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Tourism and economic structural change with endogenous wealth and human capital and elastic labor supply

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Abstract. *The purpose of this study is to introduce tourism to a small-open growth with endogenous wealth and human capital. We develop the model on the basis of the Solow-Uzawa growth model, Arrow's learning by doing, the literature of small-open economic growth models, and ideas from tourism economics. The economy consists of one service sector and one industrial sector. International tourists and domestic residents consume non-traded goods and services. We introduce endogenous land distribution between housing and supply of services. The production side is based on the traditional growth theories, while the household behavior is described by an alternative utility function proposed by Zhang (1993). We simulate the motion of the national economy and examine effects of changes in some parameters. The comparative dynamic analysis with regard to the rate of interest, the price elasticity of tourism, the global economic condition, the total productivities of the industrial and service sectors, the impact of tourism on human capital accumulation, and the propensity to save provides some important insights into the complexity of open economies with endogenous wealth and human capital.*

Keywords: tourism, price elasticity of tourism, wealth accumulation, endogenous human capital, elastic labor supply.

JEL Classification: E21, O41, O15.

1. Introduction

Tourism has played increasingly important role in economic growth in many parts of the world. Tourism is different from what is called tradable goods in traditional trade theory. Tourism goods such as monuments of national heritage, historical sites, beaches, and hot springs, are not-tradable as one has to travel to the location in order to consume them. Hence, tourism converts non-traded goods into tradable ones. As reported by the World Tourism Organization (2008), over 903 million people travelled to a foreign country in 2007. The export income of international tourism is the fourth after fuels, chemicals, and automotive products. Tourism accounts for 6 per cent of global exports overall and thirty per cent of global exports of services (Copeland, 2012). According to the UNWTO World Tourism Barometer international tourist arrivals reached 1,087 million arrivals. Foreign tourism has become an important source of income and employment in many regions of the world. Tourism may interact with local economies in different ways. Tourism uses national resources such as labor, capital and housing and thus may make these resources less available for other sectors of the economy. Tourism also generates income which may be used to develop other economic activities. To properly address these interactions one needs a dynamic equilibrium framework. This study examines the dynamic interdependence in a general equilibrium framework. It should be noted that a static equilibrium framework with tourism is recently proposed by Zeng and Zhu (2011, see also, Corden and Neary, 1982; Copeland, 1991).

Tourism economics has increasingly become an important field in economics. There are many publications on tourism in the literature of economics (e.g., Sinclair and Stabler, 1997; Luzzi and Flückiger, 2003; Hazari and Sgro, 2004; Briedenhann and Wickens, 2004; Baum, 2007; Katircioglu, 2009; Hazari and Lin, 2011; Marta et al., 2014; and Ridderstaat et al., 2014). Nevertheless, as observed by Chao et al. (2009), the study of tourism has been largely limited to the static framework. Nevertheless, important issues related to tourism, for instance national economic growth and tourism, and national human capital accumulation and tourism, cannot be properly examined within static frameworks. A main purpose of this study is to introduce tourism to growth theory with endogenous wealth and human capital. We are also concerned with changes of economic structures and endogenous time distribution between work and leisure with tourism. It should be noted that empirical studies in the literature demonstrate an opposite relationship between a tourism boom and economic development (see, for instance, Balaguer and Cantavella-Jorda, 2002; Dritsakis, 2004; Durbarry, 2004; Oh, 2005; Kim et al. 2006). Hazari and Sgro (1995) develop a model to study the dynamic relationship among tourism, capital accumulation, per capita consumption and the terms of trade. According to their study an increase in the international demand for tourism leads to a positive effect on long-run economic growth. In another study by Chao et al. (2006), it is found that an expansion of tourism can result in capital decumulation in a two-sector dynamic model with a capital-generating externality. 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. This study studies tourism and economic growth on the basis of the Solow-Uzawa growth models and Arrow's learning by doing in context of a small-open economy.

Most of the models in the neoclassical growth theory model are extensions and generalizations of the pioneering works of Solow (1956). The Solow model has been extended and generalized in numerous directions (see, Burmeister and Dobell, 1970). 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. Solow's one-sector growth model, Uzawa's two-sector growth model, and their various extensions and generalizations are fundamental for the development of new economic growth theories as well (see, for instance, Diamond, 1965; Stiglitz, 1967; Benhabib et al., 2000; Drugeon and Venditti, 2001; Ortigueira and Santos, 2002). But all these studies do not have tourism. This study structurally generalizes the Uzawa two-sector model to include tourism. As observed by Zeng and Zhu (2011), in the literature of tourism economics, almost all the models are based on a small open economy. We still follow this tradition in dealing with growth and capital accumulation within the analytical framework of small open economies. There is a large amount of the literature on economics of open economies (e.g., Obstfeld and Rogoff, 1996; Lane, 2001; Kollmann, 2001, 2002; Benigno and Benigno, 2003; Galí and Monacelli, 2005; Uya et al., 2013; Ilzetzki et al., 2013). We follow this tradition in modelling growth of small open economies.

Except introducing tourism into the neoclassical growth theory, we also take account of endogenous human capital and elastic labor supply in modeling economic growth. The literature on endogenous knowledge and economic growth has increasingly expanded since Romer (1986) re-examined issues of endogenous technological change and economic growth in his 1986's paper (see also Lucas, 1988; Chari and Hopenhayn, 1991; Grossman and Helpman, 1991; Aghion and Howitt, 1998; Martin and Ottaviano, 2001; Brecher et al., 2002; Nocco, 2005). It is well-known that Arrow (1962) first introduced learning-by-doing into the formal growth theory. In this study, we model the knowledge creation with Arrow's learning by doing. There are many applications of Arrow's idea to different issues in economic growth theory (e.g., Young, 1991, 1993; Martin and Rogers, 1997; Solow, 1997; Albelo and Manresa, 2005; Kitaura and Yakita, 2010; Shea, 2013). As Thrane (2008: 514) observe: "we know a lot about tourism consumption and its determinants and consequences. This is not the case for tourism consumption's flip side: tourism production. … The study's theoretical rationale lies in the human capital framework as set forth in labor economics and sociology." This study also considers that tourism may have positive impact on human capital growth. Hence tourism makes contribution to the national economic growth not only by direct contribution such as consuming, but also through affecting human capital development.

There are a few dynamic economic models which deal with the interdependence between economic growth and tourism with micro-behavioral foundation. Nevertheless wealth and human capital accumulation is seldom modeled with land and land markets in the literature of tourism economics. This study also takes account land use. As far as the production side and international markets are concerned, our model follows the traditional modeling framework. The model is an extension of a growth model with tourism by Zhang (2012) and Zhang's growth model with learning by dong (2014). The introduction of tourism to growth theory is influenced by Chao et al. (2006). A main different between our approach and the model by Chao *et al.* is that this study is based on an alternative utility function proposed by Zhang (1993). This model is different from Zhang's 2012 model is that this study introduce endogenous human capital and endogenous time distribution. Hence Zhang's 2012 model is a special case of the model in this study. Section 2 defines the basic model. Section 3 shows how we solve the dynamics and simulates the model. Section 4 examines effects of changes in some parameters on the economic system over time. Section 5 concludes the study. The appendix proves the main results in Section 3.

2. The growth model with tourism

This section develops a small open growth model with endogenous wealth and human capital. An open economy can import goods and borrow resources from the rest of the world or exports goods and lend resources abroad. Our model is a combination of the basic features of the well-known three models, the Solow growth model, the Uzawa two-sector growth model, and the growth models with tourism. There is a single good, called industrial good, in the world economy and the price of the industrial good is unity. Like in Chao et al. (2009) and Zhang (2012), we consider a small-open economy that produces two goods: an internationally traded good (called industrial good) and a non-traded good (called services). It should be noted that Brock (1988) also classifies economic activities similarly in a growth model of a small open economy. Brock divides goods and services into traded and non-traded and examines the dynamic adjustment of the relative price of non-traded and the current account following exogenous shocks, such as government purchases, changes in tax income or investment subsidy. This study emphasizes human capital accumulation and tourism with endogenous time. Domestic households consume both goods. We assume that foreign tourists consume only services. Capital depreciates at a constant exponential rate, δ_k, which is independent of the manner of use. The households hold wealth and land and receive income from wages, land rent, and interest payments of wealth. Land is only for residential and service use. Technologies of the production sectors are described by the Cobb-Douglas production functions, which characterized of constant returns to scale. All markets are perfectly competitive and capital and labor are completely mobile between the two sectors. Capital is perfectly mobile in international market and we neglect possibility of emigration or/and immigration. We assume that labor is homogeneous and is fixed. We assume that the economy is too small to affect the interest rate in the world market.

We use $\overline{N}$ to stand for the population. Let $T(t)$ stand for the work time of the representative household and $N(t)$ for the flow of labor services used at time t for production. We have $N(t)$ as follows

$$N(t) = H^m(t)T(t)\overline{N}, \tag{1}$$

where $H(t)$ is the level of human capital and m is the human capital utilization efficiency parameter. We call $H^m(t)$ the level of effective human capital.

Industrial sector

The industrial sector uses capital and labor as inputs. We use subscript index, i and s, to denote respectively the industrial and service sectors. Let $K_j(t)$ and $N_j(t)$ stand for the capital stocks and labor force employed by sector j, $j = i, s$, at time t. We use $F_j(t)$ to represent the output level of sector j. The production function of the industrial sector is

$$F_i(t) = A_i K_i^{\alpha_i}(t) N_i^{\beta_i}(t), \ \alpha_i, \beta_i > 0, \ \alpha_i + \beta_i = 1, \tag{2}$$

where A_i, α_i, and β_i are parameters. Markets are competitive; thus labor and capital earn their marginal products, and firms earn zero profits. The rate of interest, r^*, is fixed in international market. The wage rate, $w(t)$, is determined in domestic market. The marginal conditions are

$$r_\delta = \alpha_i A_i k_i^{-\beta_i}(t), \ w(t) = \beta_i A_i k_i^{\alpha_i}(t), \tag{3}$$

where $k_i(t) \equiv K_i(t)/N_i(t)$ and $r_\delta \equiv r^* + \delta_k$. As r^* is fixed, from (2) we have

$$k_i = \left(\frac{\alpha_i A_i}{r_\delta}\right)^{1/\beta_i}, \ w = \beta_i A_i k_i^{\alpha_i}. \tag{4}$$

Hence, we can treat k_i and w as functions of r^*.

Service sector

The service sector uses three inputs, capital $K_s(t)$, labor force $N_s(t)$, and land $L_s(t)$, to supply services. The production function of the service sector is

$$F_s(t) = A_s K_s^{\alpha_s}(t) N_s^{\beta_s}(t) L_s^{\gamma_s}(t), \ \alpha_s, \beta_s, \gamma_s > 0, \ \alpha_s + \beta_s + \gamma_s = 1, \tag{5}$$

where A_s, α_s, β_s, and γ_s are parameters. Let $p(t)$ and $R(t)$ stand respectively for the price of the service and the land rent. In this study we assume that the prices are determined by market mechanism. In reality, for instance, land rent and price may be determined by different factors (Kanemoto, 1980). The marginal conditions for the service sector are

$$\frac{r_\delta}{\alpha_s A_s} = p(t) k_s^{\alpha_s - 1}(t) l_s^{\gamma_s}(t), \ \frac{w}{\beta_s A_s} = p(t) k_s^{\alpha_s}(t) l_s^{\gamma_s}(t), \ R(t) = \gamma_s A_s p(t) k_s^{\alpha_s}(t) l_s^{\gamma_s - 1}(t), \tag{6}$$

where

$$k_s(t) \equiv \frac{K_s(t)}{N_s(t)}, \;\; l_s(t) \equiv \frac{L_s(t)}{N_s(t)}.$$

From (6) we solve

$$k_s = \frac{\alpha_s w}{\beta_s r_\delta}. \tag{7}$$

Hence, we treat k_s as a function of r^*.

Full employment of capital and labor

The total capital stocks employed by the country, $K(t)$, is used by the two sectors. The capital stock is owned either by domestic residents and the rest of the world. As full employment of labor and capital is assumed, we have

$$K_i(t) + K_s(t) = K(t), \quad N_i(t) + N_s(t) = N(t),$$

where $N(t)$ is the total labor force. We rewrite the above equations as

$$k_i N_i(t) + k_s N_s(t) = K(t), \quad N_i(t) + N_s(t) = N(t). \tag{8}$$

The capital intensities, k_i and k_s, are uniquely determined by the fixed rate of interest in international market. Solve (7)

$$N_i(t) = (K(t) - k_s N(t))k_0, \;\; N_s(t) = (k_i N(t) - K(t))k_0, \tag{9}$$

where $k_0 \equiv (k_i - k_s)^{-1}$. We assume that $k_0 \neq 0$. The labor distribution is a unique function of the total labor supply and the total capital used by the country.

Demand function of foreign tourists

Let $y_f(t)$ stand for the disposable income of foreign countries. According to Schubert and Brida (2009), we assume the following iso-elastic tourism demand function

$$D_T(t) = a(t) y_f^{\phi}(t) p^{-\varepsilon}(t), \tag{10}$$

where ϕ and ε are respectively the income and price elasticities of tourism demand. The variable, $a(t)$, is dependent on many conditions, such as infrastructures (airports and transportation systems) and environment (like criminal rates, pollutants and congestions), and cultural capital (e.g., Throsby, 1999; Beerli and Martin, 2004). We assume that tourists pay the same price in consumption as domestic people. In reality, tourism industry has many special features which have important effects on pricing (e.g., Marin-Pantelescu and Tigu, 2010; Stabler et al., 2010).

Behavior of domestic households

We now model behavior of households. We use L and $R(t)$ to denote the land and land rent. Each household gets income from land ownership, wealth and wage. Land properties may be distributed in multiple ways under various institutions. For instance, there two popular assumptions in the literature of urban economics. The first is the absentee landownership. The second is the public ownership. In the former, land is owned by absentee landlords who spend their land incomes outside the economic system. In the latter, for instance as accepted in Kanemoto (1980), the city government rents the land from the landowners at certain rent and sublets it to households at the market rent, using the net revenue to subsidize city residents equally. This study assumes that the land is equally owned by the population. This implies that the revenue from land is equally shared among the population. Consumers make decisions on choice of lot size, consumption levels of industrial goods and services as well as on how much to save. This study uses the approach to consumers' behavior proposed by Zhang (1993). The current income of the typical household is

$$y(t) = r^* \bar{k}(t) + H^m(t)T(t)w + \bar{r}(t), \tag{11}$$

where $r^* k$ is the interest payment, $H^m T w$ the wage total payment, and $\bar{r}$ the land rent income. We call $y(t)$ 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 and saving 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 consuming. The total value of the wealth that a consumer can sell to purchase goods and to save is equal to $p_i(t)\bar{k}(t)$, with $p_i(t) = 1$ at any t, where $p_i(t)$ is the price of the industrial good. Here, we assume that selling and buying wealth can be conducted instantaneously without any transaction cost. The disposable income at any point of time is

$$\hat{y}(t) = y(t) + \bar{k}(t). \tag{12}$$

The disposable income is used for saving and consumption. At time t the consumer has the total amount of income equaling $\hat{y}$ to distribute between consuming and saving. In the growth literature, for instance, in the Solow model, the saving is out of the current income, y, while in this study the saving is out of the disposable income, which is dependent both on the current income and wealth.

At each point of time, a consumer distributes the total available budget among the lot size, consumption of services, consumption of industrial goods, and saving. The budget constraint is

$$R(t)l(t) + p(t)c_s(t) + c_i(t) + s(t) = \hat{y}(t). \tag{13}$$

Equation (13) means that the consumption and saving exhaust the consumers' disposable personal income.

Let $\overline{T}(t)$ stand for the leisure time at time t. The time constraint is

$$T(t)+\overline{T}(t)=T_0,$$

where T_0 is the total available time for work and leisure. Substituting this function into (13) yields

$$H^m(t)\overline{T}(t)w+R(t)l(t)+p(t)c_s(t)+c_i(t)+s(t)=\overline{y}(t), \tag{14}$$

where

$$\overline{y}(t)\equiv\left(1+r^*\right)\overline{k}(t)+H^m(t)T_0\,w+\overline{r}(t).$$

The utility function $U(t)$ is dependent on $\overline{T}(t)$, $l(t)$, $c_s(t)$, $c_i(t)$ and $s(t)$ as follows

$$U(t)=\theta\overline{T}^{\sigma_0}(t)l^{\eta_0}(t)c_s^{\gamma_0}(t)c_i^{\xi_0}(t)s^{\lambda_0}(t),\ \ \sigma_0,\eta_0,\gamma_0,\xi_0,\lambda_0>0,$$

in which σ_0, η_0, γ_0, ξ_0, and λ_0 are the representative household's elasticity of utility with regard to leisure time, lot size, services, industrial goods, and saving. We call σ_0, η_0, γ_0, ξ_0, and λ_0 propensities to consume the leisure time, to use the lot size, to consume services, to consume industrial goods, and to hold wealth, respectively. Maximizing $U(t)$ subject to the budget constraint yields

$$\overline{T}(t)=\frac{\sigma\,\overline{y}(t)}{H^m(t)w},\ \ l(t)=\frac{\eta\,\overline{y}(t)}{R(t)},\ \ c_s(t)=\frac{\gamma\,\overline{y}(t)}{p(t)},\ \ c_i(t)=\xi\,\overline{y}(t),\ \ s(t)=\lambda\,\overline{y}(t), \tag{15}$$

where

$$\sigma\equiv\rho\sigma_0,\ \ \eta\equiv\rho\eta_0,\ \ \gamma\equiv\rho\gamma_0,\ \ \xi\equiv\rho\xi_0,\ \ \lambda\equiv\rho\lambda_0,\ \ \rho\equiv\frac{1}{\sigma_0+\eta_0+\gamma_0+\xi_0+\lambda_0}.$$

According to the definition of $s(t)$, the wealth accumulation for the household is

$$\dot{\overline{k}}(t)=s(t)-\overline{k}(t). \tag{16}$$

Full use of land

Land is used for the residential use and service production

$$l(t)\overline{N}+L_s(t)=L. \tag{17}$$

Demand and supply for services

The equilibrium condition for services is

$$c_s(t)\overline{N}+D_T(t)=F_s(t). \tag{18}$$

Accumulation of human capital

In this study, we follow Arrow's learning by doing in modeling human capital accumulation (Arrow, 1962). We propose the following human capital accumulation equation (Zhang, 2014)

$$\dot{H}(t) = \frac{\upsilon_i \, D_T^{b_i}(t)\big(F_i\,(t)/\overline{N}\big)^{a_i}}{H^{\pi_i}(t)} + \frac{\upsilon_s \, D_T^{b_s}(t)\big(F_s\,(t)/\overline{N}\big)^{a_c}}{H^{\pi_s}(t)} - \delta_h \, H(t), \tag{19}$$

where $\delta_h \ (> 0)$ is the depreciation rate of human capital, υ_j, a_j , b_j and π_j are parameters. The term $\upsilon_i \, D_T^{b_i}\left(F_i \ / \overline{N}\right)^{a_i} / H^{\pi_i}$ is the industrial sector's contribution to human capital through learning by doing. Human capital rises in per capita output level of the industrial sector, $F_i / \overline{N}$. The term $D_T^{b_i}$ stands for positive influences of foreign tourists on human capital. The term H^{π_i} indicates that as the level of human capital of the population increases, it may be more difficult (in the case of π_i being large) or easier (in the case of π_i being small) to accumulate more human capital through the industrial sector's learning by doing.

We have thus built the dynamic growth model with endogenous wealth, human capital, and tourism. The model is a synthesis of the well-known Solow-Uzawa growth and Arrow's learning-by-doing models for a small open economy with tourism.

3. The dynamics of the national economy

We now show that we can follow the motion of the economic system with two differential equations. The following lemma shows how we can determine the motion of all the variables in the dynamic system. We introduce a new variable as

Lemma

The variables, k_i, k_s, and w are uniquely determined as functions of r^*. The motion of the land rent and human capital is determine by

$$\dot{R}(t) = \Omega_R\big(R(t),\, H(t)\big),$$

$$\dot{H}(t) = \Omega_H\big(R(t),\, H(t)\big), \tag{20}$$

where Ω_R and Ω_H are functions of $R(t)$ and $H(t)$ determine in the appendix. By the following procedure we can determine all the variables as functions of $R(t)$ and $H(t)$: k_i and w by (4) → k_s by (7) → $\bar{k}(\mathrm{t})$ and $K(\mathrm{t})$ by (A15) → $N_i(\mathrm{t})$ and $N_s(\mathrm{t})$ by (A13) → $K_i(\mathrm{t}) = k_i \, N_i(\mathrm{t})$ and $K_s(\mathrm{t}) = k_s \, N_s(\mathrm{t})$ → $N(\mathrm{t})$ by (A12) → $p(\mathrm{t})$ by (A10) → $D_T(\mathrm{t})$

by (10) $\rightarrow \bar{y}(t)$ by (A4) $\rightarrow \bar{T}(t),\ l(t),\ c_i(t),\ c_s(t),\ s(t)$ by (15) $\rightarrow T(t) = T_0 - \bar{T}(t)$ $\rightarrow L_s(t)$ by (17) $\rightarrow F_i(t)$ by (A2) $\rightarrow F_s(t)$ by (5).

The lemma implies that for a given rate of interest in the global market, the economic system at any point in time can be uniquely described as functions of the land rent and human capital. Hence, if we know the motion of the land rent and human capital, we can determine the motion of the whole system. It should be remarked that in the small open growth model by Turnovsky (1996), it is concluded that the equilibrium growth rates of domestic capital and consumption are determined largely independent. The former is determined by production conditions, the latter is determined primarily by tastes. The conclusion that growth rate of domestic capital is determined by production conditions is given also in some other models of small open economies with perfect capital mobility and perfect substitutability between home capital and foreign bonds (see, for instance, Zeira, 1987). In our model, the total output levels, the capital stocks employed by the economy, and economic production structure are not only determined by the production conditions and the international rate of interest, but also by tastes. Moreover, consumption is not only determined by preferences but also related to the rate of interest and the production conditions. As the expressions of the analytical result are tedious, it is difficult to get explicit conclusions. For interpretation, we simulate the model. We specify parameter values as follows

$$r^* = 0.03,\ \delta_k = 0.05,\ N = 1.2,\ T_0 = 24,\ L = 20,\ A_i = 1,\ A_s = 1,\ \alpha_i = 0.3,\ \alpha_s = 0.2,$$
$$\beta_s = 0.6,\ \lambda_0 = 0.7,\ \xi_0 = 0.15,\ \gamma_0 = 0.06,\ \eta_0 = 0.06,\ \sigma_0 = 0.12,\ a = 1,\ y_f = 4,$$
$$\phi = 1.5,\ \varepsilon = 1.5,\ m = 0.5,\ \delta_h = 0.04,\ v_i = 2,\ y_s = 1.5,\ b_i = 0.05,\ b_s = 0.05,\ a_i = 0.3,$$
$$a_s = 0.4,\ \pi_i = 0.3,\ \pi_s = 0.3. \tag{21}$$

The rate of interest is fixed at 3 per cent and the population is 1.2. It should be remarked that although the specified values are not based on empirical observations, the choice does not seem to be unrealistic. For instance, some empirical studies on the US economy demonstrate that the value of the parameter, α, in the Cobb-Douglas production is approximately equal to 0.3. Some empirical studies show that income elasticity of tourism demand is well above unity (Syriopoulos, 1995; Lanza et al., 2003). According to Lanza et al. (2003), the price elasticity is in the range between 1.03 and 1.82 and income elasticities are in the range between 1.75 and 7.36. Refer to, for instance, Gaŕin-Mũnos (2007) for other studies on elasticities. Following the lemma, we calculate the time-independent variables as follows

$$k_i = 6.61,\ \ k_s = 5.14,\ \ w = 1.23. \tag{22}$$

We specify the initial conditions as follows

$$H(0) = 140,\ \ R(0) = 13.$$

We plot the motion of the dynamic system in Figure 1. As their initial values are fixed lower than their long-term equilibrium values, the land rent and human capital the human capital rises over time. In association with rising land, the price of services is enhanced. Rising price reduces tourist demand. In association with rising human capital, the leisure time is also increased. The total labor supply falls slightly and then rises slightly. The GDP changes slightly over time. The output level of the industrial sector is reduced and that of the service sector is increased. The labor and capital inputs o the service sectors are increased and the labor and capital inputs are reduced. The national wealth rises over time and the capital stocks employed by the country falls. The household consumes more the two goods, owns more wealth, and has smaller lot size.

Figure 1. *The Motion of the National Economy*

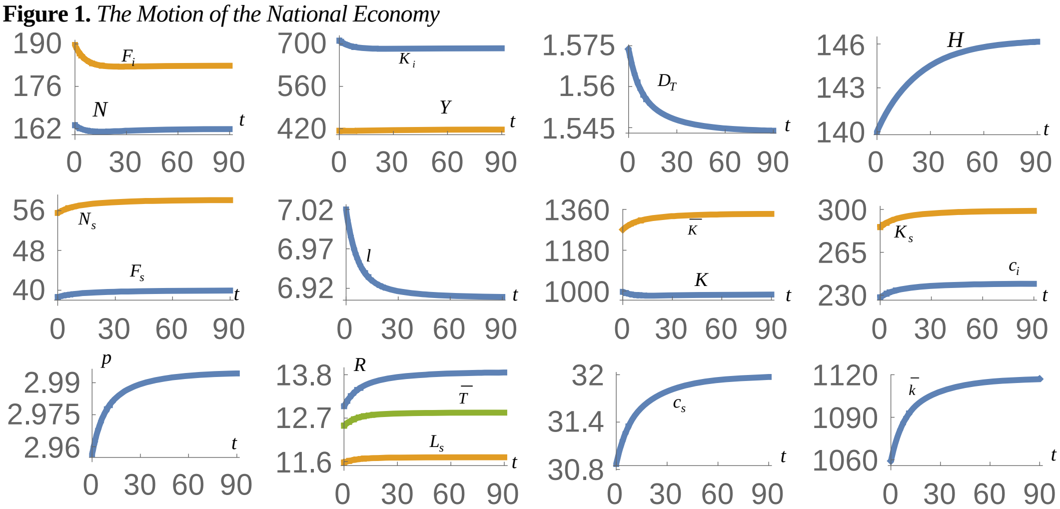


Figure 1 shows the motion of the variables over time. From the figure we observe that all the variables of the economic system tend to become stationary in the long term. This implies that the system approaches an equilibrium point. We identify the equilibrium values of the variables as follows

$$p = 2.335,\ R = 13.87,\ Y = 417.39,\ K = 984.64,\ \overline{K} = 1341.18,\ H = 146.3,\ N = 162,$$
$$DT = 1.54,\ N_i = 103.8,\ N_s = 58.17,\ K_i = 685.68,\ K_s = 298.95,\ L_s = 11.71,$$
$$F_i = 182.85,\ F_s = 39.93,\ \overline{T} = 12.84,\ c_i = 239.5,\ c_s = 31.99,\ l = 6.91,\ \bar{k} = 1117.65.$$

The eigenvalues are

$$\{-0.159,\ -0.042\}.$$

This confirms that the unique equilibrium point is stable. This also guarantees the validity of comparative dynamic analysis in the next section.

4. Comparative dynamic analysis

The previous section plots the motion of the variables. This section examines how changes in some parameters affect the national economy over time. As we have shown how to simulate the motion of the system, it is straightforward to make comparative dynamic analysis. We introduce a variable, $\bar{\Delta} x(t)$, to stand for the change rate of the variable, $x(t)$, in percentage due to changes in the parameter value.

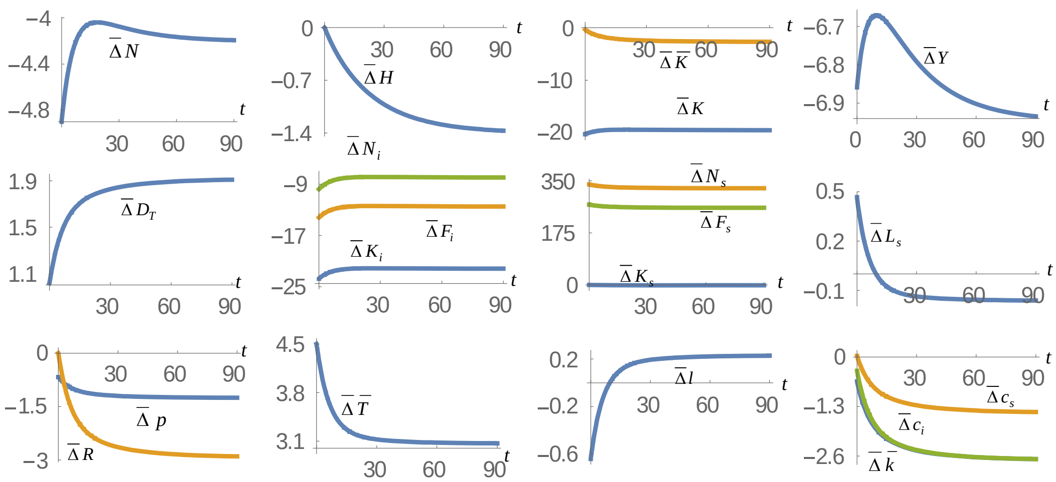
A rise in the rate of interest in the global market

First, we examine the case that all the parameters, except the rate of interest, r^*, are the same as in (21). We study what will happen to the dynamics of the economic system if the rate of interest is changed as follows: $r^* = 0.03 \Rightarrow 0.04$. It should be remarked that as we have explicitly solved the dynamics, we can also carry out comparative dynamic analysis by assuming that the rate of interest varies in time, $r^*(t)$. This is similarly true for other parameters. As the rate of interest rises from 3 percent to 4 percent in the international market, the capital intensities and wage rate are reduced as follows

$$\bar{\Delta} k_i = \bar{\Delta} k_s = -15.5, \quad \bar{\Delta} w = -4.9.$$

The cost of capital is increased, the capital intensities and wage rate are reduce. The changes in the time-dependent variables are plotted in Figure 2. The rise in the cost of capital causes the two sectors to use less capital. The capital stock employed by the national economy is thus reduced. The wealth owned by the country as well as the household are reduced. This results in the reduction in the wage rate, which is associated with reduction in the work hours. The human capital and total labor supply are decreased. The output level and two input factors of the industrial sector are reduced.

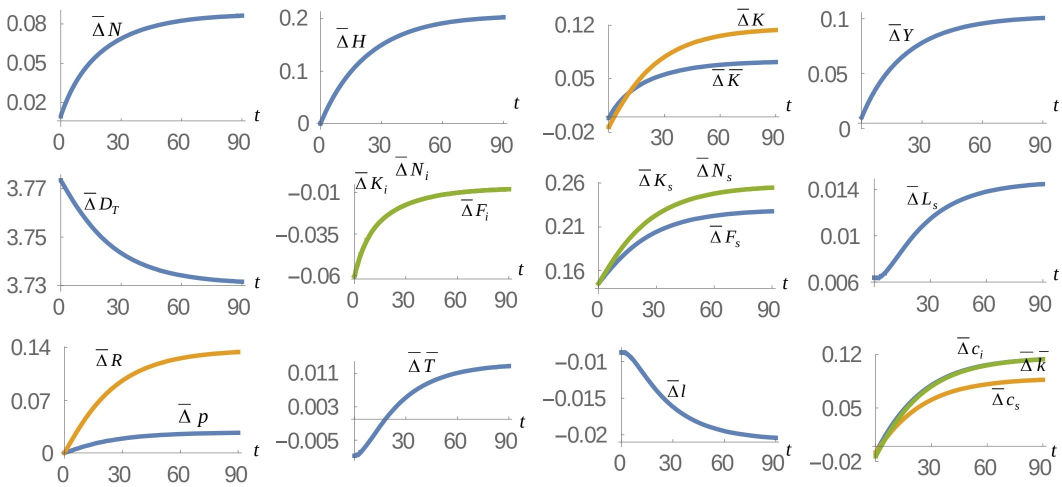
Figure 2. *A Rise in the Rate of Interest*



Global economic conditions being improved

As the country is under influences of global economies, it is important to examine what will happen when different conditions are changed in global markets. We analysed the effects of a rise in the rate of interest. We now study what will happen to the national economy when the foreign income is changed as follows: $y_f = 4 \Rightarrow 4.1$. The capital intensities and wage rate are not affected, that is, $\overline{\Delta} k_i = \overline{\Delta} k_s = \overline{\Delta} w = 0$. As foreign economic conditions are improved, more foreigners visit the economy. As more foreigners visit the country, the price of services and output of the service sector are increased. The service sector employs more labor and more capital. Human capital is increased as more tourists and higher output level of the service sector enable people accumulate more human capital. As the time distribution is slightly affected, higher human capital implies higher total labor. The land distribution is affected but very slightly. As the work hours is slightly affected and wage rate is invariant, the total wage income increased. The output and two input levels of the industrial sectors are slightly reduced. This occurs partly because the service sector serves more foreign visitors. The national resources are partly absorbed by the service sector. 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 with endogenous human capital. The consumption levels of goods and services, wealth level are all reduced initially but increased in the long time.

Figure 3. *Global Economic Conditions Being Improved*

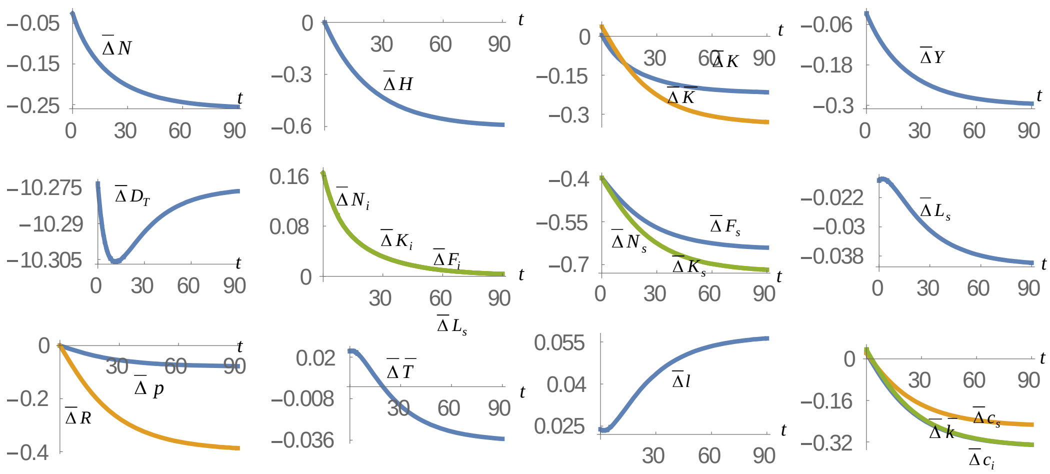


We see that an improvement in the global income reduces the living conditions and wealth of the domestic household in short term but improves these variables in the long term. It should be noted that according to Harzri and Sgro (1995) an increase in the international tourism leads to a positive effect on long-run economic growth. Our result shows that this conclusion is true in the long term, but not necessarily true in the short term. Similarly, their model shows that for a small open economy the growth in tourist consumption of services increases the welfare. Our simulation demonstrates that this conclusion is valid in the long term, but not necessarily true in the short term. We get this "new insight" because our model explicitly shows transitional processes of the economic dynamics.

The price elasticity of tourism being enhanced

We now examine the impact of the following rise in the price elasticity of tourism: $\varepsilon = 1.5 \Rightarrow 1.6$. The capital intensities and wage rate are not affected, $\overline{\Delta} k_i = \overline{\Delta} k_s = \overline{\Delta} w = 0$. The changes in the other variables are plotted in Figure 4. A rise in the price elasticity reduces the tourist demand and the price of services. The output of the service sector is reduced as the demand falls. The human capital is reduced. The time distribution is slightly affected and the total labor supply is reduced. The total capital employed by the economy and the national product are decreased. The output of the industrial sector is increased. Some of labor force is shifted from the service sector to the industrial sector. The lot size rises, while the land input of the service sector is reduced. The consumption levels of the goods and services and wealth level are reduced in the long term.

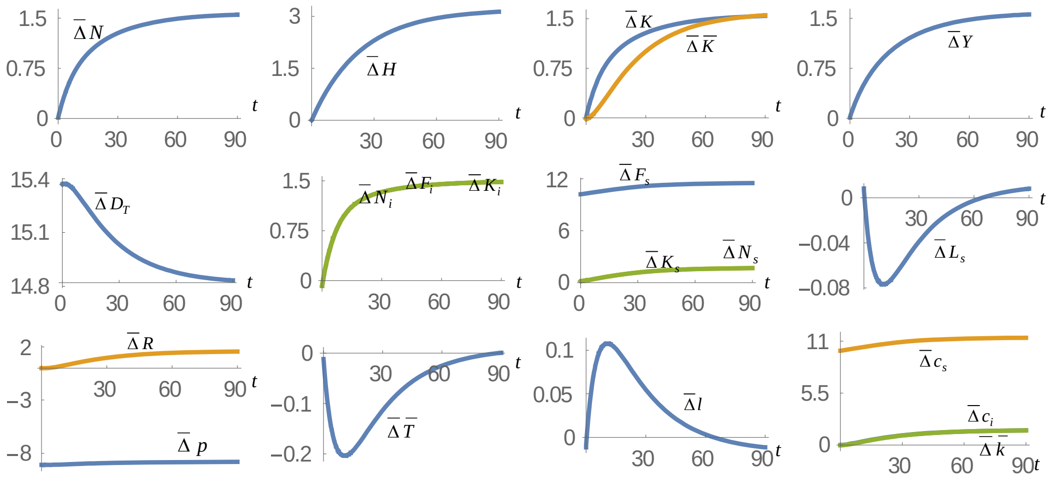
Figure 4. *The Price Elasticity of Tourism Being Enhanced*



A rise in the total productivity of the service sector

We now examine the impact of the following change in the total productivity of the service sector: $A_s = 1 \Rightarrow 1.1$. The capital intensities and wage rate of the small open economy are not affected, that is, $\overline{\Delta} k_i = \overline{\Delta} k_s = \overline{\Delta} w = 0$. We plot the effects on the other variables are plotted in Figure 5. The increased productivity of the service sector raises the output and price level of services. More foreign tourists are attracted to the country. The output level and two inputs of each sector are augmented. The GDP rises over time. The land rent is increased. The lot size is increased initially and is reduced in the long term. The land input employed by the service sector is reduced initially and is reduced in the long term. The work hours is increased initially and is not affected in the long term. The human capital and the total labor supply are increased. The country uses more capital stocks and owns more wealth. The household consumes more goods and services and owns more wealth.

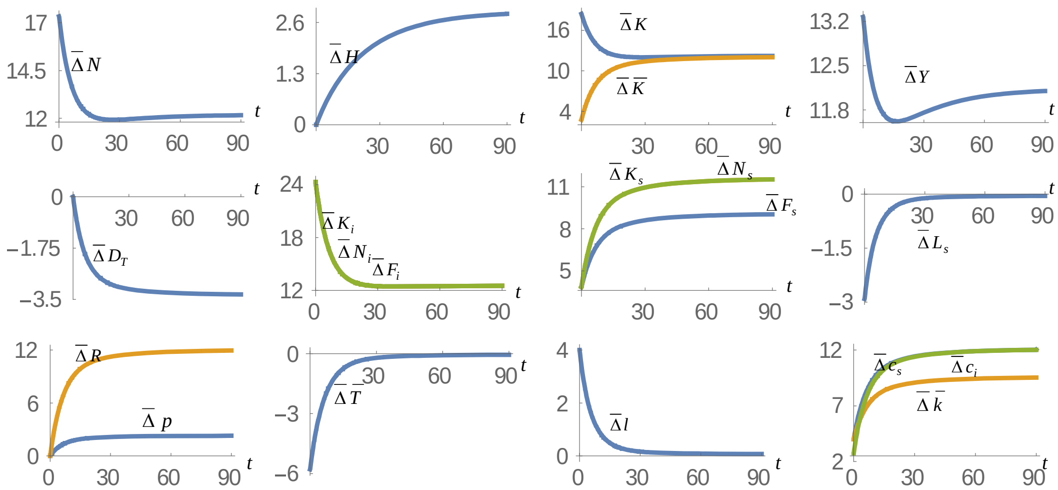
Figure 5. *A Rise in the Total Productivity of the Service Sector*



An improvement in applying human capital

We now examine what will happen to the national economy when the workers apply their human capital more effectively in the following way: $m = 0.5 \Rightarrow 0.52$. The capital intensities and wage rate are increased in the same rate. The changes in the other variables are plotted in Figure 6.

Figure 6. *An Improvement in Applying Human Capital*

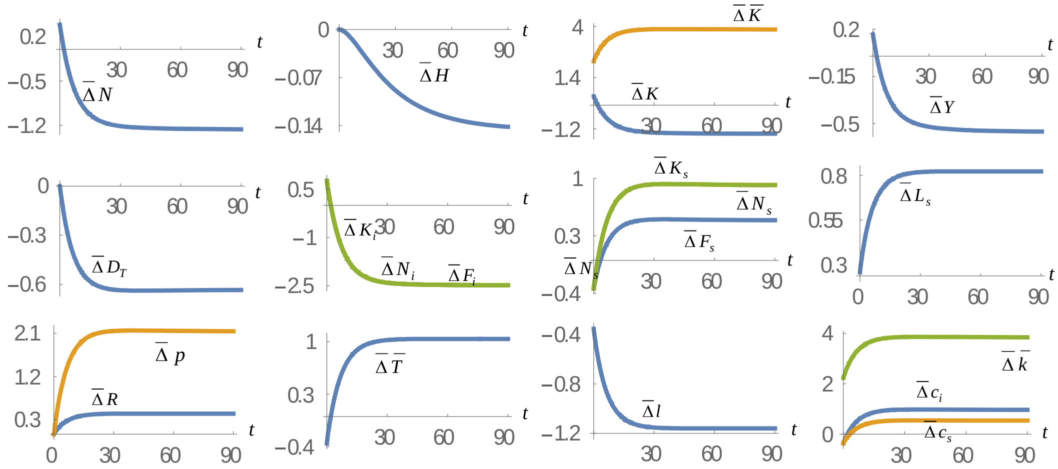


The total labor supply is increased. The GDP is increased. The price of services and the land rent are increased. The increased price reduces foreign tourists. The lot size is increased initially and is not affected in the long term. The land use of the service sector is reduced initially and is not affected in the long term. The work hours is increased initially and is not affected in the long term. The human capital and the total labor supply are increased. The country uses more capital stocks and owns more wealth. The household consumes more goods and services and owns more wealth. Each sector increases their inputs and output level.

The household's propensity to save being enhanced

We now examine what will happen to the national economy when the propensity to save is increased as follows: $\lambda_0 = 0.7 \Rightarrow 0.72$. The capital intensities and wage rate are not affected, $\bar{\Delta} k_i = \bar{\Delta} k_s = \bar{\Delta} w = 0$. The changes in the other variables are plotted in Figure 7. The household's wealth and national wealth are increased. The leisure time is reduced initially and then is increased. The human capital is reduced. The total labor supply is augmented initially and then is reduced. The price of services and the land rent are increased. The household uses less lot sizes, consumes more services and industrial goods, and owns less wealth. The economy employs more capital initially and then uses less capital. The national output is increased and then is reduced. In association with price rising the country attracts less tourism. The two inputs and output level of the service sector are increased and the two inputs and output level of the industrial sector are lowered in the long term.

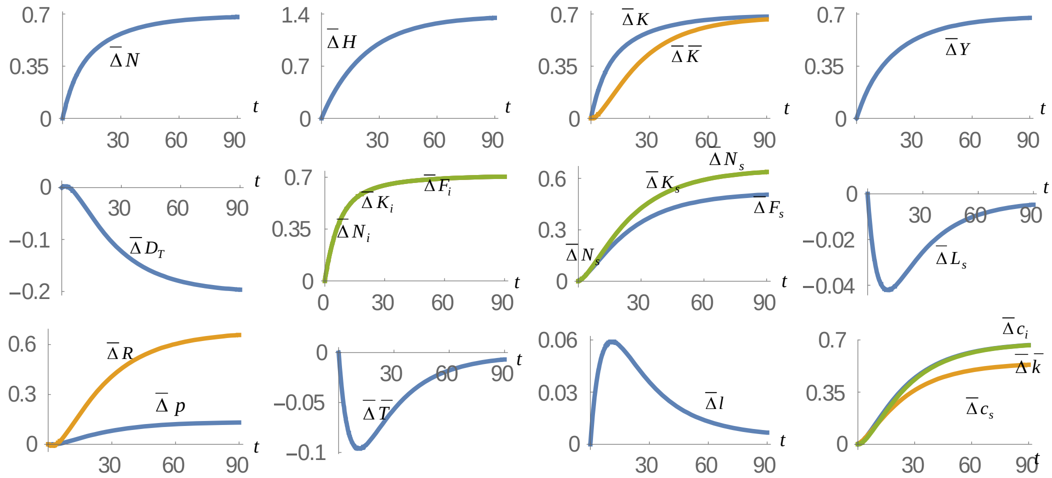
Figure 7. *The Household's Propensity to Save Being Enhanced*



Tourism more strongly affecting human capital accumulation

We now examine what will happen to the economy learns more effectively from tourism in the following way: $b_s = 0.05 \Rightarrow 0$. The capital intensities and wage rate not affected. The changes in the other variables are plotted in Figure 8. The human capital and the total labor supply are increased. The GDP is increased. The economy has more wealth and employs more physical capital. The price of services and the land rent are increased. Tourism is weakened as the price is increased. The land distribution is slightly affected. The work hours is slightly reduced. The household consumes more goods and services and owns more wealth. Each sector increases their inputs and output level.

Figure 8. *Tourism More Strongly Affecting Human Capital Accumulation*



5. Conclusions

This paper proposed an economic growth model of a small open economy with tourism and endogenous wealth and human capital in a perfectly competitive economy. The national economy consists of one service sector and one industrial sector. Following the traditional literature of small open economies, we assume that the rate of interest is fixed in international market. The production side is the same as in the neoclassical growth theory. We used a utility function, which determines saving, consumption and time distribution. The system has a unique stable equilibrium point. We simulated the motion of the model and examined effects of changes in the rate of interest, the price elasticity of tourism, the total productivities of the industrial and service sectors, the propensity to save, and the impact of tourism on human capital accumulation. The comparative dynamic analysis provides some important insights. For instance, when the price elasticity of tourism is increased, the tourist demand and the price of services are reduced; the output of the service sector is reduced; the human capital and the total labor supply are reduced; the time distribution is slightly affected; the total capital employed by the economy and the national product are decreased; the output of the industrial sector is increased; some of labor force is shifted from the service sector to the industrial sector; the lot size is increased and the land input of the service sector is reduced; and the consumption levels of the goods and services and wealth level are reduced in the long term. It should be noted that the model can be extended and generalized in different directions. For instance, it is important to study the economic dynamics when utility and production functions are taken on other functional forms. We do not consider possibilities that domestic households travel to other countries. This implies that it is important to deal with economies as an integrated whole (Clive et al., 2014). Monetary issues such as exchange rates and inflation policies are important for understanding trade issues. We also neglect tariffs and other taxes.

Appendix. Proving Lemma 1

We already showed that k_i, w, and k_s are determined as functions of r^*, which is fixed in the international market. From $K_j = k_j N_j$ and (9), we have

$$K_i = (K - k_s N)k_0 k_i, \quad K_s = (k_i N - K)k_0 k_s, \tag{A1}$$

where we omit time variable in expressions. From (6), we solve

$$R = \frac{w_s N_s}{L_s}, \tag{A2}$$

where we also use $l_s = L_s / N_s$ and $w_s \equiv w \gamma_s / \beta_s$. Insert (A2) in (15)

$$l \bar{N} + \frac{w_s N_s}{R} = L. \tag{A3}$$

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

$$\bar{y} = (1 + r^*)\bar{k} + H^m T_0 w + \frac{R L}{\bar{N}}. \tag{A4}$$

From (A4) and $l = \eta \bar{y} / R$ in (13)

$$l = \frac{(1 + r^*)\eta \bar{k} + H^m \eta T_0 w}{R} + \frac{\eta L}{\bar{N}}.$$

Insert this equation in (A3)

$$\bar{k} + \bar{w}_s N_s = m_0, \tag{A5}$$

where

$$\bar{w}_s \equiv \frac{w_s}{(1 + r^*)\eta \bar{N}}, \quad m_0(R, H) \equiv \frac{(1 - \eta) L R}{(1 + r^*)\eta \bar{N}} - \frac{H^m T_0 w}{(1 + r^*)}.$$

From $r^* + \delta_k = \alpha_s p F_s / K_s$ and (16) we have

$$c_s \bar{N} + D_T = \frac{r_\delta K_s}{\alpha_s p}. \tag{A6}$$

Insert $c_s = \gamma \bar{y} / p$ in (A6)

$$\gamma \bar{y} \bar{N} + p D_T = \frac{r_\delta K_s}{\alpha_s}. \tag{A7}$$

Insert (A4) in (A7)

$$\left(\left(1+r^*\right)\bar{k}+H^m T_0 w+\frac{RL}{\bar{N}}\right)\gamma \bar{N}+a y_f^\phi p^{1-\varepsilon}=\frac{r_\delta K_s}{\alpha_s}, \tag{A8}$$

where we also use (10). We now discuss two cases, $\varepsilon = 1$ and $\varepsilon \neq 1$, separately. In the case $\varepsilon = 1$, (A8) becomes

$$\left(\left(1+r^*\right)\bar{k}+H^m T_0 w+\frac{RL}{\bar{N}}\right)\gamma \bar{N}+a y_f^\phi=\frac{r_\delta K_s}{\alpha_s}. \tag{A9}$$

From (A5) and (A9), we delete R and get an equation which gives the relation between $\bar{k}$, H and K. As discussed in the other case, we can determine two differential equations with K and H as variables.

We now examine $\varepsilon \neq 1$. From (6) we have

$$p=\frac{wR^{\gamma_s}}{\beta_s A_s k_s^{\alpha_s} w_s^{\gamma_s}}, \tag{A10}$$

where we also use $l_s = w_s / R$ from (A2). Insert (A10) in (A8)

$$\bar{k}+m_1=\bar{r}_\delta\left(K-k_i N_i\right), \tag{A11}$$

where we use $K_s = K - K_i$, $K_i = k_i N_i$ and

$$m_1(R,H)\equiv\frac{1}{\left(1+r^*\right)}\left[H^m T_0 w+\frac{RL}{\bar{N}}+\frac{a y_f^\phi}{\gamma\bar{N}}\left(\frac{wR^{\gamma_s}}{\beta_s A_s k_s^{\alpha_s} w_s^{\gamma_s}}\right)^{1-\varepsilon}\right],$$

$$\bar{r}_\delta=\frac{r_\delta}{\left(1+r^*\right)\gamma\bar{N}\alpha_s}.$$

From (1), the time constrain and (15)

$$N=\left(\left(1-\sigma\right)T_0 H^m-\frac{\left(1+r^*\right)\sigma\bar{k}}{w}-\frac{\sigma}{w}\frac{RL}{\bar{N}}\right)\bar{N}, \tag{A12}$$

where we also use (A4). From (9) and (A12)

$$N_i=\left(\frac{K}{\bar{N}}+\frac{\left(1+r^*\right)k_s\sigma\bar{k}}{w}\right)k_0\bar{N}+m_i,\quad N_s=m_s-\left(\frac{\left(1+r^*\right)k_i\sigma\bar{k}}{w}+\frac{K}{\bar{N}}\right)k_0\bar{N}, \tag{A13}$$

where

$$m_i(R, H) \equiv \left(\frac{R \sigma L}{w \overline{N}} - (1 - \sigma) T_0 H^m \right) k_s k_0 \overline{N},$$

$$m_s(R, H) \equiv \left((1 - \sigma) T_0 H^m - \frac{\sigma}{w} \frac{R L}{\overline{N}} \right) k_i k_0 \overline{N}.$$

Substitute (A13) into (A5) and (A11) yields

$$b_1 \bar{k} - K = \Phi_1,$$
$$b_2 \bar{k} + K = - \Phi_2, \tag{A14}$$

where

$$b_1 \equiv \left[1 - \frac{(1 + r^*) \overline{w}_s k_0 \overline{N} \sigma}{w} \right] \frac{1}{\overline{w}_s k_0 \overline{N}}, \ , \ \Phi_1(R, H) \equiv \frac{m_0 - \overline{w}_s m_s}{\overline{w}_s k_0 \overline{N}},$$

$$b_2 \equiv \left[1 + \frac{(1 + r^*) k_s \bar{r}_\delta k_i k_0 \overline{N} \sigma}{w} \right] \frac{1}{(k_i k_0 - 1) \bar{r}_\delta}, \ \Phi_2(R, H) \equiv \frac{m_1 + \bar{r}_\delta k_i m_i}{(k_i k_0 - 1) \bar{r}_\delta}.$$

Solve

$$\bar{k} = \Lambda(R, H) \equiv \frac{\Phi_1 - \Phi_2}{b_1 + b_2},$$
$$K = \Psi(R, H) \equiv b_1 \Lambda - \Phi_1. \tag{A15}$$

By the following procedure we can determine all the variables as functions of R and H: k_i and w by (4) $\rightarrow$ k_s by (7) $\rightarrow$ $\bar{k}$ and K by (A15) $\rightarrow$ N_i and N_s by (A13) $\rightarrow$ $K_i = k_i N_i$ and $K_s = k_s N_s$ $\rightarrow$ N by (A12) $\rightarrow$ p by (A10) $\rightarrow$ D_T by (10) $\rightarrow$ $\bar{y}$ by (A4) $\rightarrow$ $\overline{T}$, l, c_i, c_s, s by (15) $\rightarrow$ $T = T_0 - \overline{T}$ $\rightarrow$ L_s by (17) $\rightarrow$ F_i by (A2) $\rightarrow$ F_s by (5).

From this procedure, (16) and (19), we have

$$\dot{\bar{k}} = \Omega_0(R, H) \equiv s - \bar{k}, \tag{A16}$$

$$\dot{H} = \Omega_H(R, H) \equiv \frac{\upsilon_i D_T^{b_i} \left(F_i / \overline{N}\right)^{a_i}}{H^{\pi_i}} + \frac{\upsilon_c D_T^{b_c} \left(F_c / \overline{N}\right)^{a_c}}{H^{\pi_c}} - \delta_h H. \tag{A17}$$

Taking derivatives of the first equation in (A15) with respect to time yield

$$\dot{k} = \frac{\partial \Lambda}{\partial R}\dot{R} + \Omega_H \frac{\partial \Lambda}{\partial H}. \tag{A18}$$

We do not provide the expressions in the above equation because it is tedious. Equal the right-hand sides of (A18) and (A16)

$$\dot{R} = \Omega_R(R, H) \equiv \left(\Omega_0 - \Omega_H \frac{\partial \Lambda}{\partial H}\right)\left(\frac{\partial \Lambda}{\partial R}\right)^{-1}. \tag{A19}$$

We thus proved Lemma 1.

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