TOURISM, TRADE AND WEALTH ACCUMULATION WITH ENDOGENOUS INCOME AND WEALTH DISTRIBUTION AMONG COUNTRIES

Wei-Bin. ZHANG
Ritsumeikan Asia Pacific University, Japan
wbz1 @apu.ac.jp

Abstract
The purpose of this study is to study dynamic interactions among economic growth, structural change, international trade and tourist flows. It builds a multi-country growth model with endogenous wealth accumulation and tourism. The model is unique in that it introduces endogenous tourism within a general dynamic equilibrium framework. The model is built on microeconomic foundations. It not only integrates the three well-known Solow growth model, Oniki-Uzawa trade model, and the Uzawa two-sector model, but also introduces tourist flows between economies for any number of national economies. After building the model, we demonstrate that the motion of the J -country world economy can be described by J differential equations. We also simulate the global economy with three countries, showing that the world dynamics has a unique equilibrium. We carry out comparative dynamic analysis with regard to one country's total productivity factor, the propensity to save, the propensity to tour other countries, and the population.

Key words: *trade pattern; tourism; services; growth; wealth accumulation; income and wealth distribution among countries.*

JEL Classification: *F11; O41; L83*

I. INTRODUCTION

This study proposes a multi-country growth model with international trade and economic structures. The growth mechanism is based on the Solow growth model and ideas of possible mutual benefits from free trade. In describing each country's economic structure we base our study on the Uzawa tow-sector growth. We describe trade and trade pattern determination on the basis of Oniki and Uzawa and others (for instance, Oniki and Uzawa, 1965; Frenkel and Razin, 1987; Nishimura and Shimomura, 2002; and Sorger, 2002). The Oniki-Uzawa model deals with a two-country world economy with two goods. The Oniki-Uzawa modelling framework is now often applied to study dynamic interdependence between trade patterns and economic growth. In the literature of trade and growth there some other trade models which make systematic treatments of wealth accumulation in the context of international economics. Most of trade models with endogenous wealth are either limited to two-country or small open economies. The model in this study is for any number of national economies, each national economy supplying internationally tradable goods and domestic services (which can be consumed by foreign tourists). It is a dynamic general equilibrium model, treating the global economy as an integrated whole.

A unique feature of this study is introduction of tourism into a dynamic general equilibrium model. Tourism has played increasingly important role in national economies partly due to rapid economic globalization and economic growth in different parts of the world. It is obvious that tourism has interdependent relations with economic growth and other economic activities. As far as trade is concerned, tourism is special in that it converts some non-traded goods into tradable ones. Tourism goods such as monuments of national heritage, historical sites, beaches, and hot springs, are not-tradable as their consumption is at the same location. People from other regions can enjoy the goods only by visiting the spot. Tourism affects local economies in different ways. On the one hand, tourism attracts resources such as labor and capital from other sectors of the economy and, on the other hand, the income generated by tourism encourages development of other economic activities. Foreign tourism is an important source of income and employment in some economies (Sinclair, 2002; Lee and Chang, 2008; Schubert et al., 2011; Seentanah, 2011; Sun, 2014). This study examines dynamic interdependence between tourism, trade and growth in a general equilibrium framework. Tourism has caused increasingly more attention in the literature of economics (e.g., Sinclair and Stabler, 1997; Hazari and Sgro, 2004; and Hazari and Lin, 2011). According to Chao *et al.* (2009) the study of tourism has been mainly static. It is necessary to build dynamic models on microeconomic foundation. Another important issue is related to economic structural changes with tourism. As tourism uses national resources, development of tourism affects economic structure (e.g., Corden and Neary, 1982; Copeland, 1991; Oh, 2005; Zeng and Zhu, 2011). In order to fully understand possible effects of tourism on national economic development and economic structure, it is necessary to build a dynamic general equilibrium framework. Dwyer *et al.*

(2004) discuss the need for dynamic general equilibrium modeling when studying tourism and its interaction with the rest economy. Blake *et al*. (2006) also address the issue. Nevertheless, there are a few dynamic economic models of dynamic interdependence between economic growth and tourism with micro-behavioral foundation. This study studies tourism and economic growth on basis of Uzawa's two-sector growth model (Uzawa, 1963; Galor, 1992; Mino, 1996; Cremers, 2006; Li and Lin, 2008; and Stockman, 2009).

This study applies an alternative approach to household behavior proposed by Zhang (1993). It is based on the two models recently proposed by Zhang (2012a, 2012b). Zhang (2012a) builds a multi-country trade model with wealth accumulation and economic structure. Nevertheless, the model does not take account of tourism. This study introduces tourism into this model by following Zhang (2012b) in describing behavior of tourists taking account of modelling. Different from Zhang (2012b) which is for small-open economies, this study treats tourism within a general equilibrium framework. The rest of the paper is organized as follows. Section 2 defines the basic model. Section 3 shows how we solve the dynamics and simulates the motion of the global economy. Section 4 carries out comparative dynamic analysis to examine the impact of changes in some parameters on the motion of the global economy. Section 5 concludes the study. The appendix proves the main results in Section 3.

II.THE MODEL

We use the Uzawa two-sector growth model to describe national economies. Most of the models in the neoclassical growth theory model are extensions and generalizations of the pioneering works of Solow (1956). The model has been extended and generalized in numerous directions (e.g., Diamond, 1965; Stiglitz, 1967; Burmeister and Dobell, 1970; Benhabib *et al*. 2000; Drugeon and Venditti, 2001; and Ortigueira and Santos, 2002). An important extension was initiated by Uzawa (1961), who made an extension of Solow's one-sector economy by a breakdown of the productive system into two sectors using capital and labor, one of which produces industrial goods, the other consumption goods. But all these studies do not have tourism. This study structurally generalizes the Uzawa two-sector model to include tourism. Determination of international trade pattern in our approach is based the Oniki-Uzawa model (see also, Brecher, *et al.*, 2002; Sorger, 2002). It is assumed that the countries produce a homogenous tradable commodity (see also Ikeda and Ono, 1992). There is only one (durable) good in the global economy and one (national) services and consumer goods under consideration. Domestic households consume both goods, while foreign tourists consume only services. It is assumed for analytical simplicity that tourists do not consume traded goods. Tourism converts the non-traded good into an exportable commodity. Households own assets of the economy and distribute their incomes to consume and save. Production sectors or firms use capital and labor. Exchanges take place in perfectly competitive markets. Production sectors sell their product to households or to other sectors and households sell their labor and assets to production sectors. Factor markets work well; factors are inelastically supplied and the available factors are fully utilized at every moment. Saving is undertaken only by households, which implies that all earnings of firms are distributed in the form of payments to factors of production. We omit the possibility of hoarding of output in the form of non-productive inventories held by households. The system consists of multiple countries, indexed by $j = 1, \ldots, J$. Each country has a fixed labor force, N_j, ($j = 1, \ldots, J$). Let $K_j(t)$ and $\bar{K}_j(t)$ stand for respectively the capital stocks employed and the wealth owned by country j. We also introduce $K_{ij}(t)$ and $K_{sj}(t)$ to represent the capital stocks employed by country j 's industrial sector and service sector. Capital is both internationally and domestically completely mobile. Services are country-specified and are consumed simultaneously as they are produced. Labor is internationally immobile and domestically completely mobile. We denote wage and interest rates by $w_j(t)$ and $r_j(t)$, respectively, in the j th country. In the free trade system where transaction costs are neglected, the interest rate is identical throughout the world economy, i.e., $r(t) = r_j(t)$. We use subscripts, i, s, to denote the industrial and services sectors, respectively. Let $F_{qj}(t)$ stand for the output levels of q 's sector in region j at time t, $q = i, s$.

Behavior of producers

We assume that there are two productive factors, capital, $K_{qj}(t)$, and labor, $N_{qj}(t)$, at each point in time t. The production functions are specified as

$$F_{qj}(t) = A_{qj} K_{qj}^{\alpha_{qj}}(t) N_{qj}^{\beta_{qj}}(t), \quad j = 1, \ldots, J, \; q = i, s. \tag{1}$$

We use $p_j(t)$ to stand for country j 's price of consumer goods. Markets are competitive, thus labor and capital earn their marginal products, and firms earn zero profits. The rate of interest and wage rates are determined by markets.

The production sector chooses the two variables, $K_{qj}(t)$ and $N_{qj}(t)$, to maximize its profit. The marginal conditions are given by

$$r(t) + \delta_{kj} = \frac{\alpha_{ij} F_{ij}(t)}{K_{ij}(t)} = \frac{\alpha_{sj} \, p_j(t) F_{sj}(t)}{K_{sj}(t)}, \quad w_j(t) = \frac{\beta_{ji} F_{ij}(t)}{N_{ij}(t)} = \frac{\beta_{sj} \, p_j(t) F_{sj}(t)}{N_{sj}(t)}, \tag{2}$$

where δ_{kj} are the depreciation rate of physical capital in country j. It should be noted that there is a rapidly increasing literature on identifying the factors that affect the location choice of firms (e.g., Lee and Mansfield, 1996; Henisz, 2000; Busse and Hefeker, 2007; Almazan *et. al*., 2007; De Beule and Duanmu, 2012; Colombo and Dawid, 2014). In this model for simplicity we neglect many other factors such as institutions and taxation which affect firms' behaviour.

Behavior of consumers

Consumers make decisions on choice of consumption level of commodity, how much to travel, as well as on how much to save. This study uses the approach to consumers' behavior proposed by Zhang in the early 1990s (see Zhang, 1993). This approach makes it possible to solve many national, international, urban, and interregional economic problems, such as growth problems with heterogeneous households, multi-sectors, and preference changes, which are analytically intractable by the traditional approaches in economics. Let $\bar{k}_j(t)$ stand for the per capita wealth in country j. The representative household obtains the current income

$$y_j(t) = r(t)\bar{k}_j(t) + w_j(t). \tag{3}$$

We call $y_j(t)$ the current income in the sense that it comes from consumers' wages and current earnings from ownership of wealth. The sum of income that consumers are using for consuming, saving, or travels are not necessarily equal to the current income because consumers can sell wealth to pay, for instance, the current consumption if the current income is not sufficient for buying food and touring the country. The total value of the wealth that a consumer can sell to purchase goods and to save is equal to $p_i(t)k_j(t)$, with $p_i(t) = 1$ at any t. Here, we assume that selling and buying wealth can be conducted instantaneously without any transaction cost. The disposable income is equal to

$$\hat{y}_j(t) = y_j(t) + \bar{k}_j(t). \tag{4}$$

The disposable income is used for saving and consumption. The value, $\bar{k}_j(t)$, (i.e., $p_i(t)\bar{k}_j(t)$), in the above equation is a flow variable. Under the assumption that selling wealth can be conducted instantaneously without any transaction cost, we may consider $\bar{k}_j$ as the amount of the income that the consumer obtains at time t by selling all of his wealth. Hence, at time t the consumer has the total amount of income equaling $\hat{y}_j$ to distribute consumer goods, $c_{sj}(t)$, capital goods, $c_{ij}(t)$, tourist consumption in country q, $c_{jq}(t)$, and savings, $s_j(t)$. The total cost for touring countries are

$$\sum_{q,\, q \neq j}^{J} \left(t_{jq} + p_q(t) c_{jq}(t)\right) \bar{d}_{jq}(t),$$

where t_{jq}, $\bar{d}_{jq}(t)$, and $p_q(t)c_{jq}(t)$ are respectively, the (fixed) transportation cost of each time from country j to country q, the visit times from country j to country q, and consumption of country q's services by the tourist from country j. For simplicity of analysis we neglect transportation costs, that is $t_{jq} = 0$. The budget constraints are

$$c_{ij}(t) + p_j(t) c_{sj}(t) + \sum_{q \neq j}^{J} p_q(t) d_{jq}(t) + s_j(t) = \hat{y}_j(t), \tag{5}$$

where $d_{jq}(t) = c_{jq}(t)\bar{d}_{jq}(t)$, We assume that utility functions, $U_j(t)$, are specified as follows

$$U_j(t) = c_{ij}^{\xi_{0j}}(t) c_{sj}^{\gamma_{0j}}(t) s_j^{\lambda_{0j}}(t) \prod_{q \neq j}^{J} d_{jq}^{\varepsilon_{0jq}}(t), \quad \xi_{0j}, \gamma_{0j}, \lambda_{0j} > 0, \varepsilon_{0jq} \geq 0. \tag{6}$$

Maximizing U_j subject to budget (6) yields

$$c_{ij}(t) = \xi_j \hat{y}_j(t), \quad p_j(t) c_{sj}(t) = \gamma_j \hat{y}_j(t), \quad s_j(t) = \lambda_j \hat{y}_j(t), \quad p_q(t) d_{jq}(t) = \varepsilon_{jq} \hat{y}_j(t), \\ q \neq j, \quad j, q = 1, \ldots J, \tag{7}$$

where

$$\xi_j \equiv \rho_j \xi_{0j}, \quad \gamma_j \equiv \rho_j \gamma_{0j}, \quad \lambda_j \equiv \rho_j \lambda_{0j}, \quad \varepsilon_{jq} \equiv \rho_j \varepsilon_{0jq}, \quad \rho_j \equiv \frac{1}{\xi_{0j} + \gamma_{0j} + \lambda_{0j} + \sum_{q \neq j}^{J} \varepsilon_{0jq}}.$$

The above equations mean that the service consumption, consumption of the good and saving are positively proportional to the available income. It should be noted that Schubert and Brida (2009) use an iso-elastic tourism demand function as follows

$$D_T(t) = a\, y_f^{\phi}(t)\, p^{-\varepsilon}(t),$$

where $y_f(t)$ denotes the disposable income of foreign countries, ϕ and ε are respectively the income and price elasticities of tourism demand. Our model is similar to the case of $\phi = 1$ and $\varepsilon = 1$.

According to the definition of $s_j(t)$, the wealth accumulation is given by

$$\dot{\bar{k}}_j(t) = s_j(t) - \bar{k}_j(t). \tag{8}$$

The equation simply states that the change in the wealth is equal to the savings minus the dissavings.

Full employment of capital and labor

The total capital stocks utilized by country j, $K_j(t)$, is distributed between the two sectors. Full employment of labor and capital implies

$$K_{ij}(t) + K_{sj}(t) = K_j(t), \quad N_{ij}(t) + N_{sj}(t) = N_j, \quad j = 1, \ldots, J. \tag{9}$$

Balance conditions for global wealth

The total capital stocks employed by the production sectors are equal to the total wealth owned by all the countries. That is

$$\sum_{j=1}^{J} K_j(t) = \sum_{j=1}^{J} \bar{k}_j(t) N_j. \tag{10}$$

Equilibrium conditions for national consumer goods

For each country, the demand for services equals the supply of services at any point time

$$N_j c_{sj}(t) + \sum_{q \neq j}^{J} d_{qj}(t) N_q = F_{sj}(t). \tag{11}$$

We thus built the dynamic growth model with endogenous distribution of wealth, consumption and labor distribution, and capital accumulation. We now examine dynamic properties of the system.

III. THE DYNAMICS AND EQUILIBRIUM

As the dynamic system consists of any (finite) number of nations, it should be nonlinear and highly dimensional. It is almost impossible to provide analytical properties of the nonlinear dynamic system. Nevertheless, we can rely on computer simulation to plot the motion of the dynamic system. The following lemma shows that the dimension of the dynamical system is equal to the number of nations. The following lemma provides a computational procedure for calculating all the variables at any point of time. First, we introduce a new variable $z_1(t)$

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

Lemma

The motion of the economic system is determined by J differential equations with $z_1(t)$ and $\{\bar{k}_j(t)\}$, where $\{\bar{k}_j(t)\} \equiv (\bar{k}_2(t), \cdots, \bar{k}_J(t))$ and as the variables

$$\dot{z}_1(t) = \Phi_1(z_1(t), \{\bar{k}_j(t)\}),$$
$$\dot{\bar{k}}_j(t) = \Phi_j(z_1(t), \{\bar{k}_j(t)\}), \quad j = 2, \ldots, J, \tag{12}$$

in which $\Phi_j(t)$ are unique functions of $z_1(t)$ and $\{\bar{k}_j(t)\}$ defined in the appendix. At any point in time the other variables are unique functions of $z_1(t)$ and $\{\bar{k}_j(t)\}$ by the following procedure: $r(t)$ by (A2) $\to w_j(t)$ by (A3) $\to p_j(t)$ by (A3) $\to$ $\bar{k}_1(t)$ by (A15) $\to$ $\hat{y}_j(t)$ by (A8) $\to$ $c_{ij}(t)$, $c_{sj}(t)$, $d_{jq}(t)$ and $s_j(t)$ by (11) $\to$ $N_{sj}(t)$ by (A9) $\to$ $N_{ij}(t)$ by (A10)$\to$ $K_{sj}(t)$ and $K_{ij}(t)$ by (A1) $\to$ $K_j(t)$ by (9) $\to$ $F_{ij}(t)$ and $F_{sj}(t)$ by the definitions $\to$ $U_j(t)$ by (6) $\to K(t) = \sum_{j=1}^{J} K_j(t)$.

The lemma presents a computational procedure for plotting the motion of the economic system with any number of national economies. As it is difficult to interpret the analytical results, to study properties of the system we simulate the model with the following parameter values

$$\begin{aligned} &N_1 = 20,\ N_2 = 30,\ N_3 = 10,\ A_{i1} = 1.2,\ A_{i2} = 1,\ A_{i3} = 0.8,\ A_{s1} = 1.1,\ A_{s2} = 0.9,\ A_{s3} = 0.7,\ \alpha_{i1} = 0.31, \\ &\alpha_{i2} = 0.33,\ \alpha_{i3} = 0.32,\ \alpha_{s1} = 0.33,\ \alpha_{s2} = 0.32,\ \alpha_{s3} = 0.36,\ \delta_{k1} = 0.05,\ \delta_{k2} = 0.04,\ \delta_{k3} = 0.045,\ \lambda_{01} = 0.7, \\ &\gamma_{01} = 0.15,\ \xi_{01} = 0.1,\ \varepsilon_{012} = 0.002,\ \varepsilon_{012} = 0.007,\ \lambda_{02} = 0.65,\ \gamma_{02} = 0.07,\ \xi_{02} = 0.12,\ \varepsilon_{021} = 0.004,\ \varepsilon_{023} = 0.008, \\ &\lambda_{03} = 0.6,\ \gamma_{03} = 0.98,\ \xi_{03} = 0.15,\ \varepsilon_{031} = 0.004,\ \varepsilon_{032} = 0.008. \end{aligned} \tag{13}$$

Country $1, 2$ and $3's$ populations are respectively $20, 30$ and 10. Country 3 has the smallest population. Country $1's$ total productivities of the two sectors, A_{i1} and A_{s1}, are highest, country $2's$ second and Country $3's$ lowest. We call countries $1, 2$ and 3 respectively as highly productive, productive, and lowly productive economies (HPE, PE, LPE). We specify the values of the parameters, α_j, in the Cobb-Douglas productions near 0.3 (for instance, Miles and Scott, 2005; Abel *et al*., 2007). The HPE's propensity to save is 0.7, the PE's is 0.65, and the LPE's is 0.6. The depreciation rates of physical capital are near 0.05. We assume that each country's propensities to consume tourism vary between countries which the country's households visit. It should be remarked that there are many empirical studies about income elasticity of tourism demand (Syriopoulos, 1995; Lanza *et al*., 2003), and price elasticities (Gaŕin-Mũnos, 2007). We specify the initial conditions as follows:

$$z_1(0) = 0.06,\ \bar{k}_2(0) = 3,\ \bar{k}_3(0) = 2. \tag{14}$$

The motion of the system is given in Figure 1. In Figure 1 each country's gross domestic product (GDP) and the world's gross global product (GGP) are defined as follows

$$Y_j(t) = F_{ij}(t) + p_j(t) F_{sj}(t),\ Y(t) = \sum_{j=1}^{J} Y_j(t).$$

The total wealth and GGP fall. The GDPs of and capital used by the three economies also fall. The HPE's levels of output, labor and capital levels of the capital goods sector rise over time till these values achieve at their equilibrium values. The PE's and LPE's levels of output, labor and capital levels of the capital goods sector fall. The PE's levels of output, labor and capital levels of the consumer goods sector are augmented. The PE's and LPE's levels of output, labor and capital levels of the consumer goods sector are lowered. The prices of consumer goods rise in the

HPE and the PE, while the price falls in the LPE. The rate of interest rises slightly. The wage rates fall in all the economies. The HPE's wealth per household, consumption levels of the two goods fall, the PE's wealth per household and consumption levels of the two goods rise, and the LPE's wealth per household and consumption levels of the two goods change slightly. Country 1's tourist consumption levels in the other two countries fall, and the other two countries' tourist consumption levels in the other countries rise. It should be remarked that as our model is a general equilibrium dynamic system, the change in any variable in the global economy is closely related o changes in the other variables. We do not explain how these changes react to each other as it is tedious.

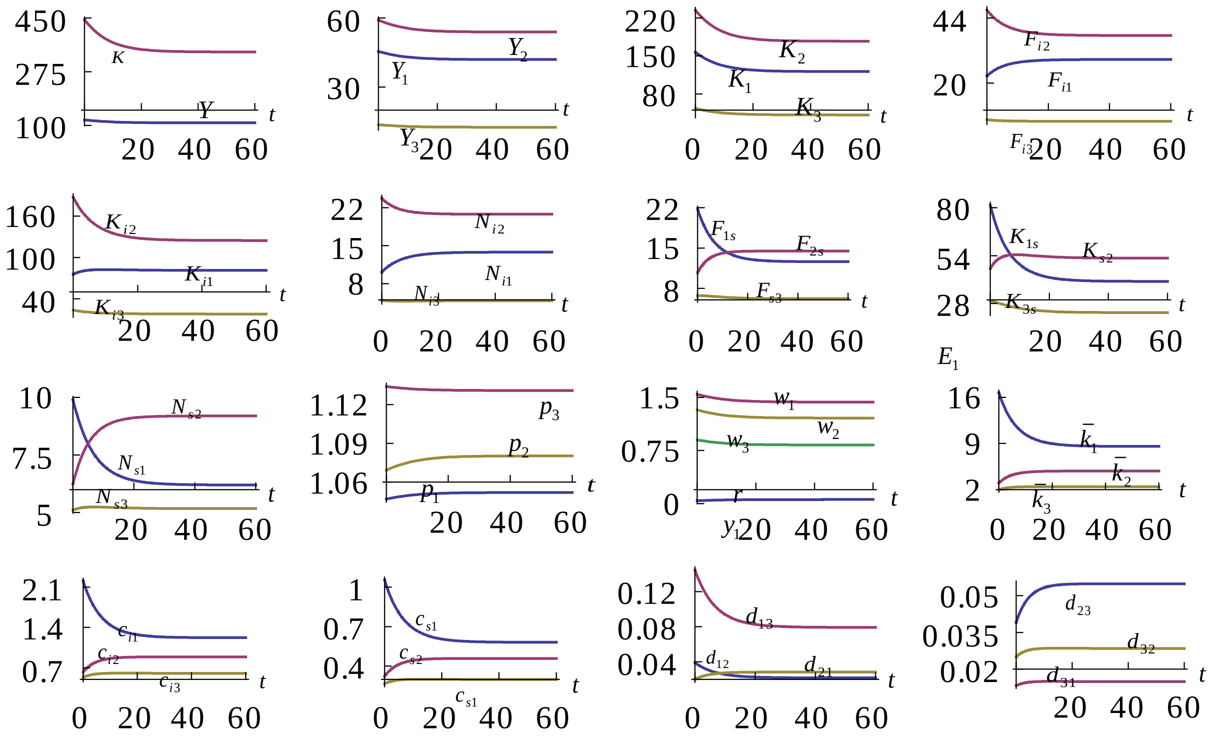

Figure 1 – The motion of the three national and global economies

From Figure 1 we observe that all the variables become stationary in the long term. This is true with different initial values. The simulation results hint on the existence of a stable equilibrium point. Following the lemma under (13), we calculate the equilibrium values of the variables as follows

$$Y = 108.47,\ K = 339.62,\ r = 0.06,\ Y_1 = 41.97,\ Y_2 = 53.91,\ Y_3 = 12.59,\ K_1 = 121.26,\ K_2 = 177.22,$$
$$K_3 = 41.14,\ F_{i1} = 28.69,\ F_{i2} = 37.55,\ F_{i3} = 5.89,\ K_{i1} = 81.26,\ K_{i2} = 124.58,\ K_{i3} = 18.03,$$
$$N_{i1} = 13.8,\ N_{i2} = 20.8,\ N_{i3} = 4.83,\ F_{s1} = 12.62,\ F_{s2} = 14.47,\ F_{s3} = 6.21,\ K_{s1} = 40.01,\ K_{s2} = 52.63,$$
$$K_{s3} = 23.1,\ N_{s1} = 6.2,\ N_{s2} = 9.2,\ N_{s3} = 5.17,\ p_1 = 1.05,\ p_2 = 1.13,\ p_3 = 1.08,\ w_1 = 1.44,$$
$$w_2 = 1.21,\ w_3 = 0.83,\ \bar{k}_1 = 8.56,\ \bar{k}_2 = 4.81,\ \bar{k}_3 = 2.42,\ c_{i1} = 1.22,\ c_{i2} = 0.89,\ c_{i3} = 0.6,\ c_{s1} = 0.58,$$
$$c_{s2} = 0.46,\ c_{s3} = 0.3,\ d_{12} = 0.022,\ d_{13} = 0.079,\ d_{21} = 0.028,\ d_{23} = 0.055,\ d_{31} = 0.015,\ d_{32} = 0.028.$$

It is straightforward to calculate the values of the three eigenvalues as follows

$$\{-0.243,\ -0.185,\ -0.147\}.$$

The eigenvalues are real and negative. The equilibrium point is locally stable. This guarantees the validity of exercising comparative dynamic analysis. This also implies that the world economy is stable. We now study what will happen to the global economy when some national conditions are shifted.

IV. COMPARATIVE DYNAMIC ANALYSIS

This section examines effects of changes in some parameters. We simulated the motion of the national and global economies under (13) and (14). It is significant to examine how the economic system reacts to exogenous changes. As the lemma provides the computational procedure to calibrate the motion of all the variables, it is straightforward to examine effects of change in any parameter on transitory processes as well stationary states of all the variables. We introduce a variable $\overline{\Delta} x_j(t)$ to stand for the change rate of the variable, $x_j(t)$, in percentage due to changes in the parameter value.

An improvement in the HPE's total factor productivity of the capital goods sector

First, we study effects of the HPE’s technological change in the capital goods sector on the global economy. It has been argued that productivity differences explain much of the variation in incomes across countries, and technology plays a key role in determining productivity. We now show how an enlarged gap in technologies between countries affects trade patterns and national economies. We see what will happen to the global economy when $A_{i1}: 1.2 \Rightarrow 1.3.$ We plot the effects in Figure 2. As the technology is improved, there are economic structural changes. The rate of interest initially rises but falls in the long term. The HPE's capital sector attracts more capital as its technology is improved. Before the total capital stock in the global market are increased sufficiently, the capital stocks employed by all other sectors are reduced. In the long term all the sectors' capital stocks are increased. Initially the capital goods sector in the HPE attracts some labor force from the consumer goods sector, the capital goods sectors lose some labor inputs. In the long term the capital goods sectors in the three economies lose some labor force as the sector in the HPE becomes more productive and more capital is accumulated. Initially the consumer goods sectors in the three economies employ less capital and produce less. In the long term the consumer goods sectors in the three economies employ more capital and produce more. The GDP of the HPE is enhanced. The GDP levels of the other two economies fall initially and rise in the long term. The wage rates, wealth levels, and consumption levels are increased in all the economies in the long term, even though the effects on some of these variables are slight. The HPE's price of consumer goods is increased, the PE's price of consumer goods is almost not affected, and the LPE's price of consumer goods is reduced. The HPE's tourists consumption in the other two economies fall initially and rise in the long term. The PE's tourists consumption in the HPE falls in association with rising price in the HPE. The PE's tourists consumption in the LPE falls initially and rises in the long term. The LPE's tourists consumption in the other two economies fall initially and rise in the long term.

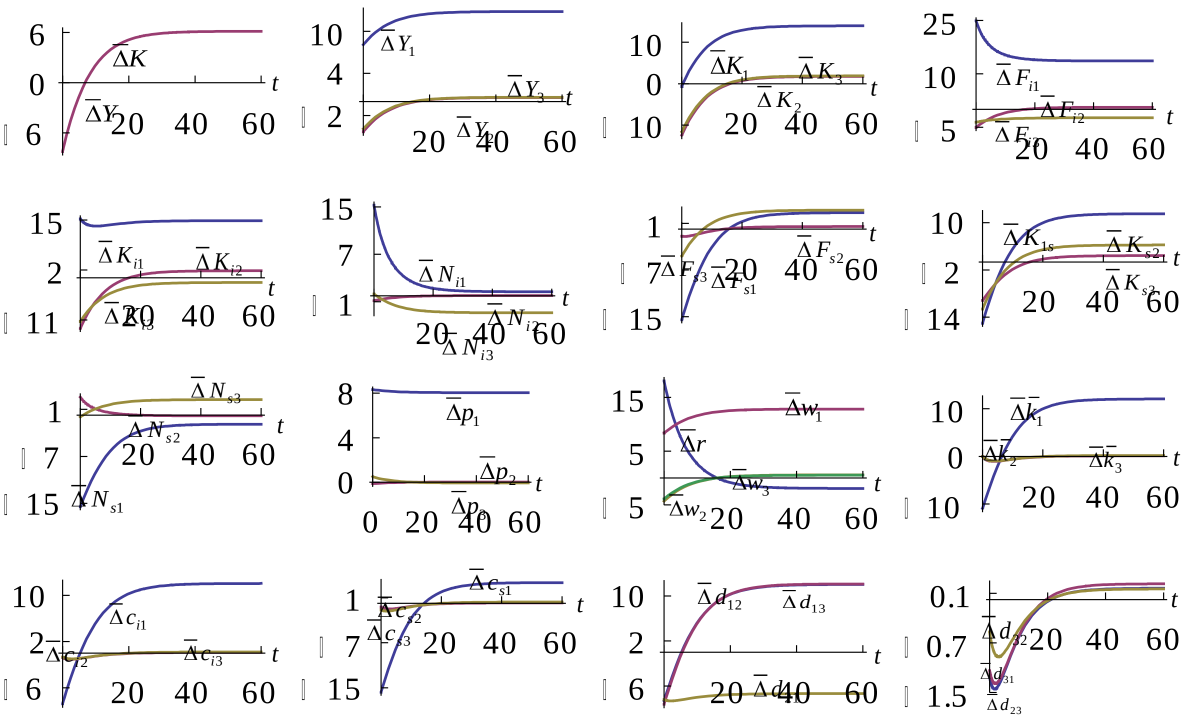

Figure 2 – A rise in country 1's total factor productivity of the capital goods sector

A rise in the LPE's population

It is well known that the relationship between population change and economic development is both empirically and theoretically ambiguous. Some theoretical models show situation-dependent interactions between population and economic growth (e.g., Galor and Weil, 1999; Boucekkine, *et al*., 2002; Bretschger, 2013). There are also mixed conclusions in empirical studies on the issue (e.g., Furuoka, 2009; Yao *et al*., 2013). Although this study is not concerned with endogenous population dynamics, we will study effects of changes in the population sizes. We now show how the global economy is affected when the LPE experiences the following population growth: $N_3: 10 \Rightarrow 11$. We plot the effects in Figure 3. The population growth brings about increases in the GGP and global wealth. The contribution to the growth of the GGP is mainly due to the growth of the LPE's GDP as the other two countries' GDPs are slightly affected. The rise of the population causes the rate of interest to increase and the wage rates of all the countries to fall. The net consequence of the rise of interest and fall in the wage rate makes the household in the HPE to accumulate more wealth and consume more the two goods, and the net consequences of the rise of interest and fall in the wage rates make the households both in the PE and the LPE to accumulate less wealth and consume less the two goods. The expenditures on tourism in the two countries from the HPE's household are increased, and the expenditures on tourism in the two countries from each of the two other countries' household are reduced. The price of consumer goods in the LPE is reduced as a consequence of enlarged population, and the prices in the other two economies are slightly affected. The LPE produces more the two goods and employs more the two input factors.

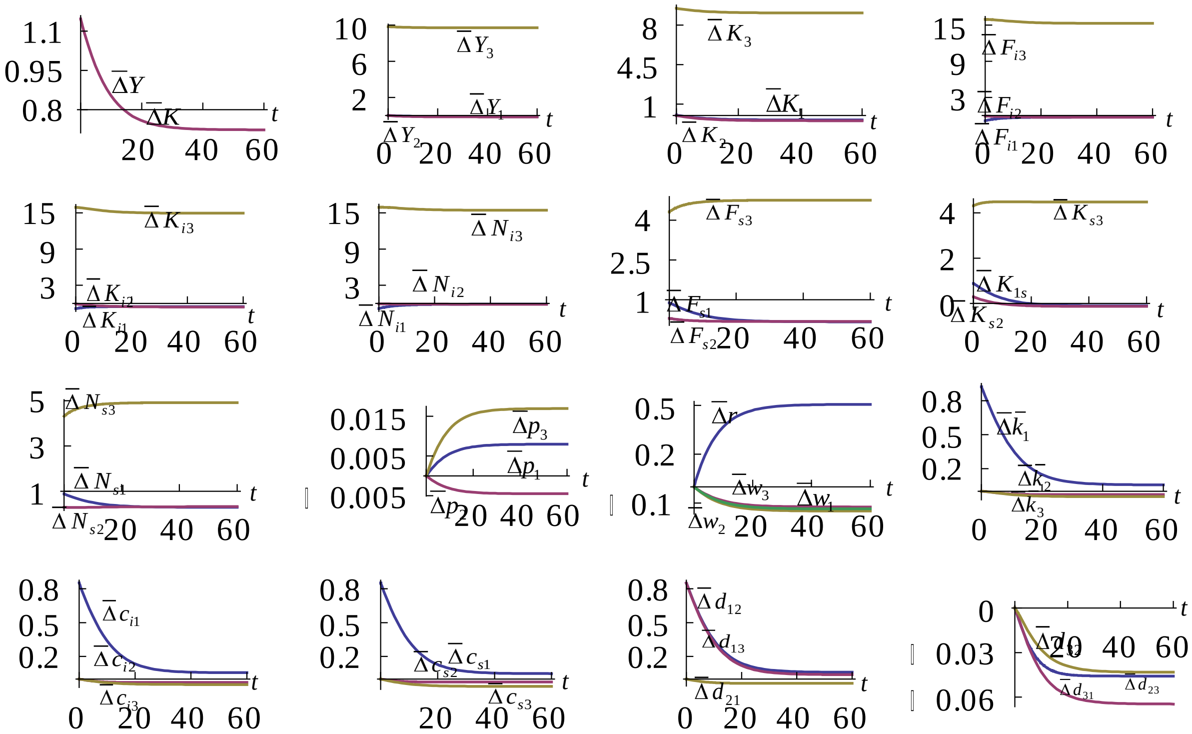

Figure 3 – A country's population being increased

The HPE increasing its propensity to tour the LPE

Preferences of different households are important for understanding economic structures. We now examine the effects of the following change in the HPE's propensity to tour the LPE: $\varepsilon_{013}: 0.007 \Rightarrow 0.01$. The simulation result is plotted by Figure 4. The immediate effect is that the household of the HPE spends more on touring the LPE. The demand from the HPE's tourists for the LPE's consumer goods should enhance the price of consumer goods in the LPE. On the other hand, the increased demand also encourages the supply of consumer goods in the LPE. The net consequence reduces the price of consumer goods in the LPE. As the HPE spends more on consumer goods in the LPE, the GGP and global wealth are reduced. The GDPs of both the HPE and PE are reduced, and the GDP of the LPE is initially increased and lowered in the long term. As the HPE spends more on the foreign consumer goods, the demand for the domestic consumer goods falls. Moreover, the other two economies do not spend more on the HPE's consumer goods. The net consequence lowers the output level of the HPE's consumer goods. The PE's output level of consumer goods sector is slightly affected. Because of the expansion of its consumer goods sector, the LPE's output level of the capital goods sector is reduced. The other two countries' output levels of the capital sectors are slightly affected. The falling global wealth is associated with enhancing rate of interest and falling wage rates in all the economies. The HPE's household accumulates less wealth. The wealth levels of the households in the PE and the LPE are slightly affected. The consumption level of any of the two goods by any household is reduced. In fact, empirical studies in the literature demonstrate an opposite relationship between a tourism boom and economic development (for instance, Balaguer and Cantavella-Jorda, 2002; Dritsakis, 2004; Durbarry, 2004; Oh, 2005; Kim *et al.* 2006). Harzri and Sgro (1995) show that an increase in the international tourism leads to a positive effect on long-run economic growth of a small open economy. Our result shows that this conclusion is true in the short run, but not necessarily true in the short term. We get this conclusion because our model explicitly shows transitional processes of the economic dynamics and it deals with the world economy as an integrated whole. It should be also noted that the study by Chao *et al.* (2006) shows that an expansion of tourism can result in capital decumulation in a two-sector dynamic model with a capital-generating externality. Our simulation demonstrates the same conclusion in the long term even without any externality.

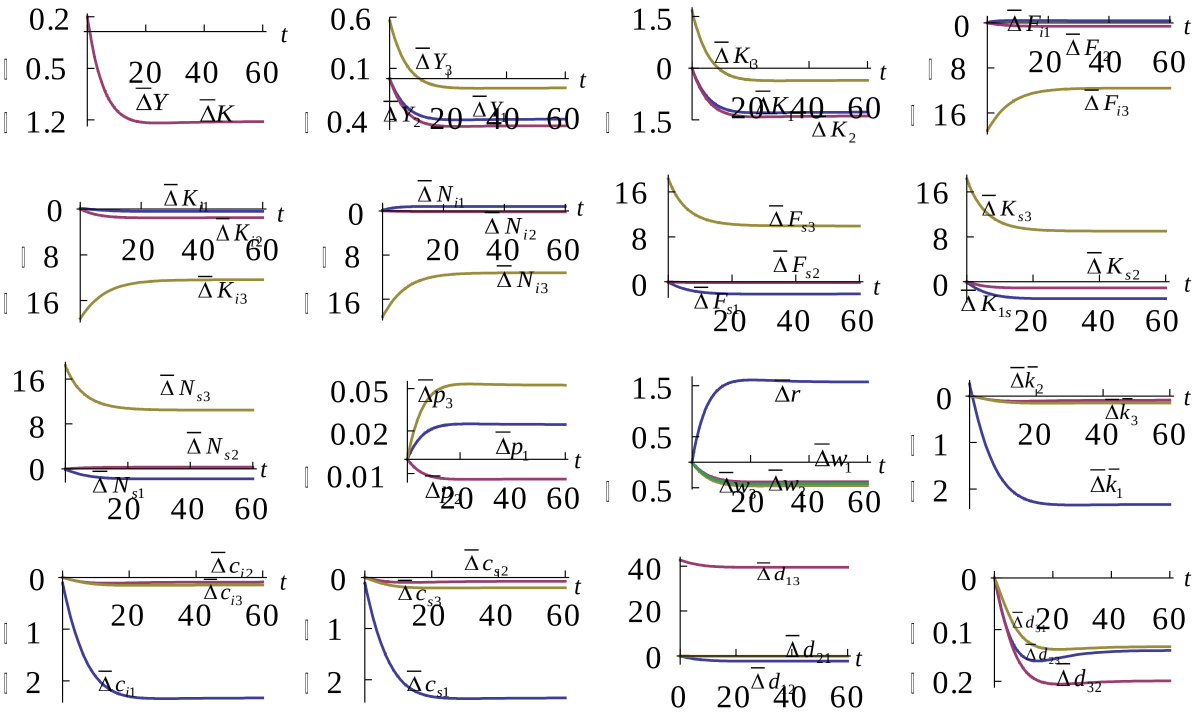

Figure 4 – One country raising its propensity to tour another country

A rise in the HPE's propensity to save

We are concerned with the effects of the following rise in the HPE's propensity to save: $\lambda_{01}: 0.7 \Rightarrow 0.72$. The simulation result is plotted by Figure 5. As the household increases the propensity to save, the HPE's household accumulates more wealth. As higher proportion of the disposable income is saved, the household's consumption levels of the two goods and tourism are initially reduced. The consumption levels of the HPE's household are increased in the long term. The per household's wealth and consumption levels of the two goods and tourism in both the PE and the LPE are all increased. Hence, the increase in the propensity to save benefits all the households in the global economy. In macroeconomic levels, the output levels, GDPs, global wealth and GGP are all increased. The rate of interest is reduced and wage rates are increased. The labor forces are redistributed.

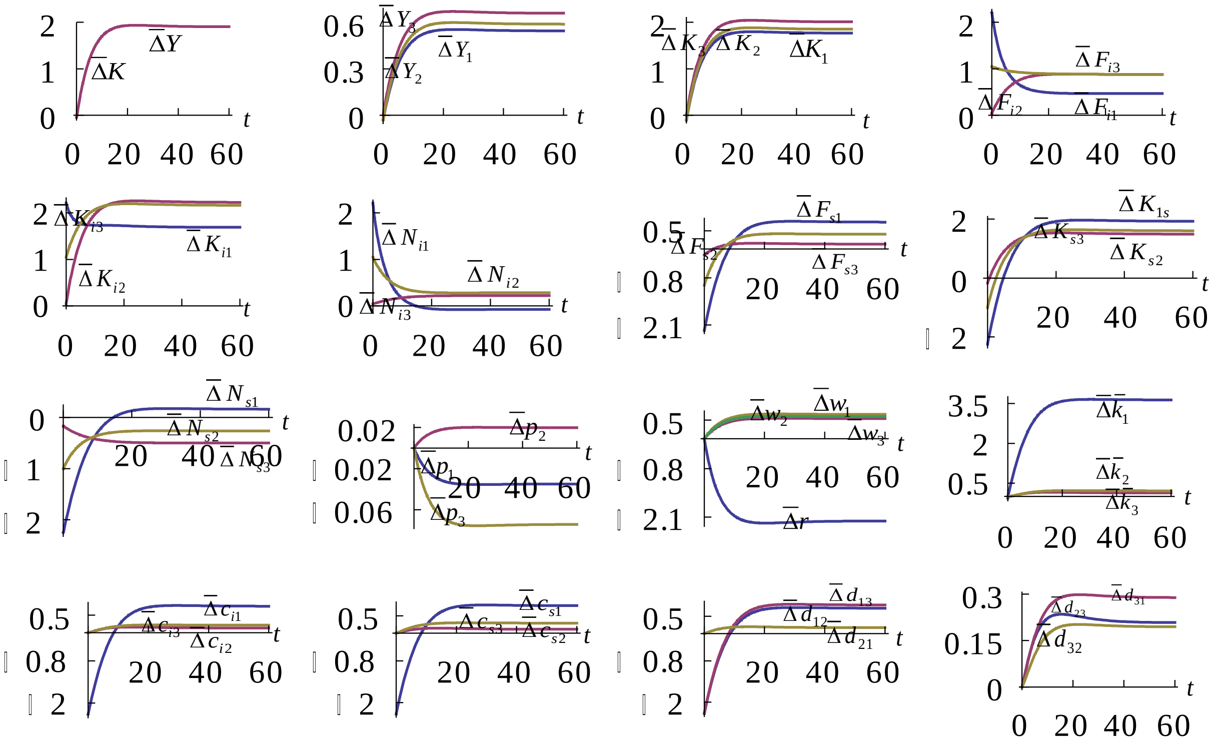

Figure 5 – A rise in the highly productive economy's propensity to save

A rise in the LPE's propensity to consume consumer goods

We are concerned with the effects of the following rise in the LPE's propensity to consume consumer goods: $\gamma_{03}: 0.08 \Rightarrow 0.1$. The simulation result is plotted by Figure 6. The household in the LPE consumes more consume goods, accumulates less wealth, consumes less consume goods, and tours less. The price of consumer goods in the LPE falls and the prices in the other two economies are slightly affected. Consumption behavior of the households in the HPE and the PE are slightly affected. The GGP and global wealth are reduced. As demonstrated in Figure 6, the national economic structures also affected.

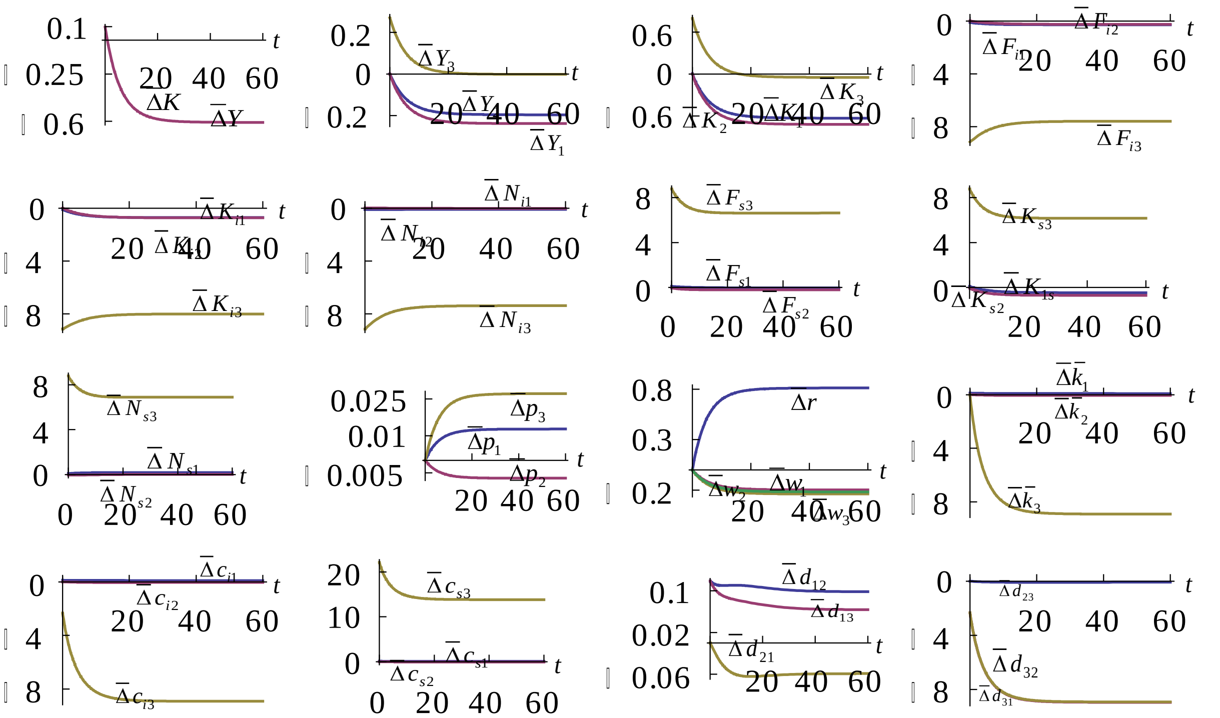

Figure 6 – A rise in an economy's propensity to consume consumer goods

V. CONCLUDING REMARKS

This paper proposed an economic growth model to demonstrate dynamic interactions among economic growth, economic structural change, international trade and tourist flows. It built a multi-country growth model with endogenous wealth accumulation and tourism. The model is unique in this type of neoclassical growth models with trade in that it introduces endogenous tourism within a general equilibrium framework. The model is built on microeconomic foundations. It not only integrated the three well-known key models – the Solow growth model, the Oniki-Uzawa trade model, and the Uzawa two-sector model - in growth theory and international growth economics, but also introduced tourist flows between economies for any number of national economies. We demonstrated that the motion of the J -country world economy can be described by J differential equations. We also simulated the global economy with three countries, respectively called highly productive, productive, and lowly productive economies. We showed that the world dynamics has a unique equilibrium. We carried out comparative dynamic analysis with regard to one country's total productivity factor, the propensity to save, the propensity to tour other countries, the population. It should also be remarked that our model can be extended and generalized in different directions. For instance, it is significant to examine behavior of the dynamic system when the utility functions or/and production functions are taken on other forms. The Solow model and Uzawa two-sector growth models are the two key models in the neoclassical economic growth theory and the Oniki-Uzawa growth model is a main key model of global economic dynamics with capital accumulation. These models have been generalized and extended in different ways. We may extend our model on the basis of the contemporary literature of economics.

VI. APPENDIX: PROVING THE LEMMA

We now derive dynamic equations for global economic growth. From (2), we have

$$z_j \equiv \frac{r + \delta_k}{w_j} = \frac{a_j N_{ij}}{K_{ij}} = \frac{b_j N_{sj}}{K_{sj}}, \tag{A1}$$

where

$$a_j \equiv \frac{\alpha_{ij}}{\beta_{ij}}, \ \ b_j \equiv \frac{\alpha_{sj}}{\beta_{sj}}.$$

Insert $z_j / a_j \equiv N_{ij} / K_{ij}$ in $r + \delta_{kj} = \alpha_{ij} F_{ij} / K_{ij}$ from (2)

$$r(z_j) = \frac{\alpha_{ij} A_{ij}}{a_j^{\beta_{ij}}} z_j^{\beta_{ij}} - \delta_{kj}, \ \ j = 1, ..., J. \tag{A2}$$

From (A2) we get

$$z_j(z_1) = a_j \left(\frac{r + \delta_{kj}}{\alpha_{ij} A_{ij}} \right)^{1/\beta_{ij}}, \ \ j = 2, ..., J. \tag{A3}$$

From (A1) and (A2), we have

$$w_j(z_1) = \frac{r + \delta_{kj}}{z_j}. \tag{A4}$$

From $z_j = b_j N_{sj} / K_{sj}$ and (1), we have

$$p_j(z_1) = \frac{b_j^{\beta_{sj}} (r + \delta_{kj})}{\alpha_{sj} A_{sj} z_j^{\beta_{sj}}}. \tag{A5}$$

From (11) and (7) we have

$$\gamma_j \hat{y}_j N_j + \sum_{q \neq j}^{J} \varepsilon_{qj} \hat{y}_q N_q = p_j F_{sj}. \tag{A6}$$

Insert (1) in (A6)

$$\gamma_j \hat{y}_j N_j + \sum_{q \neq j}^{J} \varepsilon_{qj} \hat{y}_q N_q = \frac{w_j N_{sj}}{\beta_{sj}}. \tag{A7}$$

By (3) we have

$$\hat{y}_j \left(z_1, \bar{k}_j\right) = (1 + r)\bar{k}_j + w_j. \tag{A8}$$

Substituting (A8) into (A7) yields

$$N_{sj}\left(z_1, \left(\bar{k}_j\right)\right) = \bar{R}_j + \left(\gamma_j N_j \bar{k}_j + \sum_{q \neq j}^{J} \varepsilon_{qj} N_q \bar{k}_q\right) R_j, \tag{A9}$$

where

$$R_j(z_1) \equiv \left(\frac{1 + r}{w_j}\right)\beta_{sj}, \quad \bar{R}_j(z_1) \equiv \beta_{sj} \gamma_j N_j + \frac{\beta_{js}}{w_j} \sum_{q \neq j}^{J} w_q \varepsilon_{qj} N_q.$$

From $N_{ij} + N_{sj} = N_j$ and (A9), we solve

$$N_{ij}\left(z_1, \left(\bar{k}_j\right)\right) = N_j - N_{sj}. \tag{A10}$$

With (A10) and (A11) we determine the labor distribution as functions of z_1 and $\left(\bar{k}_q\right)$. From (A1) and (A10) we have

$$K_{ij}\left(z_1, \left(\bar{k}_j\right)\right) = \frac{a_j N_{ij}}{z_j}, \quad K_{sj}\left(z_1, \left(\bar{k}_j\right)\right) = \frac{b_j N_{sj}}{z_j}. \tag{A11}$$

From (9) and (10), we have

$$\sum_{j=1}^{J} \left(K_{ij} + K_{sj}\right) = \sum_{j=1}^{J} \bar{k}_j N_j. \tag{A12}$$

Inserting (A12) in (A11) implies

$$\sum_{j=1}^{J} \frac{a_j N_j}{z_j} + \sum_{j=1}^{J} \bar{z}_j N_{sj} = \sum_{j=1}^{J} \bar{k}_j N_j. \tag{A13}$$

where $\bar{z}_j \equiv \left(b_j - a_j\right)/ z_j$. Insert (A9) in (A13)

$$\gamma_1 N_1 \bar{z}_1 R_1 \bar{k}_1 + \sum_{j=1}^{J} \left(\sum_{q \neq j}^{J} \varepsilon_{qj} N_q \bar{k}_q\right) \bar{z}_j R_j = R_0 + \bar{k}_1 N_1. \tag{A14}$$

where

$$R_0\left(z_1, \left\{\bar{k}_j\right\}\right) = \sum_{j=2}^{J} \bar{k}_j N_j - \sum_{j=1}^{J} \frac{a_j N_j}{z_j} - \sum_{j=1}^{J} \bar{z}_j \bar{R}_j - \sum_{j=2}^{J} \gamma_j N_j \bar{z}_j R_j \bar{k}_j.$$

where $\{\bar{k}_j\} \equiv (\bar{k}_2, ..., \bar{k}_J)$. Solve (A14) with respect to $\bar{k}_1$

$$\bar{k}_1 = \Phi(z_1, \{\bar{k}_j\}) \equiv$$
$$\left[R_0 - \left(\sum_{q=2}^{J} \varepsilon_{q1} N_q \bar{k}_q\right)\bar{z}_1 R_1 - \sum_{j=2}^{J}\left(\sum_{q \neq j,1}^{J} \varepsilon_{qj} N_q \bar{k}_q\right)\bar{z}_j R_j\right]\left(\gamma_1 \bar{z}_1 R_1 - 1 + \sum_{j=2}^{J} \varepsilon_{1j} \bar{z}_j R_j\right)^{-1} \frac{1}{N_1}. \quad \text{(A15)}$$

Substitute $s_j = \lambda \hat{y}_j$ and $r\bar{k}_j + w_j$ into (8)

$$\dot{\bar{k}}_1 = \Phi_0(z_1, \{\bar{k}_j\}) \equiv (1 + r)\lambda_1 \Phi + \lambda_1 w_1 - \Phi, \quad \text{(A16)}$$

$$\dot{\bar{k}}_j = \Phi_j(z_1, \bar{k}_j) \equiv (1 + r)\lambda_j \bar{k}_j + \lambda_j w_j - \bar{k}_j, \quad j = 2, ..., J. \quad \text{(A17)}$$

Taking derivatives of equation (A15) with respect to t yields

$$\dot{\bar{k}}_1 = \frac{\partial \Phi}{\partial z_1}\dot{z}_1 + \sum_{j=2}^{J} \Phi_j \frac{\partial \Phi}{\partial \bar{k}_j}, \quad \text{(A18)}$$

where we use (A17). Insert (A18) in (A16)

$$\dot{z}_1 = \Phi_1(z_1, \{\bar{k}_j\}) \equiv \left(\Phi_0 - \sum_{j=2}^{J} \Phi_j \frac{\partial \Phi}{\partial \bar{k}_j}\right)\left(\frac{\partial \Phi}{\partial z_1}\right)^{-1}. \quad \text{(A19)}$$

Following the procedure in the lemma we describe the dynamics of the economic system.

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