}{\beta_{js} A_{js}}. \tag{A4}$$

From the definitions of $\bar{y}_j$, we have

$$\bar{y}_j = (1+r)\bar{k}_j + h_j T_0 w_j. \tag{A5}$$

Insert $p_j c_j = \xi_j \bar{y}_j$ in (21)

$$\xi_j \, \overline{N}_j \, \overline{y}_j = p_j \, F_{js} \, . \tag{A6}$$

Substituting (A5) in (A6) yields

$$N_{js} = g_j \, \xi_j \, \overline{k}_j + \xi_j \, \overline{g}_j \, , \tag{A7}$$

where we use $w_j \, N_{js} = \beta_{js} \, p_j \, F_{js}$ and

$$g_j(z_1) \equiv \left(\frac{1+r}{w_j}\right) \beta_{js} \, \overline{N}_j \, , \quad \overline{g}_j \equiv \beta_{js} \, h_j \, T_0 \, \overline{N}_j \, .$$

From (A5) and (17), we have

$$\overline{T}_j = \frac{(1+r)\sigma_j \, \overline{k}_j}{h_j \, w_j} + \sigma_j \, T_0 \, . \tag{A8}$$

Equation (A8) implies

$$T_j = (1-\sigma_j)T_0 - \frac{(1+r)}{h_j \, w_j} \sigma_j \, \overline{k}_j \, . \tag{A9}$$

From (A9) and (1) we have

$$N_j = (1-\sigma_j)R_{0j} - R_j \, \sigma_j \, \overline{k}_j \, , \tag{A10}$$

where

$$R_{0j} \equiv h_j \, \overline{N}_j \, T_0 \, , \quad R_j \equiv \frac{(1+r)\overline{N}_j}{w_j} .$$

From (11) we have

$$N_{ji} = N_j - N_{js} \, . \tag{A11}$$

From (A1) and (19), we get

$$\frac{N_{ji}}{z_j\,\overline{\beta}_{ji}} + \frac{N_{js}}{z_j\,\overline{\beta}_{js}} = K_j\,. \tag{A12}$$

Insert (A11) in (A12)

$$\tilde{\beta}_j\,N_j + \overline{\beta}_j\,N_{js} = K_j\,, \tag{A13}$$

where

$$\tilde{\beta}_j \equiv \frac{1}{z_j\,\overline{\beta}_{ji}},\quad \overline{\beta}_j \equiv \left(\frac{1}{\overline{\beta}_{js}} - \frac{1}{\overline{\beta}_{ji}}\right)\frac{1}{z_j}.$$

Substitute (A7) and (A10) into (A13)

$$K_j = R_{kj}\,\bar{k}_j + \tilde{R}_{0j}\,, \tag{A14}$$

where

$$R_{kj} \equiv \overline{\beta}_j\,g_j\,\xi_j - R_j\,\sigma_j\,\tilde{\beta}_j\,,\quad \tilde{R}_{0j} \equiv \left(1-\sigma_j\right)\tilde{\beta}_j\,R_{0j} + \overline{\beta}_j\,\xi_j\,\bar{g}_j\,.$$

Sum equations (A14)

$$K = \sum_{j=1}^{J} R_{kj}\,\bar{k}_j + R_0\,, \tag{A15}$$

where

$$R_0 \equiv \sum_{j=1}^{J} \tilde{R}_{0j}\,.$$

From (13) and (14) we have

$$\bar{k}_j = \varphi_j\left(K,\left\{\tilde{k}_j\right\}\right) \equiv \frac{K\,\tilde{k}_j}{\overline{N}},\quad j = 2, \ldots, J\,. \tag{A16}$$

As

$$\sum_{j=1}^{J}\tilde{k}_j\,\bar{N}_j = \frac{\bar{N}}{K}\sum_{j=1}^{J}\bar{k}_j\,\bar{N}_j = \bar{N},$$

we have

$$\tilde{k}_1 = \varphi_j\left(\left\{\tilde{k}_j\right\}\right) \equiv \left(\bar{N} - \sum_{j=2}^{J}\tilde{k}_j\,\bar{N}_j\right)\frac{1}{\bar{N}_1}. \tag{A17}$$

We have

$$\bar{k}_1 = \varphi_j\left(K,\,\left\{\tilde{k}_j\right\}\right) \equiv \frac{K\,\tilde{k}_1}{\bar{N}}. \tag{A18}$$

Insert (A16) and (A18) in (A15)

$$K = \frac{K}{\bar{N}}\sum_{j=1}^{J}R_{kj}\,\tilde{k}_j + R_0. \tag{A19}$$

Solve (A19) with K as the variable

$$K = \varphi\left(z_1,\,\left\{\tilde{k}_j\right\}\right) \equiv R_0\left(1 - \frac{1}{\bar{N}}\sum_{j=1}^{J}R_{kj}\,\tilde{k}_j\right)^{-1}. \tag{A20}$$

It is straightforward to confirm that all the variables can be expressed as functions of z_1 and $\left\{\tilde{k}_j\right\}$ by the following procedure: z_j by (A3) → r and w_j by (A2) → $\tilde{k}_1$ by (A17) → ω_j by (15) → σ_{j0}, ξ_{j0}, and λ_{j0} by (16) → σ_j, ξ_j, and λ_j by (16) → K by (A20) → $\bar{k} = K/\bar{N}$ → $\bar{k}_j$ by (14)→ K_j by (A14)→ N_j by (A10) → N_{js} by (A7) → N_{ji} by (A11) → K_{js} and K_{ji} by (A1) → $\bar{y}_j$ by (A5) → F_{ji} and F_{js} by the definitions → p_j by (A4) → $\bar{T}_j$, c_j and s_j by (13) →$T_j = T_0 - \bar{T}_j$. From this procedure, (23) and (18), we have

$$\dot{K} = \Lambda_K\left(z_1,\,\left\{\tilde{k}_j\right\}\right) \equiv F - \sum_{j=1}^{J}\delta_{jk}\,K_j, \tag{A21}$$

$$\dot{\bar{k}}_j = \Lambda_j\left(z_1,\,\left\{\tilde{k}_j\right\}\right) \equiv \lambda_j\,\bar{y}_j - \bar{k}_j,\quad j = 1, \dots, J. \tag{A22}$$

Take derivatives of equation (A16) with respect to t implies

$$\dot{\tilde{k}}_j = \frac{\tilde{k}_j}{\overline{N}}\dot{K} + \frac{K}{\overline{N}}\dot{\tilde{k}}_j, \quad j = 2, ..., J. \tag{A23}$$

From (A21) - (A23) we get

$$\dot{\tilde{k}}_j = \Omega_j\left(z_1, \{\tilde{k}_j\}\right) \equiv \frac{\Lambda_j \overline{N}}{K} - \frac{\tilde{k}_j \Lambda_K}{K}, \quad j = 2, ..., J. \tag{A24}$$

Take derivatives of (A20) with respect to time

$$\dot{K} = \frac{\partial \varphi}{\partial z_1}\dot{z}_1 + \sum_{j=2}^{J}\Omega_j \frac{\partial \varphi}{\partial \tilde{k}_j}, \tag{A25}$$

where we use (A19). Equal (A19) and (A25)

$$\dot{z}_1 = \Omega_1\left(z_1, \{\tilde{k}_j\}\right) \equiv \left(\Lambda_K - \sum_{j=2}^{J}\Omega_j \frac{\partial \varphi}{\partial \tilde{k}_j}\right)\left(\frac{\partial \varphi}{\partial z_1}\right)^{-1}. \tag{A26}$$

In summary, we proved the lemma.

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