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GROWTH AND NATIONAL DEBT WITH IMPORTED GOODS, TOURISM, AND PUBLIC GOODS

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Abstract

The paper develops an economic growth model of a small open economy with government debt, tourism and imported goods in a perfectly competitive economy. The national economy consists of three, industrial, service and the public sectors. The production side is based on neoclassical growth theory. The household behavior is modeled according to Zhang's approach. Non-linear dynamics interaction between the economic structural change, capital accumulation and public debt under different combinations of taxes on goods sector, the service sector, the wage income, the rate of interest, consumption of goods, and the consumption of service are also described. The model, simulate and demonstrate that the system has a unique unstable equilibrium point. Comparative dynamic analysis is carried out to provide insights into complicated consequences of environmental changes; for instance, if government spends more out of national income, the short-run consequences are debt, and the ratio of debt. The national output is increased and the economy employs more capital; thus it produces less and borrows more from foreign economies, more tourists visit the country; the household has less wealth and reduces consumption of the three goods. The industrial sector shrinks and the service sector expands.

Key Words: Tourism, Government Debt, Tax Rates, Public Goods, Economic Growth.
JEL Classification: O41, H11, H60.

I. Introduction

Rapid development of tourism and high government debts are well-observed economic phenomena in many economies. Although, tourism and government debts are analyzed in the recent literature of economics, most of these formal studies examine either the debt problems or the tourism, but not in an integrated analytical framework. The purpose of this study is to examine the dynamic interdependence between economic growth, government debt, and tourism, within a dynamic general equilibrium framework.

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Tourism has experienced rapid development in recent decades as people, not only from the developed economies but also from the developing ones, travel domestically and internationally [Andereck, et al. (2005), Matarrita-Cascante (2010), and Antonakakis, et al. (2015)]. Chou (2013) described the development of tourism as follows: “The total impact of the industry is impressive. In 2011, it contributed to 9 per cent of global GDP, a value of over US$6 trillion, and accounted for 255 million jobs. Over the next ten years, this industry was expected to grow by an average of 4 per cent, annually. This will bring it to 10 per cent of global GDP or about US$ 10 trillion. By the year 2022, it is anticipated that it will account for 328 million jobs, one in every ten jobs on the planet.” There are many studies about relationship between tourism spending and economic growth [(e.g., Sinclair and Stabler (1997), Luzzi and Flückiger (2003), Hazari and Sgro (1995) and (2004), and Hazari and Lin (2011)]. Most of the literature is empirical [(e.g., Corden and Neary (1982), and Copeland (1991), and (2012), and there are few formal studies on relation between growth and tourism. As reviewed by Chao, et al. (2009), theoretical research of tourism has been mainly static. According to Zhang (2017), the lacking of theoretical research is partly due to introduction of tourism into economic growth theory which is analytically not easy. Different from the other goods, tourism converts non-traded goods into tradable ones. It also compete resources, such as labor and capital with other sectors of the economy [e.g., Balaguer and Cantavella-Jorda (2002), Dritsakis (2004), Durbarry (2004), Oh (2005), and Kim, et al. (2006)]. In order to study the impact of tourism, properly, it is necessary to construct a dynamic general equilibrium framework [(Dwyer, et al. (2004), Blake, et al. (2006)].This study propose a dynamic analytical framework, not only to deal with interdependence between tourism and economic growth, but also to include the national debt with endogenous in context of a small-open economy.

Government debts have become an important issue in developing, as well as developed economies. The issues are complicated as national debts have complicated relations with GDP, taxes, taxation structures, population structure, government’s social and economic activities, population structure, human capital, international trade, and the economic growth. There are some theoretical models on relations between national debts and growth. As far as the purpose of this study is concerned, these models are limited in scope in the sense that tourism is not included. This study deals with issues related to debts and economic growth with tourism in the neoclassical growth framework. Dynamics of debts are dealt by considering government expenditure and different taxes in a competitive economy. There are few models which include productive fiscal policy as a determinant of persistent economic growth [Barro (1990), Turnovsky (2000), and (2004), Gómez (2008), and Park (2009)]. In this study the government has a set of control measures; such as the total expenditures and tax rates on industrial sector’s output, service sector’s output, wage income, consumption and the interest income. Moreover, behavior of households is modeled with the approach proposed by

Zhang. Almost, all recent theoretical literature of dynamic interactions between economic growth and public debts use either the Ramsey framework in continuous time [Cohen and Sachs (1986), Blanchard and Fischer (1989), Barro, et al. (1995), Semmler and Sieveking (2000), Guo and Harrison (2004), and Giannitsarou (2007); or the OLG modeling framework in discrete time [(Diamond (1965), Farmer (1986), Turnovsky and Sen (1991), Azariadis (1993), dela Croix and Michel(2002), and Chalk (2000)]. Zhang's approach is applied to deal with the complicated issues.

This study is constructed for a small open economy as pointed out by Zeng and Zhu (2011).Almost all growth models in tourism economics are built for small open economies [e.g., Obstfeld and Rogoff (1998), Lane (2001), Kollmann (2001), and (2002), Benigno and Benigno (2003), and Galí and Monacelli (2005], and this tradition is followed in the study. Much attention is focused on the impact of disturbances, in the literature of small open economies such as global economic crisis and price of inputs [e.g., Sachs (1982), Svensson and Razin (1983), Matsuyama (1987), Mendosa (1995), Kose (2002), and Turnovsky and Chattopadhyay (2003)]; but, preference for goods and tourism is not properly examined in a general equilibrium framework. The effects of preference for foreign goods on trade balance, national and government debts, and long-run economic growth is examined. This paper is a synthesis of Zhang's recent two models [(Zhang (2016) and (2017)]. Zhang's (2016) model is on government debt without tourism for a closed economy while Zhang's (2017) model deals with growth and tourism for a small-open economy without tourism. The two models are developed within the same framework as they differ in it a way that they deal in different issues. This study is to integrate the two models to add the issues within a single general equilibrium framework. The rest of the paper is organized as follows. Section II defines the basic model (the growth model with tourism). Section III provides a computational procedure to plot the motion of economy and simulates the model. Section IV carries out comparative dynamic analysis and, section V concludes the study. The Appendix proves the main results addressed in Section III.

II. The Growth Model with Tourism

The main economic growth mechanism (in this study) is based on the neoclassical growth model [Solow (1956), Burmeister and Dobell (1970), Zhang (2005). The model is framed in accordance with the traditional two-sector growth model proposed by Uzawa (1961) and based on basic features of the other two approaches – the literature of a small open economic growth model with tourism and the growth model with public debt [Diamond (1965)]. The household decision is based on Zhang's approach [Zhang (1993) and (2005)]. Following Chao, et al. (2009) an economy that is small and open, and produces two goods is considered an international industrial good and the national services. National services are 'tradable' in a sense that foreign tourists come to visit the country and consume services. The economy produces industrial goods, consumption goods, and public goods; and consist of three (industrial, consumer, and public) goods sectors. It is assumed that population N is constant and homogeneous. Subscript index, i, s, and p, are used to denote the industrial and service sectors, respectively. The public sector uses capital and labor as inputs and supplies to public services which are freely available to consumers. The public sector is financed by the government which taxes the households and the two production sectors. The price of industrial goods is unity. Technologies of production sectors are described by the Cobb-Douglas production functions. The markets are perfectly competitive and capital, and labor is completely mobile among sectors. Let τ_i, τ_s, τ_w, and τ_k, stand (respectively) for, fixed tax rates on industrial output, service output, wage income, and the interest income. The study introduce that $\bar{\tau}_x \equiv 1 - \tau_x$, where, $x = i, s, w, k$. $K_j(t)$ and $N_j(t)$ are used to represent capital stocks and labor force employed by sector j, $j = i, s, p$, at time t. The $F_j(t)$ is used to represent the output level of sector j. As expressed by Zhang (2017) the imported goods which are not produced by the domestic economy but are consumed by the domestic consumers, are also included. The introduction of these goods enables to consider the impact of domestic households' preference for those goods which cannot be produced by the domestic economy; for instance, a stronger desire for foreign luxury goods may affect the domestic economic structure. There are two types of consumers: domestic households and foreign tourists. It is assumed that domestic households consume two goods and the services, while foreign tourists consume only services. Tourism converts services into exportable commodity; and in case of the model of this study the economy freely import and export the goods. The price of industrial goods is unity. Capital depreciate at a constant exponential rate (δ_k) and the rate of interest and price of imported goods is denoted by r^* and p_z respectively. It is assumed that r^* and p_z are constant. Capital and labor are completely mobile between the two sectors. Capital is perfectly mobile in the international market and possibility of emigration and/or immigration is neglected.

1. The Industrial Sector

The production function of the industrial sector is

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

where, A_i, α_i and β_i are parameters. The wage rate $w(t)$ is determined in domestic labor market. The marginal conditions for the industrial sector are

$$r_\delta = \bar{\tau}_i \alpha_i A_i k_i^{-\beta_i}(t), w(t) = \bar{\tau}_i \beta_i A_i k_i^{\alpha_i}(t), \tag{2}$$

where, $k_i(t) \equiv K_i(t) / N_i(t)$ and $r_\delta \equiv r^* + \delta_k$.

2. The Service Sector

The production function of the service sector is,

$$F_s(t) = A_s K_s^{\alpha_s}(t)\, N_s^{\beta_s}(t),\ \alpha_s, \beta_s > 0,\ \alpha_s + \beta_s = 1, \tag{3}$$

where A_s, α_s, and β_s are parameters. The $p(t)$ is used to stand for price of service.

The marginal conditions for service sector are

$$r_\delta = \overline{\tau}_s\, \alpha_s A_s\, p(t) k_s^{\alpha_{s-1}}(t),\ w = \overline{\tau}_s\, \beta_s A_s\, p(t)\, k_s^{\alpha_s}(t), \tag{4}$$

where $k_s(t) \equiv K_s(t)/N_s(t)$.

3. The Public Sector

The production of public services is to combine capital $K_p(t)$ and labor force, $N_p(t)$, as follows:

$$F_p(t) = A_p K_p^{\alpha_{0p}}(t)\, N_p^{B_{0p}}(t) \alpha_{0p}, \beta_{0p}, A_p > 0. \tag{5}$$

Let $Y_p(t)$ stand for government's expenditure on supplying the public goods and services. The national output is defined by

$$Y(t) = F_i(t) + p(t)\, F_s(t).$$

Different from Zhang (2016) where government expenditure is constant over time, this study assumes that $Y_p(t)$ is proportional to national output, as:

$$Y_p(t) = \tau Y(t) \tag{6}$$

where τ (<1) is a non-negative parameter. This implies that the government is endogenously determined. The public sector is faced with the following budget constraint,

$$r_\delta K_p(t) + w(t)\, N_p(t) = Y_p(t) \tag{7}$$

Maximization of public services under the budget constraint yields

$$r_\delta K_p(t) = \alpha_p\, Y_p(t),\ w(t)\, N_p(t) = \beta_p\, Y_p(t) \tag{8}$$

in which

$$\alpha_p \equiv \frac{\alpha_{0p}}{\alpha_{0p} + \beta_{0p}},\ \beta_p \equiv \frac{\beta_{0p}}{\alpha_{0p} + \beta_{0p}}.$$

4. Full Employment of Capital and Labor

The total capital stock employed by the country $K(t)$ is employed by the three sectors. The full employment of labor and capital is represented by,

$$K_i(t) + K_s(t) + K_p(t) = K(t), \qquad N_i(t) + N_s(t) + N_p(t) = N \tag{9}$$

5. Demand Function of Foreign Tourists

On the basis of Schubert and Brida (2009), following iso-elastic tourism demand function is:

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

where, ϕ and ε are respectively the public service and price elasticities of tourism demand. It is considered that $\bar{a}(t)$ is dependent on many conditions, such as environment (like criminal rates, pollutants and congestions), foreign countries' economic conditions, and infrastructure (airports and transportation system). It is assumed that tourists pay the same price for services as paid by the domestic households [e.g., Marin-Pantelescu and Tigu (2010), Stabler, et al. (2010)]. The validity depends on economies. There are different policies to tax or subsidize tourists. In this modelling framework it is not difficult to relax this assumption.

6. The Current and Disposable Incomes of Domestic Households

The behavior of domestic households is modeled by Zhang's approach [Zhang (1993)]. The implications of this approach are similar to those in the Keynesian consumption function. The models based on permanent income hypothesis are empirically much more valid than the approach in the Solow model or in Ramsey model [Zhang (2005)]. First, $a(t)$ is used to represent the value of wealth owned by a representative household. The wealth gets the return rate r^* Both, wage income and income from wealth are taxed by the government. The current income $Y(t)$ is:

$$Y(t) = \bar{\tau}_w w(t) + \bar{\tau}_a r^* a(t) \tag{11}$$

The disposable income at any point in time is the sum of current income and the value of wealth. The disposable income $y(t)$ is as follows:

$$\hat{y}(t) = y(t) + a(t) \tag{12}$$

The disposable income is used for saving and consumption. At time t the consumer has the total amount of income equaling $\hat{y}(t)$ to distribute among consuming and saving.

7. The Budget of Domestic Households

At each point in time, a consumer distributes the total available budget between consumption of services $c_s(t)$, industrial goods $c_i(t)$ imported goods $c_z(t)$ and savings $s(t)$. The budget constraint is:

$$(1+\tilde{\tau}_s)\, p(t)\, c_s(t) + (1+\tilde{\tau}_i)\, c_i(t) + (1+\tilde{\tau}_z)\, p_z c_z(t) + s(t) = \hat{y}(t). \tag{13}$$

Equation (13) means that consumption and savings exhaust the consumers' disposable income. The household spends the cost of consumption services $(1+\tilde{\tau}_s)\, p(t)\, c_s(t)$, on consuming industrial goods $c_i(t)$, and on consuming imported goods $(1+\tilde{\tau}_z)\, p_z c_z(t)$. Equation (13) also implies that saving is equal to disposable income, minus the total expenditure on consuming goods and services.

8. The Utility Function

The utility level $U(t)$ of the household is dependent on $c_s(t)$, $c_z(t)$, $c_i(t)$ and $s(t)$ and is assumed as follows:

$$U(t) = \theta(F_p(t))\, c_s^{\gamma_0}(t)\, c_i^{\xi_0}(t)\, c_z^{\eta_0}(t)\, s^{\lambda_0}(t) \eta_0,\ \gamma_0,\ \xi_0,\ \lambda_0 > 0.$$

in which γ_0, ξ_0, η_0, and λ_0 are elasticities of utility with regard to services, industrial goods, imported good, and savings. Propensities of γ_0, ξ_0, η_0, and λ_0 are called to consume services, to consume industrial goods, to consume imported goods, and to hold wealth, respectively. It is noted that $\theta(F_p(t))$ takes account of possible impact of public services on the utility. Maximizing $U(t)$ subject to (13) yields,

$$c_s(t) = \frac{\gamma \hat{y}(t)}{p(t)},\ c_i(t) = \xi \hat{y}(t),\ c_z(t) = \frac{\eta \hat{y}(t)}{p_z},\ s(t) = \lambda \hat{y}(t). \tag{14}$$

where

$$\gamma \equiv \frac{\rho\gamma_0}{1+\tilde{\tau}_s},\ \xi \equiv \frac{\rho\xi_0}{1+\tilde{\tau}_i},\ \eta \equiv \frac{\rho\eta_0}{1+\tilde{\tau}_z},\ \lambda \equiv \rho\lambda_0,\ \rho \equiv \frac{1}{\eta_0+\gamma_0+\xi_0+\lambda_0}.$$

9. The Change in Wealth

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

$$\dot{a}(t) = s(t) - a(t). \tag{15}$$

This equation states that change in wealth equals the savings minus the dissavings.

10. The Government Budget

The government finances the current spending by collecting taxes and issuing interest-bearing debt. The income comes from taxing the two sectors, the interest income of wealth, and the consumption. Let $T_p(t)$ stand for the government's tax income, which gives:

$$T_p(t) = \tau_i F_i(t) + \tau_s p(t) F_s(t) + [\tau_a r^* a(t) + \tilde{\tau}_i c_i(t) + \tilde{\tau}_s p(t) c_s(t) + \tilde{\tau}_z p_z c_z(t)] N \quad (16)$$

11. The Dynamics of Debt

The governments' debt can be owned by domestic, as well as the foreign households. The rate of interest on debt is determined in the global market. The government debt follows the following dynamics

$$\dot{D}(t) = r^* D(t) + Y_p(t) - T_p(t) \quad (17)$$

Change in government debt is the interest payment for the current debt and government expenditure on supplying public goods minus the tax income.

12. Balance of Demand and Supply for Services

The equilibrium condition for services is,

$$c_s(t) N + D_T(t) = F_s(t). \quad (18)$$

13. The National Debt

According to the concepts, the national debt $\bar{D}(t)$ is as follows,

$$\bar{D}(t) = D(t) + K(t) - a(t) N. \quad (19)$$

and thus, the dynamic growth model is built with endogenous wealth, consumption, and tourism.

III. Dynamics of the National Economy

The Appendix shows that the motion of economic system is determined by two differential equations. The following lemma in the Appendix shows as to how the motion of all variables in the dynamic system can be determined.

1. Lemma

Variables, k_i, k_s, k_p, w and p are determined as functions of r^* in the Appendix. The motion of $N_s(t)$ and $D(t)$ is determined by,

$$\dot{N}_s(t) = \Lambda_N (N_s(t)),$$
$$\dot{D}(t) = \Lambda_D (D(t), N_s(t)), \tag{20}$$

in which Λ_N and Λ_D are respectively, defined in the Appendix. It determines all other variables as functions of $N_s(t)$ and $D(t)$ as follows: $a(t)$ by(A-18) → $N_i(t)$ by (A-17) → $K(t)$ by (A-16) → $K_i(t)$ and $K_s(t)$ by (A-10) → $F_i(t)$ and $F_s(t)$ by (A-8) → $D_T(t)$ by (18) → $\hat{y}(t)$ by (A-6) → $c_i(t)$, $c_s(t)$, $c_z(t)$, and $s(t)$ by (14) → $Y_p(t)$ by (6) → $K_p(t)$ and $N_p(t)$ by (8).

The lemma implies that motion of economic system at any point in time can be uniquely described as functions of the debt, the labor input of the service sector and the other exogenous variables (the rate of interest, land resource, technology, and preference). As it is explicitly difficult to interpret the analytical results, the model is simulated and its parameters are specified as follows:

$$r^* = 0.07,\ p_z = 4,\ \delta_k = 0.05,\ N = 100,\ A_i = 1.2,\ A_s = 1.1,\ A_{0p} = 0.6,$$
$$\alpha_i = 0.31,\ \alpha_s = 0.36,\ \alpha_{0p} = 0.2,\ \beta_{0p} = 0.4,\ \lambda_0 = 0.9,\ \xi_0 = 0.2,\ \gamma_0 = 0.15,$$
$$\eta_0 = 0.05,\ \bar{a} = 1,\ p_z = 1,\ y_f = 5,\ \phi = 0.5,\ \varepsilon = 1.2,\ \tau = 0.01,\ \tau_i = 0.03,$$
$$\tau_s = 0.03,\ \tilde{\tau}_i = 0.03,\ \tilde{\tau}_s = 0.01,\ \tau_w = 0.01,\ \tau_z = 0.05,\ \tau_a = 0.03. \tag{21}$$

The rate of interest is fixed at 7 per cent, the population is at per cent, and the propensity to save is 0.9 per cent. The propensities to consume goods and services are respectively, 0.2 and 0.15 per cent; the propensity to consume imported goods is per cent and the price of imported goods is one per cent. Some empirical studies shows 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 of 1.03 and 1.82 per cent and income elasticity is in the range of 1.75 and 7.36 per cent. There are other studies on elasticity of tourism [e.g., Gaŕin-Mũnos (2007]. The ratio of government expenditure to the national income is specified as one per cent. The tax rate on production and consumption sectors is between 1 and 5 percents. Following lemma, the time-independent variables is calculated as follows,

$$w = 1.32, \quad p = 1. \tag{22}$$

The following initial condition is as:

$$N_s(0) = 9.5, \ D(0) = 115.$$

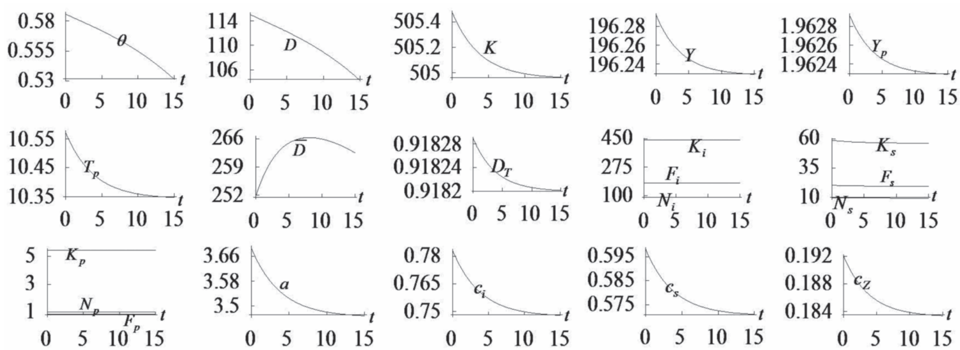

FIGURE 1

The Motion of the National Economy

The motion of the dynamic system is plotted in Figure 1 with mathematica where motion is plotted only for a short period of time. The system does not converge to an equilibrium in the long term.

The equilibrium values of variables are calculated as follows:

$$\theta = 0.61,\ K = 505,\ Y = 196,\ Y_p = 1.96,\ T_p = 10.34,\ D = 119.7,\ \bar{D} = 278.4,$$
$$w = 1.32,\ p = 1,\ N_i = 89.9,\ N_s = 9.98,\ N_p = 0.99,\ K_i = 443.4,\ K_s = 56.1,$$
$$K_p = 5.45,\ F_i = 177,\ F_s = 19.24,\ F_p = 0.84,\ D_T = 0.92,\ a = 0.46,\ c_i = 0.75,$$
$$c_z = 0.18,\ c_s = 0.57. \qquad (23)$$

The eigen-values at the equilibrium point are {-0.26, 0.07} and the unique equilibrium point is unstable. The instability means cannot conduct the comparative statics analysis and the comparative dynamic analysis, effectively in the long-run, as the system will not move along a stable path, over time. The comparative dynamic analysis is conducted in the short-run, in the next section.

IV. Comparative Dynamic Analysis

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

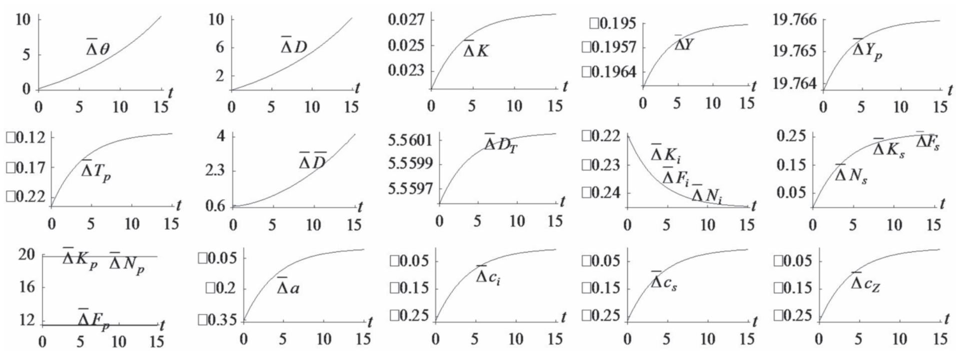

FIGURE 2

Rise in the Expenditure Ratio on Public Good

1. *Rise in the Expenditure Ratio on Public Goods*

First, the impact of change in expenditure ratio on public good: $\tau : 0.01 \Rightarrow 0.012$ is examined and the model is then simulated with Mathematica. Figure 2 plots the short-run effects on the economic system. The motion before the exogenous change takes place is provided in Figure 1 where new state is reflected in the change in per cent. As the economic system is unstable, it is not sustainable. The long-term movement of the economic system cannot be effectively followed. In fact, the debt will become extremely (negatively) large when the simulation period is longer than 50 per cent. In the rest of the paper the short-term motion of the system is illustrated. As the ratio increases, the debt and ratio of debt, and the national output are increased. The national economy employs slightly more capital, produces less, and borrows more from foreign economies. As the increased expenditure ratio enlarges the public sector, more tourists visit the country. The wage rate and price of services are not affected. The household has less wealth and reduces consumption of the three goods. There are also economic structural changes. The industrial sector shrinks and the service sector expands.

The effects on equilibrium point are listed as in (24) and can be seen that the effects on equilibrium point are different from the short-term effects. At the new equilibrium the government debt is reduced at the new equilibrium point, $D = (T_p - Y_p)/r^*$. As the expenditure rise, it's ratio reduces the tax income and expands the scale of public sector; thus the debt is reduced. Although, more foreigners tour the country, the household's wealth and consumption levels are not affected.

$$\bar{\Delta}\theta = -4.6,\ \bar{\Delta}K = 0.03,\ \bar{\Delta}Y = -0.2,\ \bar{\Delta}Y_p = 19.8,\ \bar{\Delta}T_p = -0.11,\ \bar{\Delta}D = -4.8,$$
$$\bar{\Delta}\bar{D} = -2,\ \bar{\Delta}w = 0,\ \bar{\Delta}p = 0,\ \bar{\Delta}N_i = -0.25,\ \bar{\Delta}N_s = 0.27,\ \bar{\Delta}N_p = 19.8,$$
$$\bar{\Delta}K_i = -0.25,\ \bar{\Delta}K_s = 0.27,\ \bar{\Delta}K_p = 19.8,\ \bar{\Delta}F_i = -0.25,\ \bar{\Delta}F_s = 0.27,$$
$$\bar{\Delta}F_p = 11.4,\ \bar{\Delta}D_T = 5.6,\ \bar{\Delta}a = \bar{\Delta}c_i = \bar{\Delta}c_z = \bar{\Delta}c_s = 0. \qquad (24)$$

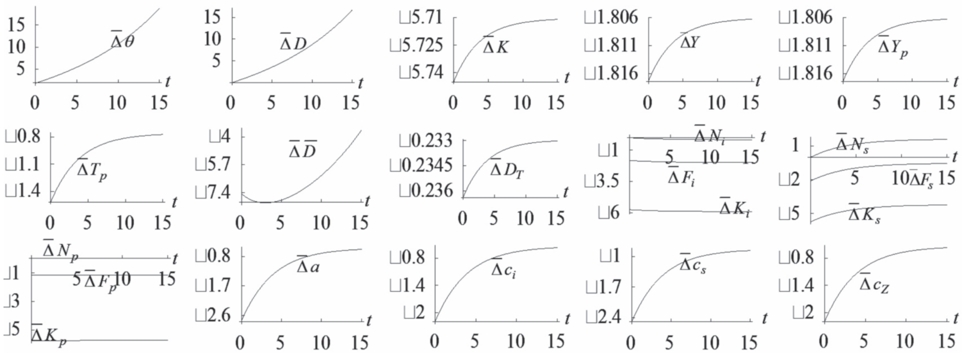

FIGURE 3

Rise in the Rate of Interest in Global Markets

2. Rise in the Rate of Interest in Global Markets

Now the rate of interest is allowed to be changed as $r^* = 0.07 \Rightarrow 0.075$. Changes are plotted in time-dependent variables in Figure 3. In response to the rising cost of capital the three sectors use less capital; and hey also produce less. Some of the labor force is shifted from the industrial sector to service sector. Capital stock employed by the national economy falls and the net consequence of reduced wage income and the increased rate of interest falls in the wealth. There are less foreign visitors and, the national output and expenditure on public goods fall. The house-holds consume less; and the government debt and ratio of debt to national output are increased.

The effects on the equilibrium point are given in (25).

$$\bar{\Delta}\theta = -5.44,\ \bar{\Delta}K = -5.71,\ \bar{\Delta}Y = -1.81,\ \bar{\Delta}Y_p = -1.81,\ \bar{\Delta}T_p = -0.76,\ \bar{\Delta}D = -7.15,$$
$$\bar{\Delta}\bar{D} = -12.8,\ \bar{\Delta}w = -1.82,\ \bar{\Delta}p = -0.3,\ \bar{\Delta}N_i = -1.6,\ \bar{\Delta}N_s = 1.6,\ \bar{\Delta}N_p = 0.1,$$
$$\bar{\Delta}K_i = -5.9,\ \bar{\Delta}K_s = -4.2,\ \bar{\Delta}K_p = -5.7,\ \bar{\Delta}F_i = -2,\ \bar{\Delta}F_s = -0.52,$$
$$\bar{\Delta}F_p = -1.17,\ \bar{\Delta}D_T = -0.23,\ \bar{\Delta}a = \bar{\Delta}c_i = \bar{\Delta}c_z = -0.53,\ \bar{\Delta}c_s = 0.83. \tag{25}$$

3. Rise in the Tax Rate on the Service Sector

The model of this study includes different tax income resources. As the model is developed in a general equilibrium framework, it is straightforward to analyze the effects of change in any tax rate on the national economy. The tax rate is then increased as: τ_s : $0.03 \Rightarrow 0.04$. Changes in the time-dependent variables are plotted in Figure 4. The public sector and service sector expands and the industrial sectors shrinks; the capital stock employed by national economy rises and the national output also rises. The government debt and national debt are reduced; and more tourists come to the country. The household owns less and also consumes less.

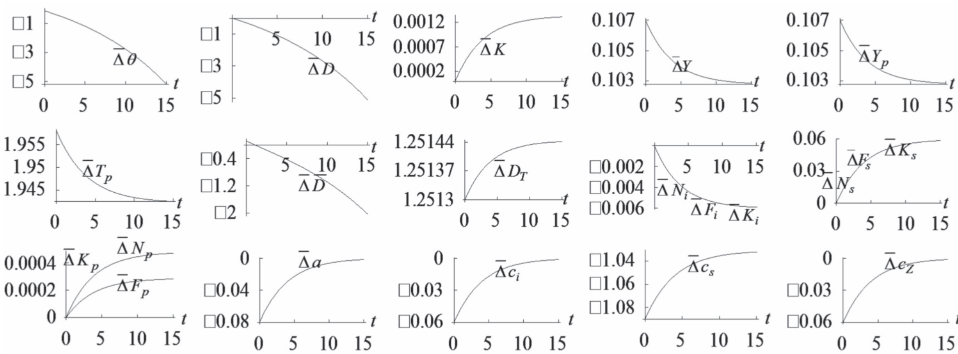

FIGURE 4

Rise in the Tax Rate on the Service Sector

The effects on equilibrium point are given in (26).

$$\bar{\Delta}\theta = 2.27,\ \bar{\Delta}K = 0.002,\ \bar{\Delta}Y = 0.1,\ \bar{\Delta}Y_p = 0.1,\ \bar{\Delta}T_p = 1.94,\ \bar{\Delta}D = 2.37,$$
$$\bar{\Delta}\bar{D} = 1.02,\ \bar{\Delta}w = 0,\ \bar{\Delta}p = 1.04,\ \bar{\Delta}N_i = -0.007,\ \bar{\Delta}N_s = 0.06,\ \bar{\Delta}N_p = 0.1,$$
$$\bar{\Delta}K_i = -0.007,\ \bar{\Delta}K_s = 0.06,\ \bar{\Delta}K_p = 0.1,\ \bar{\Delta}F_i = -0.007,\ \bar{\Delta}F_s = 0.06,$$
$$\bar{\Delta}F_p = 0.06,\ \bar{\Delta}D_T = 1.28,\ \bar{\Delta}a = \bar{\Delta}c_i = \bar{\Delta}c_z = 0,\ \bar{\Delta}c_s = -1.03. \quad (26)$$

4. The Price of Foreign Goods Rises

Now, to study on what happens to the economic system when price of foreign goods is increased; it can be seen that $p_z : 1 \Rightarrow 1.1$ and changes in time-dependent variables are plotted in Figure 5. The household consume less imported goods, though it has more wealth and consume the other two goods more. The government debt and

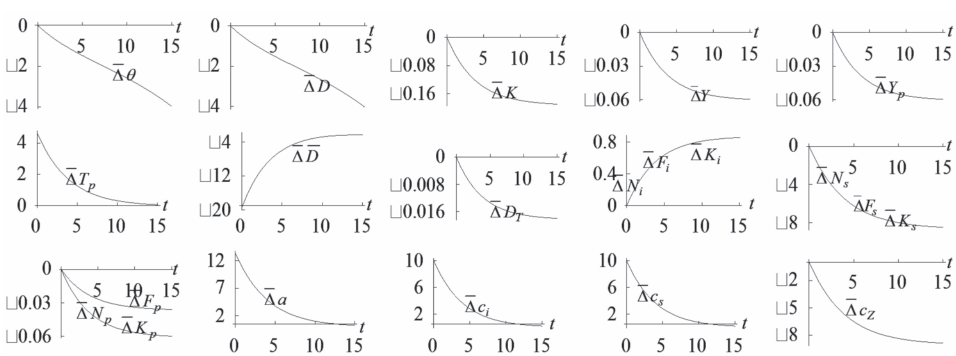

FIGURE 5

Price of Foreign Goods Rises

national debt falls and the industrial sector expands; but the other two sectors shrinks. The economy uses less capital and produces less. The tax income rises and the national expenditure on public goods falls. The result is that there are less tourists.

The effects on equilibrium point are given in (27).

$$\bar{\Delta}\theta = 0.03,\ \bar{\Delta}K = -0.19,\ \bar{\Delta}Y = -0.06,\ \bar{\Delta}Y_p = -0.06,\ \bar{\Delta}T_p = -0.04,\ \bar{\Delta}D = -0.03,$$
$$\bar{\Delta}\bar{D} = -0.36,\ \bar{\Delta}w = 0,\ \bar{\Delta}p = 0,\ \bar{\Delta}N_i = 0.88,\ \bar{\Delta}N_s = -8.7,\ \bar{\Delta}N_p = -0.06,$$
$$\bar{\Delta}K_i = 0.88,\ \bar{\Delta}K_s = -8.7,\ \bar{\Delta}K_p = -0.06,\ \bar{\Delta}F_i = 0.88,\ \bar{\Delta}F_s = -8.7,$$
$$\bar{\Delta}F_p = -0.04,\ \bar{\Delta}D_T = -0.02,\ \bar{\Delta}a = 0,\ \bar{\Delta}c_i = 0,\ \bar{\Delta}c_z = -9.09,\ \bar{\Delta}c_s = 0. \quad (27)$$

5. *The Propensity to Save Rises*

It can now be studied as to what happens to the economic system if price of foreign goods is increased, and $\lambda_0 : 0.9 \Rightarrow 0.91$. Changes in time-dependent variables are plotted in Figure 6. The household has more wealth and consumes more, the industrial sector shrinks slightly but the other two sectors expands, the government debt and national debt falls. The economy uses less capital and produces more. The tax income rises and the national expenditure on public goods falls.

The effects on equilibrium point are given in (28).

$$\bar{\Delta}\theta = 0.2,\ \bar{\Delta}K = 0.004,\ \bar{\Delta}Y = 0.001,\ \bar{\Delta}Y_p = 0.001,\ \bar{\Delta}T_p = 0.17,\ \bar{\Delta}D = 0.2,$$
$$\bar{\Delta}\bar{D} = -1.54,\ \bar{\Delta}w = 0,\ \bar{\Delta}p = 0,\ \bar{\Delta}N_i = -0.02,\ \bar{\Delta}N_s = 0.2,\ \bar{\Delta}N_p = 0.001,$$
$$\bar{\Delta}K_i = -0.02,\ \bar{\Delta}K_s = 0.2,\ \bar{\Delta}K_p = 0.001,\ \bar{\Delta}F_i = -0.02,\ \bar{\Delta}F_s = 0.2,$$
$$\bar{\Delta}F_p = 0.001,\ \bar{\Delta}D_T = 0.0004,\ \bar{\Delta}a = 1.3,\ \bar{\Delta}c_i = 0.2,\ \bar{\Delta}c_z = 0.2,\ \bar{\Delta}c_s = 0.2. \quad (28)$$

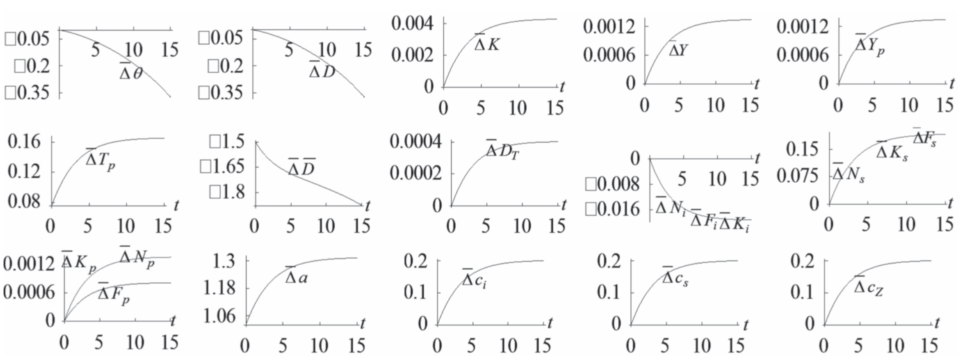

FIGURE 6

Propensity to Save Rises

V. Conclusion

This paper develops an economic growth model of a small open economy with government debt, tourism and imported goods in a perfectly competitive economy. The study focuses on effects of changes in preference; for imported goods, national expenditure on supplying public goods and different taxes on the dynamic paths of government debt, trade balance and economic growth. The national economy consists of three - industrial, service and public sectors. The assumption of small open economies implies that the rate of interest is fixed in the international market. The production side is based on the neoclassical growth theory. The household behavior is modelled according to Zhang's utility function. The nonlinear dynamic interaction is described between the economic structural change, capital accumulation and public debt, under different combinations of taxes on goods sector, the service sector, the wage income, rate of interest, consumption of goods, and the consumption of service. It simulates the model and demonstrate the system that has a unique unstable equilibrium point. The effect of changes in some parameters on behavior of the economic system is examined. The comparative dynamic analysis provides some important insights. It should be noted that the model is made with many strict assumptions which may extend and generalize it in different directions. For instance, it is important to study the economic dynamics when utility and production functions are taken on other functional forms. The government expenditure is a complicated issue. How much to spend on different public goods may depend not only on the national income, but also on the other factors. The possibilities of domestic households travel other countries are not considered. Monetary issues such as exchange rates and inflation policies are important for understanding the trade issues.

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APPENDIX

Proving the Lemma

From (2), the following equation is solved:

$$k_i = \left(\frac{\bar{\tau}_i \alpha_i A_i}{r_\delta} \right)^{1/\beta_i}, \; w = \bar{\tau}_i \beta_i A_i k_i^{\alpha_i}. \tag{A-1}$$

where, k_i and w are considered as functions of r^*.

From (4), we obtain: $$k_s = \frac{\alpha_\sigma w}{\beta_s r_\delta}, \quad p = \frac{w}{\bar{\tau}_s \beta_s A_s k_s^{\alpha_s}}. \tag{A-2}$$

It is determined that k_s and p are functions of r^*, which implies that they are time-independent, as shown in (20).From (8), we have,

$$k_p = \frac{\alpha_p w}{\beta r_\delta}, \tag{A-3}$$

where, $k_p = K_p/N_p$

Now, we insert (A-1) – (A-3) in (9) to obtain,

$$k_i N_1 + k_s N_s + k_p N_p = K. \tag{A-4}$$

Equations (A-4) and (9) will follow to,

$$N_i + k_1 N_s = k_0 K - k_n, \tag{A-5}$$

where, $$k_0 \equiv \frac{1}{k_i - k_p}, \; k_1 \equiv (k_s - k_p)\, k_0, \; k_n \equiv k_p k_0 N.$$

Equations (11) and (12), will have,

$$\hat{y} = \bar{\tau}_w w + (\bar{\tau}_a r^* + 1)\, a. \tag{A-6}$$

Inserting (A-6) in (14), we obtain

$$c_s = \frac{\gamma \overline{\tau}_w \, w + (\overline{\tau}_a \, r^* + 1) \, \gamma a.}{p}. \tag{A-7}$$

From Equations (1) and (3), the following equation is obtained,

$$F_i = A_i \, k_i^{\alpha_i} \, N_i, F_s = A_s \, k_s^{\alpha_s} \, N_s \tag{A-8}$$

Inserting (A-7) and (A-8) in (18), we obtain

$$\frac{\gamma \overline{\tau}_w \, Nw + (\overline{\tau}_a \, r^* + 1) \, N\gamma a}{p} + \bar{a} \, F_p^{\phi} \, p^{\phi} = A_s \, k_s^{\alpha_s} \, N_s \tag{A-9}$$

where (10) is used. From the definitions of k_i and k_s , we have

$$K_i = k_i \, N_i \, , K_s = k_s \, N_s \tag{A-10}$$

From (6), we have, $Y_p = \tau \, (F_i + pF_s)$ (A-11)

Inserting (A-8) in (A-11), we have

$$Y_p = \tau \, A_i \, k_i^{\alpha_i} \, N_i + \tau p \, A_s \, k_s^{\alpha_s} \, N_s. \tag{A-12}$$

From (A-8) and (A-12), we have

$$N_p = a_i \, N_i + a_s \, N_s, \tag{A-13}$$

where, $a_i \equiv \dfrac{\beta_p \, \tau \, A_i \, k_i^{\alpha_i}}{w}, \; a_s \equiv \dfrac{\beta_p \, \tau \, p \, A_s \, k_s^{\alpha_s}}{w}.$ (A–14)

Insert $k_p = K_p/N_p$ in (A-13)

$$K_p = k_p \, a_i \, N_i + K_p \, a_s \, N_s, \tag{A-15}$$

Add (A-10) and (A-15),

$$K = (k_i + k_p \, a_i) \, N_i + (k_s + k_p \, a_s) \, N_s, \tag{A-16}$$

where, we use(9).

Insert (A-16) in (A-5) $N_i = b_0 - bN_s$, (A-17)

where, $$b \equiv \frac{(k_s + k_p\, a_s)\, k_0 - k_1}{(k_i + k_p\, a_i)\, k_0 - 1}\ ,\ \ b_0 \equiv \frac{k_n}{(k_i + k_p\, a_i)\, k_0 - 1}$$

Using (18), $D_T = F_s - c_s\, N.$ (A-18)

It is noted that k_i, k_s, k_p, w and p are determined as functions of r^*. By the following procedure we can determine all other variables as functions of N_s :a by (A-18) → N_i by (A-17) → K by (A-16) → K_i and K_s by (A-10) → F_i and F_s by (A-8) → D_T by (18) → $\hat{y}$ by (A-6) → c, c_s, c_z, s by (14) → Y_p by (6) → K_p and N_p by (8) → K_p and N_p by (8).

From (A9) and this procedure, we solve

$$a = \Lambda(N_s) \equiv \frac{(A_s\, k_s^{\alpha_s}\, N_s - \bar{a}\, F_p^{\phi}\, p^{\phi}\,)\, p - \gamma \bar{\tau}_w\, Nw}{(\bar{\tau}_a\, r^* + 1)\, N\gamma} \tag{A-19}$$

From (15) and (17), we have

$$\dot{a}\, \Lambda_0\,(a) \equiv s - a, \tag{A-20}$$

$$\dot{D} = \Lambda_D\,(D,\, N_s) \equiv r^*\, D + U_p - T_p \tag{A-21}$$

Taking derivatives of (A-19) with respect to t

$$\dot{a} = \frac{d\Lambda}{dN_s}\, \dot{N}_s \tag{A-22}$$

From (A-20) and (A-22), we have

$$\dot{N}_s = \Lambda_N\,(N_s) \equiv \Lambda_0 \left(\frac{d\Lambda}{dN_s}\right)^{-1} \tag{A-23}$$

Thus the lemma is proved.