ECREG STUDIES
Vol. 13, No. 4, 2020
www.ers.edu.pl
PDF OPEN ACCESS
eISSN 2451-182X

sciendo

ECONOMIC AND REGIONAL STUDIES
STUDIA EKONOMICZNE I REGIONALNE

ISSN 2083-3725 Volume 13, No. 4, 2020

Authors' contribution/ Wkład autorów:
A. Study design/ Zaplanowanie badań
B. Data collection/ Zebranie danych
C. Statistical analysis/ Analiza statystyczna
D. Data interpretation/ Interpretacja danych/
E. Manuscript preparation/ Przygotowanie tekstu
F. Literature search/ Opracowanie piśmiennictwa
G. Funds collection/ Pozyskanie funduszy

ECONOMIC DEVELOPMENT AND INTERNATIONAL AND INTERREGIONAL TOURISM

ROZWÓJ GOSPODARCZY A TURYSTYKA MIĘDZYNARODOWA I MIĘDZYREGIONALNA

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Zhang, W.B. (2020). Economic development and international and interregional tourism/ Rozwój gospodarczy a turystyka międzynarodowa i międzyregionalna. *Economic and Regional Studies, 13*(4), 375-387. https://doi.org/10.2478/ers-2020-0028

ORIGINAL ARTICLE

JEL code: Z32, O41

Submitted:
October 2020

Accepted:
October 2020

Tables: 0
Figures: 8
References: 36

Summary

Subject and purpose of work: Tourism was the fastest growing industry until the outbreak of Covid-2019. Nevertheless, there are a few studies on how the industry interacts with the rest of economies within a comprehensive analytical framework. The main concern of this study is how international and interregional tourism interacts with national economic development and economic structural change. Tourism and economic growth are investigated in a multi-regional small open economy which is perfectly competitive.
Materials and methods: National economy consists of multiple regions and each region has three sectors: industry, service, and housing. Production side is the same as in the neoclassical growth theory. Households move freely between regions, equalizing utility level between regions by selecting housing, goods, tourism, and saving. A region's amenity is endogenously related to the region's population.
Results: We explicitly solve the dynamics of the multi-regional economy. The system has a unique stable equilibrium point.
Conclusions: We simulate the motion of the model and examine the effects of changes in the rate of interest, foreigners' preference for visiting a region, a region 's total productivity of the service sector, domestic consumers' preference for visiting a region, as well as the propensity to save, the propensity to consume regional services and housing.

Keywords: interregional trade, international tourism, services, growth, wealth accumulation

ORYGINALNY ARTYKUŁ NAUKOWY

Klasyfikacja JEL: Z32, O41

Zgłoszony:
październik 2020

Zaakceptowany:
październik 2020

Tabele: 0
Rysunki: 8
Literatura: 36

Streszczenie

Przedmiot i cel pracy: Turystyka jest najszybciej rozwijającą się branżą do czasu Covid-2019. Niemniej jednak istnieje kilka badań dotyczących interakcji branży z pozostałymi gospodarkami w ramach kompleksowych ram analitycznych. Głównym przedmiotem zainteresowania tego badania jest interakcja turystyki międzynarodowej i międzyregionalnej z krajowym rozwojem gospodarczym i zmianami strukturalnymi w gospodarce. Badamy turystykę i wzrost gospodarczy w wieloregionalnej, małej, otwartej gospodarce, która jest doskonale konkurencyjna. **Materiały i metody:** Gospodarka narodowa składa się z wielu regionów, a każdy region ma trzy sektory - przemysłowy, usługowy i mieszkaniowy. Strona produkcyjna jest taka sama jak w neoklasycznej teorii wzrostu. Gospodarstwa domowe swobodnie przemieszczają się między regionami, wyrównując poziom użyteczności między regionami, wybierając mieszkanie, towary, wycieczki i oszczędzanie. Udogodnienia regionu są endogenicznie związane z populacją regionu. **Wyniki:** Wyraźnie rozwiązujemy dynamikę gospodarki multiregionalnej. System posiada unikalny stabilny punkt równowagi. **Wnioski:** Symulujemy ruch modelu i badamy skutki zmian stopy procentowej, preferencji obcokrajowców do zwiedzania regionu, całkowitej produktywności sektora usług w regionie, preferencji krajowych konsumentów do zwiedzania regionu, skłonności do oszczędzania, skłonności do korzystania z usług regionalnych oraz do konsumpcji mieszkań.

Słowa kluczowe: handel międzyregionalny, turystyka międzynarodowa, usługi, wzrost gospodarczy, akumulacja bogactwa

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Journal indexed in/ Czasopismo indeksowane w: AgEcon Search; AGRO; Arianta; Baidu Scholar; BazEkon; Cabell's Whitelist; CNKI Scholar; CNPIEC – cnpLINKer; EBSCO Discovery Service; EBSCO-CEEAS; EuroPub; Google Scholar; Index Copernicus ICV 2017-2019: 100,00; J-Gate; KESLI-NDSL; MyScienceWork; Naver Academic; Naviga (Softweco); POL-index; Polish Ministry of Science and Higher Education 2015-2018: 9 points; Primo Central; QOAM; ReadCube; Semantic Scholar; Summon (ProQuest); TDNet; WanFang Data; WorldCat.

Introduction

Tourism is the fastest growth industry until the Covid-2019 occurred. Nevertheless, there are a few studies on how the industry interacts with the rest of economies within a comprehensive analytical framework. For instance, one may ask about interdependence between wealth accumulation, tourism, economic structural change, and technological changes. This study examines dynamic interactions between economic growth, economic change, international tourism, interregional tourism, and trade in a perfectively competitive environment. The model is a synthesis of a few approaches in economic theories. A main concern of this study is how international and interregional tourism interacts with national economic development and economic structural change. Tourism is different from what is called tradable goods in traditional trade theory. Tourism goods are not-tradable in the traditional trade theory as one has to travel to the location in order to consume them. Through international and interregional tourism non-traded goods become tradable ones. Moreover, tourism uses national resources such as labor and capital 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 (e.g., Sinclair and Stabler, 1997; Luzzi and Flückiger, 2003; Dritsakis, 2004; Durbarry, 2004; Briedenhann and Wickens, 2004; Katircioglu, 2009; Hazari and Lin, 2011; and Ridderstaat, *et al.*, 2014). Chao *et al.* (2009) demonstrates that most of these economic studies of tourism are conducted within static frameworks (see also, Zeng and Zhu, 2011; Corden and Neary, 1982; Copeland, 1991). 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 tries to introduce tourism to growth theory with endogenous wealth in a multi-regional equilibrium framework. It should be noted that in the literature of tourism economics, almost all the models are built within a small open economic framework (e.g., Zeng and Zhu, 2011). 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; Gali and Monacelli, 2005; Uya, *et al*. 2013; and Ilzetzki, *et al*. 2013). We follow this tradition in dealing with dynamic interdependence between economic structural change, public goods, tourism, and wealth accumulation.

According to Fujita and Thisse (2002: 389), "Clearly, space and time are intrinsically mixed in the process of economic development. However, the study of their interaction is a formidable task. … Not surprisingly, therefore, the field is still in its infancy, and relevant contributions have been few." This statement is still true as there are many interactions over time and space which are not analyzed in an integrated framework with microeconomic foundation. In fact interregional aspects of economics had been largely neglected in (mainstreams of) economics until new economic geography has recently obtained much attention. Although many papers and books have been recently published in the field of economic geography, almost all these works have neglected wealth accumulation. Obviously, capital accumulation and capital and labor mobility are important variables for explaining spatial dynamics. As pointed out by Baldwin and Martin (2004: 2675-6), "Many of the most popular economic geography models focus on labor (…) These are unsuited to the study of growth." Capital accumulation is seldom modeled with land use pattern and land markets in the literature of geographical economics. Wealth concentration and clustering of people into a single metropolitan area should be explained in an integrated analytical framework. This study develops a general equilibrium framework with multiple regions, interregional tourism and capital accumulation under perfect competition. The growth mechanism of this study is based on the neoclassical growth model (Solow, 1956). This study attempts to extend neoclassical growth theory with capital accumulation to a multi-regional economy with interregional tourism. Moreover, our study is limited to a small open economy with economic geography. There are some economic models which deal with growth and capital accumulation of small open economies (e.g., Obstfeld and Rogoff, 1999). The paper is a synthesis of three models recently proposed by Zhang (2007, 2012, and 2015). None of these models takes account of international and interregional tourism. 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.

The multi-regional growth model with tourism

This section develops a small-open three-sector growth model with endogenous wealth and interregional and foreign tourism. We consider that the open economy can import goods and borrow resources from the rest of the world or exports goods and lend resources abroad. Our model is an integration of the basic features of a few well-known models in the literature of economic growth (Oniki and Uzawa, 1965; Deardorff, 1973; Ruffin, 1979; Findlay, 1984; Eaton, 1987; Brecher *et al*., 2002; and Sorger, 2003). They include the Solow growth model, the Uzawa two-sector growth model, small-open economic growth literature, 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), we consider the economy produces housing and two goods: an internationally traded good (called industrial good) and a non-traded good (called services). This study extends the traditional model by taking account of interregional and international tourism. We assume that foreign tourists can visit any region and consume only services. We assume that the economy is too small to affect the interest rate in the world market. The rate of interest, *i,s* is fixed in international market. Capital depreciates at a constant exponential rate, δ_{kj}. Land is only for residential use. Technologies of the production sectors are described by the Cobb-Douglas production functions. All markets are perfectly competitive and capital and labor are completely mobile between the industrial and service 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. A person is free to choose his residential location. We assume that any person chooses the same region where he works and lives. Each region has fixed land. Land quality, climates, and environment are homogenous within each region, but they vary between regions. We neglect transportation cost of commodities between and within regions. As becomes evident late on, although it is conceptually not difficult to introduce transportation cost function and to provide balance conditions for demand and supply and for price equalization conditions with transportation cost, the problem will become analytically too complicated. The assumption of zero transportation cost of commodities implies price equality for the commodity among regions. As amenity and land are immobile, wage rates and land rent may not be equal among regions.

Let N stand for the given population of the economy. Domestic households consume both industrial goods and services, 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. 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 $j = 1, ..., J$. Each region has a fixed land, L_j ($j = 1, ..., J$). Let $K_j(t)$ and $\bar{K}_j(t)$ stand for respectively the capital stocks employed and the wealth owned by region j. We use subscripts, *i,s*, to denote the industrial and services sectors, respectively. Capital is both internationally and domestically completely mobile. Services are region-specified and are consumed simultaneously as they are produced. We denote wage rates by $w_j(t)$ in the th region. 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

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

We use $p_j(t)$ to stand for region 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 to maximize its profit. The marginal conditions are given by

$$r^* + \delta_{kj} = \frac{\alpha_{ij} \, F_{ij}(t)}{K_{ij}(t)} = \frac{\alpha_{sj} \, p_j(t) \, F_{sj}(t)}{K_{sj}(t)}, \quad (2)$$

$$w_j(t) = \frac{\beta_{ji} \, F_{ij}(t)}{N_{ij}(t)} = \frac{\beta_{sj} \, p_j(t) \, F_{sj}(t)}{N_{sj}(t)}, \quad (3)$$

where δ_{kj} are the depreciation rate of physical capital in region j. It should be noted that there is a rapidly increasing literature on identifying the factors that affect the location choice of firms. In this model for simplicity we neglect many other factors such as institutions and taxation which affect firms' behavior.

The current and disposable incomes

Each worker may get income from land ownership, wealth ownership and wages. To simplify the model, we accept the assumption of "absentee landownership" which means that the income of land rent is spent outside the economic system. Households rent the land in competitive market and the government uses the income for military or other public purposes. Consumers make decisions on choice of lot size, consumption levels of services and commodities as well as on how much to save. Different from the optimal growth theory in which utility defined over future consumption streams is used, we do not explicitly specify how consumers depreciate future utility resulted from consuming goods and services. This study uses the approach to consumers' behavior proposed by Zhang (1993). Let $\bar{k}_j(t)$ stand for the wealth owned by a household in region j. The household in region obtains income

$$y_j(t) = r^* \, \bar{k}_j(t) + w_j(t), j = 1, \cdots, J, \quad (4)$$

from the interest payment, $r^*\bar{k}_j(t)$ We call y_j the current income in the sense that it comes from consumers' wages and consumers' current earnings from ownership of wealth. The sum of income that consumers are using for consuming, saving, or transferring 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 region. The total value of wealth that the representative household of region j can sell to purchase goods and to save is equal to $\bar{k}_j(t)$. Here, we assume that selling and buying wealth can be conducted instantaneously without any transaction cost. The disposable income is equal to

$$\hat{y}_j(t) = y_j(t) + \bar{k}_j(t). \quad (5)$$

The disposable income is used for saving and consumption. It should be noted that the variable, $\bar{k}_j(t)$ in equation (5) is considered as a flow variable, just like the income, $y_j(t)$. Under the assumption that selling wealth can be conducted instantaneously without any transaction cost, we may consider $\bar{k}_j(t)$ 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 $\hat{y}_j(t)$ to distribute between consuming and saving. It should also be remarked that in the growth literature, for instance, in the Solow model, the saving is out of the current income $y_j(t)$ while in this study saving is out of the disposable income.

The budgets and optimal behavior

At each point of time, a consumer distributes the total available budget between housing, $l_j(t)$ saving, $s_j(t)$ consumption of goods, $c_{ij}(t)$ consumption of services, $c_{sj}(t)$ and tourist consumption in region $q, c_{ij}(t)$ The total cost for touring the country is

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

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

$$R_j(t)l_j(t) + p_j(t)c_{sj}(t) + c_{ij}(t) + s_j(t) + + \sum_{q,q\neq j}^{J} p_q(t)d_{jq}(t) = \hat{y}_j(t), \quad (6)$$

where $d_{jq}(t) = \bar{c}_{jq}(t)\bar{d}_{jq}(t)$ and

$$\hat{y}_j(t) \equiv r^* \bar{k}_j(t) + w_j + \bar{k}_j(t).$$

A consumer decides how much to consume housing, to consume, to travel, and to save. Equation (6) means that consumption and savings exhaust the consumers' disposable personal income.

We assume that the utility level $U_j(t)$ that the consumers obtain is dependent on the consumption levels of commodity and services, traveling, and saving. The utility level of the consumer in region j is specified as follows

$$U_j(t) = \theta_j(t)\, l_j^{\eta_0}(t)\, c_{ij}^{\xi_0}(t)\, c_{sj}^{\gamma_0}(t)\, s_j^{\lambda_0}(t) \prod_{q\rightleftarrows\rightleftarrows\neq j}^{J} d_{jq}^{\varepsilon_{0q}}(t),$$

$$\eta_0, \xi_0, \gamma_0, \lambda_0 > 0, \varepsilon_{0q} \geq 0, \quad (7)$$

where $\theta_j(t)$ is called region j's amenity level. Maximizing U_j subject to budget (6) yields

$$R_j(t)\, l_j(t) = \eta_j \hat{y}_j(t), c_{ij}(t) = \xi_j \hat{y}_j(t),$$

$$p_j(t)c_{sj}(t) = \gamma_j \hat{y}_j(t), s_j(t) = \lambda_j \hat{y}_j(t),$$

$$p_q(t)\, d_{jq}(t) = \varepsilon_{jq} \hat{y}_j(t), q \neq j, j, q = 1, \ldots. J, \quad (8)$$

where

$$\eta_j \equiv \rho_j\, \eta_0, \xi_j \equiv \rho_j\, \xi_0, \gamma_j \equiv \rho_j\, \gamma_0, \lambda_j \equiv \rho_j\, \lambda_0, \varepsilon_{jq} \equiv \equiv \rho_j\, \varepsilon_{0q}, \rho_j \equiv \frac{1}{\xi_0 + \gamma_0 + \lambda_0 + \sum_{q\neq j}^{J} \varepsilon_{0q}}.$$

The above equations mean that the service consumption, consumption of the good and saving are positively proportional to the available income.

The regional amenities

The concept of amenity measures a region's attractiveness for households. Amenities are affected by infrastructures, regional cultures and climates. People cluster together for different reasons. As argued by Glaeser *et al.* (2001), consumption amenities have increasingly played more important role in economic geography. In this study, we incorporate amenity into the consumer location decision by assuming that amenity is an endogenous variable. In this study, we assume that amenity is affected by population. We specify θ_j as follows

$$\theta_j(t) = \bar{\theta}_j N_j^b(t), j = 1, \cdots, J, \quad (9)$$

where $\bar{\theta}_j(> 0)$ and b are parameters. We don't specify sign of b as the population may have either positive or negative effects on regional attractiveness.

The foreign tourists' demand

Schubert and Brida (2009) use an iso-elastic tourism demand function as follows: $D_T(t) = a y_f^{\varphi}(t) p^{-\varepsilon}(t)$ where $y_f(t)$ denotes the disposable income of foreign countries, φ and ε are respectively the income and price elasticities of tourism demand. We specify the tourism demand function $D_j(t)$ for region j as follows

$$D_j(t) = a_j p_j^{-\varepsilon_j}(t), \quad (10)$$

where a_j and ε_j are parameters.

Wealth accumulation

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

$$\dot{\bar{k}}_j(t) = s_j(t) - \bar{k}_j(t). \quad (11)$$

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

Equalization of utility levels

As households are assumed to be freely mobile among the regions, it is reasonable to consider that households migrate where utility is higher. Under the assumptions that households can move freely and rapidly, the utility level of people should be equal, irrespective of in which region they live, i.e.

$$U_j(t) = U_m(t), j, m = 1, \cdots, J. \quad (12)$$

We neglect possible costs for migration.

Equilibrium conditions for national consumer goods

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

$$N_j(t)c_{sj}(t) + \sum_{q\neq j}^{J} d_{qj}(t)N_q(t) + D_j(t) = F_{sj}(t). \quad (13)$$

Full employment of regional resources

The total capital stocks employed by the region is equal to the sum of the capital stocks employed by the two sectors

$$K_{ij}(t) + K_{sj}(t) = K_j(t), j = 1, \cdots, J. \quad (14)$$

The labor is fully employed in each region

$$N_{ij}(t) + N_{sj}(t) = N_j(t), j = 1, \cdots, J. \quad (15)$$

Land is fully used

$$l_j(t)\, N_j(t) = L_j, j = 1, \cdots, J. \quad (16)$$

National resources being fulling employed

The total capital stock employed by the economy is equal to the sum of the capital stocks employed by all the regions. That is

$$K(t) = \sum_{j=1}^{J} K_j(t). \quad (17)$$

The total wealth of the national economy is the sum of the wealth owned by all the households

$$\bar{K}(t) = \sum_{j=1}^{J} \bar{k}_j(t)\, N_j(t). \quad (18)$$

Labor force is fully employed

$$\sum_{j=1}^{J} N_j(t) = N. \quad (19)$$

Trade balances

We introduce $B(t) = \hat{K}_j(t) - K(t)$ as the value of the economy's net foreign assets at *t*. The income from the net foreign assets, $E(t)$ which may be either positive, zero, or negative, is equal to $r^* B_j(t)$ We have:

$$E(t) = r^*\, B(t). \quad (20)$$

We have thus built the multi-regional model of a small open economy with capital accumulation and interregional and interregional tourism.

The Dynamics of the National Economy

Multi-regional dynamics system is seemingly complicated. Nevertheless, its motion is given by a set of (unconnected) linear differential equations. The following lemma, which is proved in the appendix, shows how we can determine the motion of all the variables in the dynamic system.

Lemma

The variables, w_j, p_j and D_j are uniquely determined as functions of r^*. The motion of per-capita wealth is given by

$$\bar{k}_j(t) = \left(\bar{k}_j(0) - \frac{\lambda_j\, w_j}{\bar{\lambda}_j}\right) e^{-\bar{\lambda}_j t} + \frac{\lambda_j\, w_j}{\bar{\lambda}_j}, j = 1, \cdots, J, \quad (21)$$

in which are parameters defined in the appendix. The other variables are uniquely determined by the following procedure: $\hat{y}_j(t)$ by (A5) → $c_{ij}(t)$, $s_j(t)$ and $d_{jq}(t)$ by (8) → $N_j(t)$ by (A12) → $l_j(t) = L_j/N_j(t)$ → $R_j(t)$ by (8) → $N_{sj}(t)$ by (A13) → $N_{ij}(t)$ by (A14) → $K_{sj}(t) = N_{sj}(t)k_{sj}$ → $K_{ij}(t)$ → $N_{ij}(t)k_{ij}$ → $K_j(t) = K_{ij}(t) + K_{sj}(t)$ → $F_{qj}(t)$ by the definitions → $\bar{K}_j(t) = \bar{k}_j(t)N_j(t)$ → $\bar{K}(t)$ by (18) → $K(t)$ by (17) → $\bar{K}_j(t) = \bar{k}_j(t)N_j(t)$ → $B(t) = \hat{K}(t) - K(t)$.

The dynamic system has a unique equilibrium point and the equilibrium point is stable as $\bar{\lambda}_j > 0$. As we have explicitly solved the model, it is straightforward to analyze the behavior of the model. For clear illustration, we simulate the model. We specify the parameter values as follows

$$r^* = 0.05, N = 100, \alpha_{ij} = 0.33, b = 0.08, \lambda_0 = 0.7,$$

$$\gamma_0 = 0.05, \eta_0 = 0.07, \xi_0 = 0.1, \varepsilon_j = 0.5, \delta_{kj} = 0.05,$$

$$\begin{pmatrix} A_{i1} \\ A_{i2} \\ A_{i3} \end{pmatrix} = \begin{pmatrix} 1 \\ 0.95 \\ 0.9 \end{pmatrix}, \begin{pmatrix} A_{s1} \\ A_{s2} \\ A_{s3} \end{pmatrix} = \begin{pmatrix} 1.1 \\ 0.9 \\ 0.9 \end{pmatrix}, \begin{pmatrix} \bar{\theta}_1 \\ \bar{\theta}_2 \\ \bar{\theta}_3 \end{pmatrix} = \begin{pmatrix} 3.5 \\ 4.2 \\ 5.1 \end{pmatrix},$$

$$\begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix} = \begin{pmatrix} 2 \\ 3 \\ 10 \end{pmatrix}, \begin{pmatrix} L_1 \\ L_2 \\ L_3 \end{pmatrix} = \begin{pmatrix} 6 \\ 13 \\ 20 \end{pmatrix},$$

$$\begin{pmatrix} \alpha_{s1} \\ \alpha_{s2} \\ \alpha_{s3} \end{pmatrix} = \begin{pmatrix} 0.33 \\ 0.32 \\ 0.36 \end{pmatrix}, \begin{pmatrix} \varepsilon_{01} \\ \varepsilon_{02} \\ \varepsilon_{03} \end{pmatrix} = \begin{pmatrix} 0.002 \\ 0.004 \\ 0.009 \end{pmatrix}. \quad (22)$$

The rate of interest is fixed at 5 per cent and the population is 100. Region 1 has the highest level of productivity. Region 2's level of productivity is the second, next to region 1's. It should be remarked that although the specified values are not based on empirical observations, the choice does not seem to be unrealistic. We specify α_{ij} and α_{sj} near 0.3. With regard to the technological parameters, what are important in our interregional study are their relative values. This is similarly true for the specified differences in land and amenity parameters among regions. The domestic consumer has a stronger preference for touring region 3 than for the other two regions. The foreign tourist also has a stronger preference for touring region 3 than for the other two regions. To simulate the model we specify the initial conditions as follows

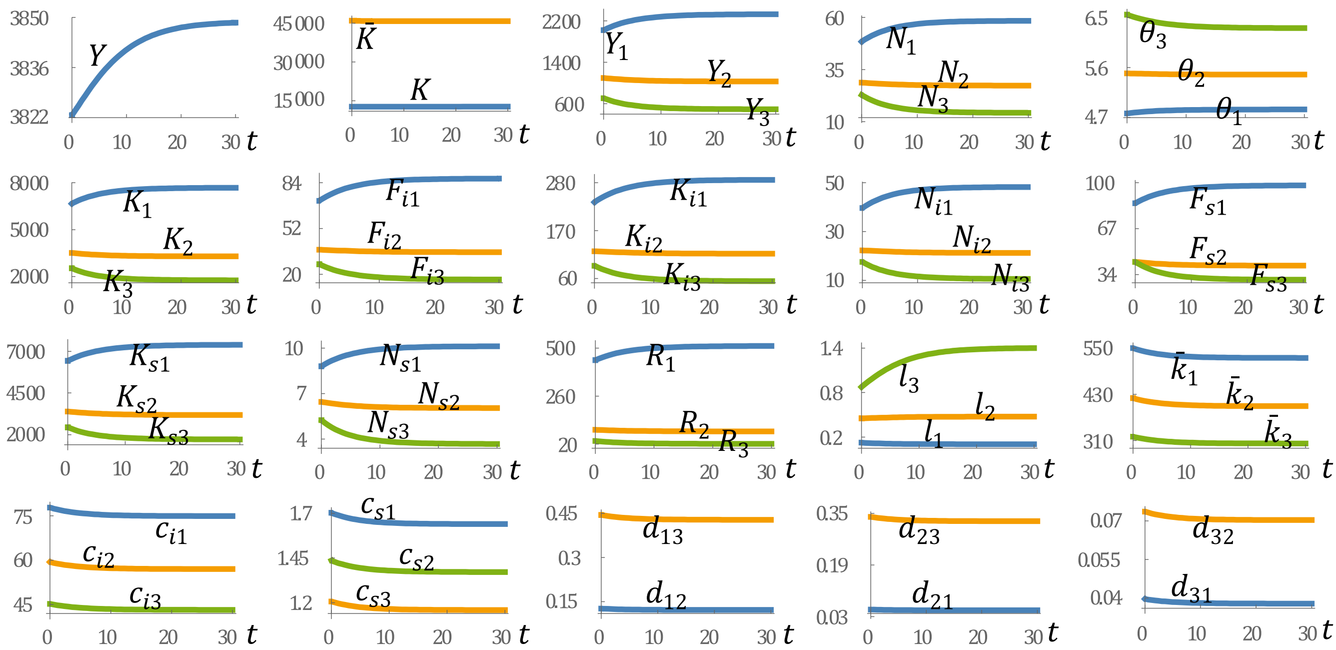

Figure 1. The Motion of the National Economy

$$\bar{k}_1(0) = 550, \bar{k}_2(0) = 420, \bar{k}_3(0) = 320.$$

The motion is plotted in Figure 1. We see that the variables tend to become stationary.

The initial values of the per-capita wealth $\bar{k}_j(0)$ are higher than their equilibrium values. Figure 1 shows that the wealth levels and consumption levels of the households in all the regions fall over time. The national wealth is higher than the physical capital employed by the economy. Region 1's (2's) total output is higher than region 2's (3's). Region 1 attracts more people from the other two regions. The consumer from region 1 travels to region 3 more than region 2. The motion of the other variables is also plotted in Figure 1. The equilibrium values are listed as $Y = 3784$, $K = 12568$, $\bar{k} = 44949$,

$$\begin{pmatrix} Y_1 \\ Y_2 \\ Y_3 \end{pmatrix} = \begin{pmatrix} 2195 \\ 979 \\ 609 \end{pmatrix}, \begin{pmatrix} K_1 \\ K_2 \\ K_3 \end{pmatrix} = \begin{pmatrix} 7244.7 \\ 3136.9 \\ 2186.7 \end{pmatrix}, \begin{pmatrix} F_{i1} \\ F_{i2} \\ F_{i3} \end{pmatrix} = \begin{pmatrix} 81.7 \\ 33.3 \\ 22.8 \end{pmatrix},$$

$$\begin{pmatrix} K_{i1} \\ K_{i2} \\ K_{i3} \end{pmatrix} = \begin{pmatrix} 269.7 \\ 109.8 \\ 75.2 \end{pmatrix}, \begin{pmatrix} N_{i1} \\ N_{i2} \\ N_{i3} \end{pmatrix} = \begin{pmatrix} 45.4 \\ 20 \\ 14.8 \end{pmatrix}, \begin{pmatrix} F_{s1} \\ F_{s2} \\ F_{s3} \end{pmatrix} = \begin{pmatrix} 92.5 \\ 38.5 \\ 37.2 \end{pmatrix},$$

$$\begin{pmatrix} K_{s1} \\ K_{s2} \\ K_{s3} \end{pmatrix} = \begin{pmatrix} 6875 \\ 3027 \\ 2112 \end{pmatrix}, \begin{pmatrix} N_{s1} \\ N_{s2} \\ N_{s3} \end{pmatrix} = \begin{pmatrix} 9.55 \\ 5.76 \\ 4.53 \end{pmatrix}, \begin{pmatrix} D_1 \\ D_2 \\ D_3 \end{pmatrix} = \begin{pmatrix} 0.42 \\ 0.61 \\ 2.52 \end{pmatrix},$$

$$\begin{pmatrix} \theta_1 \\ \theta_2 \\ \theta_3 \end{pmatrix} = \begin{pmatrix} 4.82 \\ 5.45 \\ 6.46 \end{pmatrix}, \begin{pmatrix} R_1 \\ R_2 \\ R_3 \end{pmatrix} = \begin{pmatrix} 480.2 \\ 78.9 \\ 29.4 \end{pmatrix}, \begin{pmatrix} p_1 \\ p_2 \\ p_3 \end{pmatrix} = \begin{pmatrix} 22.8 \\ 24.6 \\ 15.8 \end{pmatrix},$$

$$\begin{pmatrix} w_1 \\ w_2 \\ w_3 \end{pmatrix} = \begin{pmatrix} 148.3 \\ 111.7 \\ 82.9 \end{pmatrix}, \begin{pmatrix} \bar{k}_1 \\ \bar{k}_2 \\ \bar{k}_3 \end{pmatrix} = \begin{pmatrix} 524.4 \\ 399.1 \\ 303.8 \end{pmatrix}, \begin{pmatrix} l_1 \\ l_2 \\ l_3 \end{pmatrix} = \begin{pmatrix} 0.11 \\ 0.51 \\ 1.03 \end{pmatrix},$$

$$\begin{pmatrix} c_{i1} \\ c_{i2} \\ c_{i3} \end{pmatrix} = \begin{pmatrix} 74.9 \\ 57 \\ 43.4 \end{pmatrix}, \begin{pmatrix} c_{s1} \\ c_{s2} \\ c_{s3} \end{pmatrix} = \begin{pmatrix} 1.6 \\ 1.2 \\ 1.4 \end{pmatrix},$$

$$\begin{pmatrix} d_{12} \\ d_{13} \\ d_{21} \end{pmatrix} = \begin{pmatrix} 0.12 \\ 0.43 \\ 0.5 \end{pmatrix}, \begin{pmatrix} d_{23} \\ d_{31} \\ d_{32} \end{pmatrix} = \begin{pmatrix} 0.33 \\ 0.04 \\ 0.07 \end{pmatrix}. \quad (23)$$

Comparative Dynamic Analysis

We plotted the motion of the economic system in the previous section. This section conducts comparative dynamic analysis, demonstrating how a change in the parameter alternates paths of the economic growth. As we can describe the motion of the system for any set of parameters, it is straightforward to make comparative dynamic analysis. This study uses the variable, $\Delta x(t)$ to represent the change rate of the variable, $x(t)$ in percentage due to a given change in the parameter value.

A rise in the rate of interest

First, we examine what will happen to the motion of the economic variables if the rate of interest is changed as follows: $r^*: 0.05 \Rightarrow 0.06$, where "⇒" stands for "being changed to". As the cost of capital in global markets is increased, the time-independent variables are affected

$$\Delta p_1 = -12.3, \Delta p_2 = -12.6, \Delta p_3 = -11.6, \Delta D_1 = 6.8,$$
$$\Delta D_2 = 7, \Delta D_3 = 6.4, \Delta w_j = -19.8.$$

The prices and wage rates in all the regions are reduced. The tourists of all the regions are increased. The impacts on the time-dependent variables are plotted in Figure 2. Each region employs less capital stock. The national economy employs less capital and has lower national income. Each region also produces less. Both region 2 and region 3 attract more people

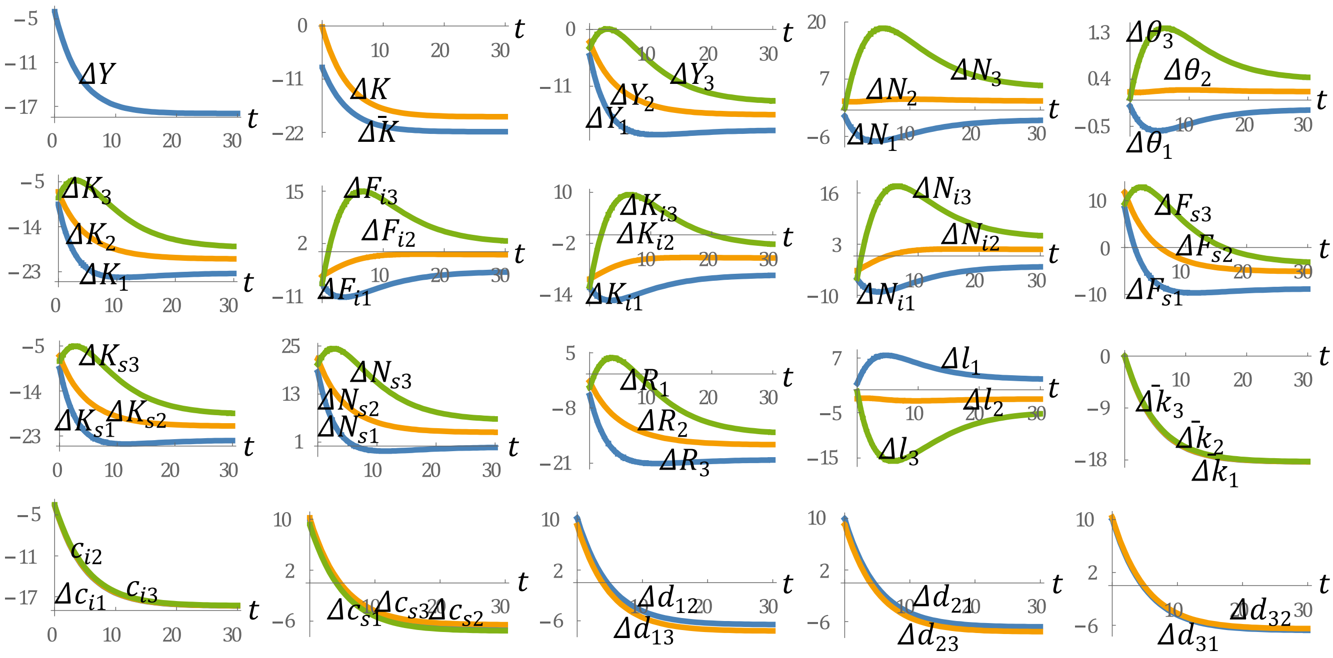

Figure 2. A Rise in the Rate of Interest

from region 1. The amenities are enhanced in the regions with more people and the amenity is lowered in the region with falling population. The lot sizes in region 2 and region 3 are reduced and the lot size in region 1 is reduced. The land rents in region 2 and region 3 are lowered. The land rent in region 1 is augmented initially and reduced in the long term. People travel more initially and travel less in the long term. All the consumers have less wealth and consume less industrial goods. They consume more services initially and less in the long term. All the regions reduce the output levels of the industrial sectors initially; region 1 reduces the output level in the long term and other two regions augment the output levels. All the sectors use less capital stock in the long term. The service sectors of all the regions produce less in the long term.

Foreigners' preference for touring region 3 being enhanced

We now study the impact of the following change in foreigners' preference for region 3: a_3: $10 \Rightarrow 12$ The time-independent variables are affected as follows

$$\Delta p_j = \Delta w_j = \Delta D_1 = \Delta D_2 = 0, \Delta D_3 = 20.$$

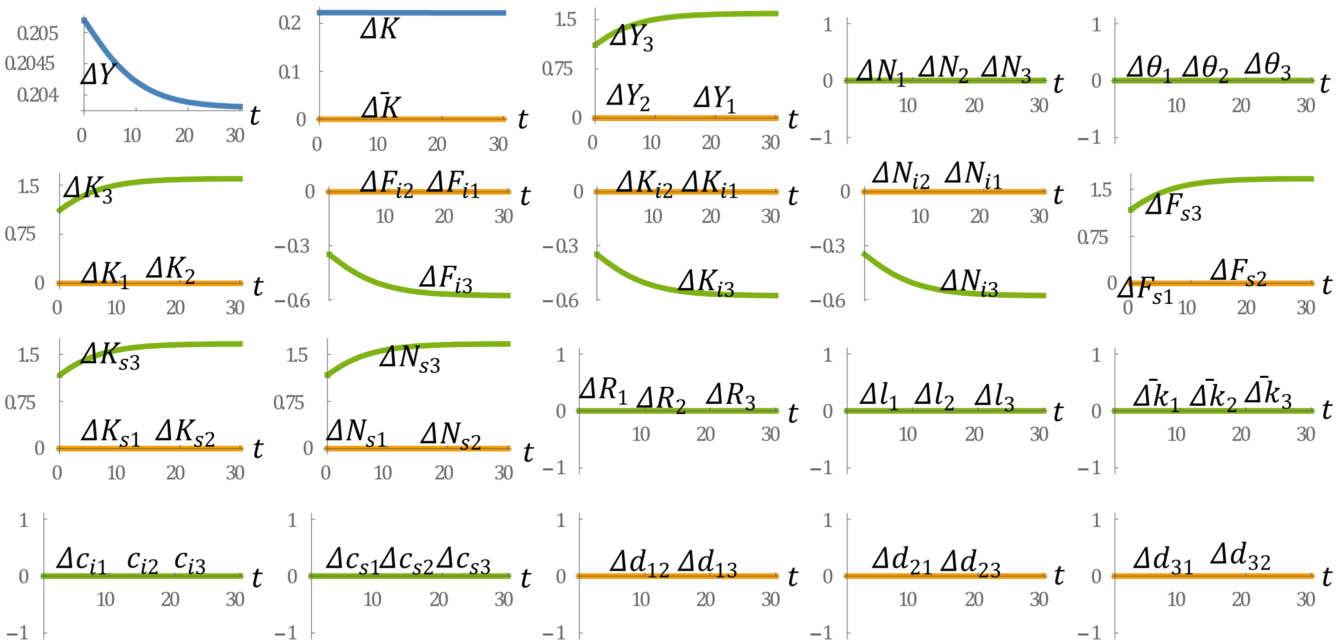

Figure 3. Foreigners' Preference for Touring Region 3 Being Enhanced

The prices and wage rates in all the regions are not affected. Region 3's number of foreign tourists is increased 20 by per cent. The other two regions' numbers of foreign tourists are not affected. The impacts on the time-dependent variables are plotted in Figure 3. The values of per household's consumption, wealth and lot size are slightly affected. The land rents are slightly affected. The national income and capital stock employed by the economy are augmented. Region 3's total output is increased. The labor distributions between the regions are slightly affected. Some of region 3's labor force is shifted from the region's industrial sector to the region's service sector. The output level of the service sector is increased, and the output level of the industrial sector is reduced.

A rise in region 3's total productivity of the service sector

We now study what will happen to the economy if region 3's total productivity of the service sector is changed as follows: $A_{s3}: 0.9 \Rightarrow 1$ The time-independent variables are affected

$$\Delta p_1 = \Delta p_2 = \Delta D_1 = \Delta D_2 = \Delta w_j = 0,$$

$$\Delta p_3 = -10, \Delta D_3 = 5.4.$$

Region 3's price of services is reduced. The fall in the price attracts more foreign tourists to the region. The other time-independent variables are not affected. The impacts on the time-dependent variables are plotted in Figure 4. The national output, capital stock employed and wealth are all reduced. Although region 2 increases its output by 24 per cent, the other two regions' total outputs are reduced. This occurs as some people migrate to region 3 from the other two regions. As more people implies higher amenity, we see that the population distributed is strongly affected by the service productivity change. The two sectors in region 3 increase their inputs and output levels. The other two regions reduce their inputs and output levels. The land rent and amenity in region 3 are enhanced and the land rents and amenities in the other two regions are reduced. No household's wealth and consumption of industrial goods is affected. The households of regions 1 and 2 more frequently travel to region 3. There is no change in the numbers of domestic tourists in region 1 and 2.

Domestic consumers' preference for touring region 3 being enhanced

We now study what will happen to the economy if domestic consumers' preference for touring region 3 is enhanced as follows: $\varepsilon_{03}: 0.009 \Rightarrow 0.01$. The time-independent variables are not affected. The impacts on the time-dependent variables are plotted in Figure 5. As people increase their preference for travelling, all the consumers have less wealth and consume less goods and services. The economy's total income, total wealth, and total capital employed are increased initially and reduced in the long term. Region 1's and 2's total incomes are increased initially and reduced in the long term. Region 3's total income is reduced initially and increased reduced in the long term. Region 1's and 2's population, amenity levels, output levels, and two input factors total incomes are increased initially and reduced in the long term. Region 3's population, amenity levels, output levels, and two input factors total income are reduced initially and augmented in the long term.

A rise in the propensity to save

We now study the effects of a rise in the propensity to save as follows: $\lambda_0: 0.7 \Rightarrow 0.71$. The time-independent variables are not affected (Figure 6). The per capital wealth is increased in all the regions. The household of each region consumes less goods and services

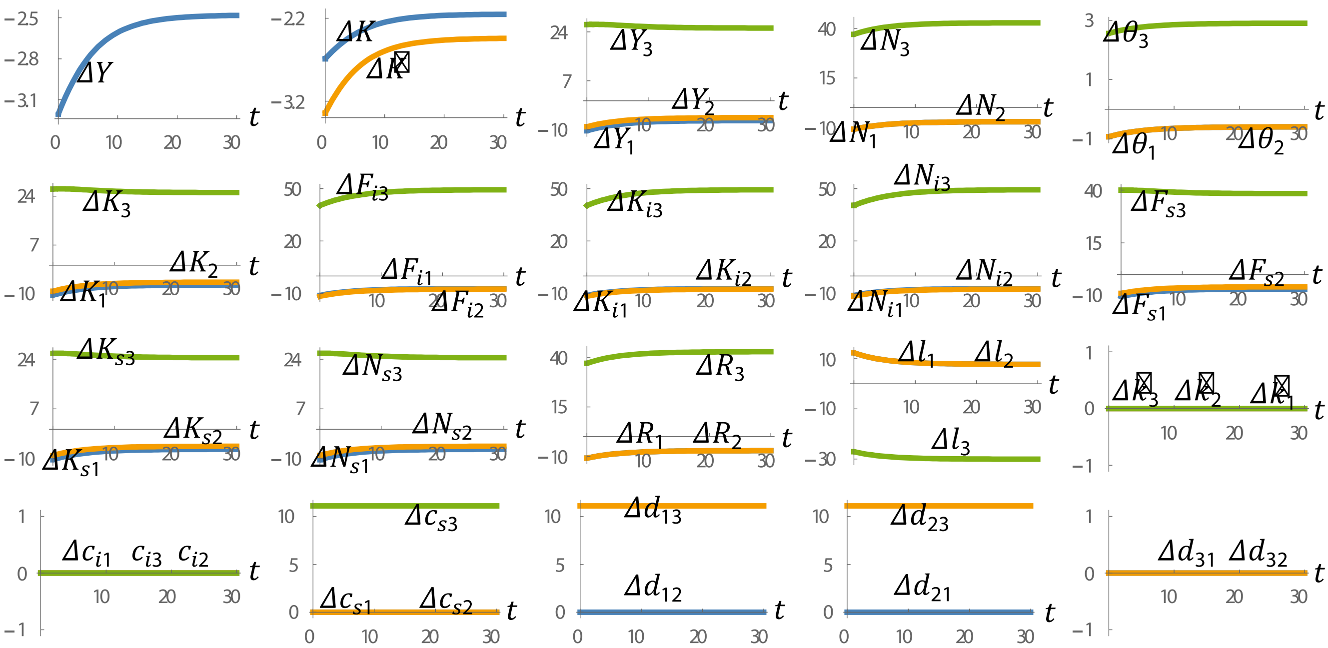

Figure 4. A Rise in the Region 3's Total Productivity of the Service Sector

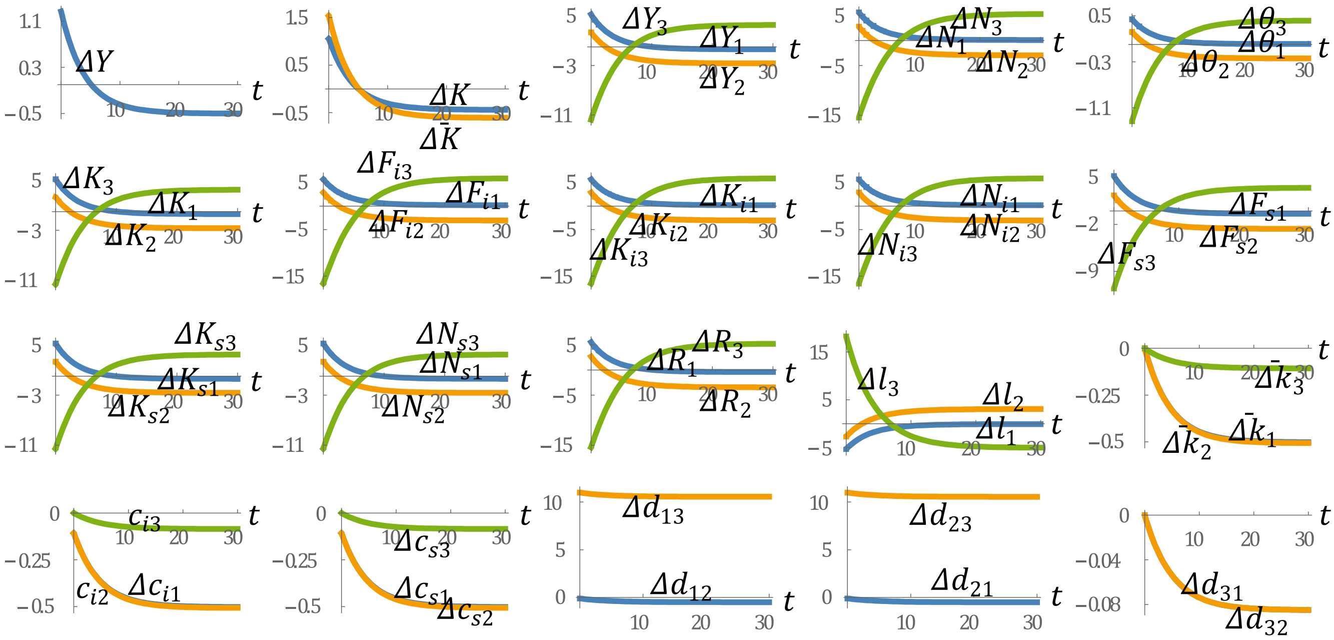

Figure 5. Domestic Consumers' Preference for Touring Region 3 Being Enhanced

initially and increases the consumption levels of goods and services. The household in each region spends less initially on tourism and more in the long term. Region 1 has more people, higher amenity, produces more goods and services, and employs more inputs. The other two regions have less people, lower amenity, produce less goods and services, and reduce the two inputs. The national output, wealth and capital employed are augmented.

A rise in the propensity to consume regional services

We now study the effects of a rise in the propensity to consume services as follows: λ_0: 0.05 $\Rightarrow$ 0.06. The time-independent variables are not affected (Figure 7). The per capital wealth is reduced in all the regions. The household of each region consumes less commodity and more services. The household in each region spends less on tourism. Region 1 has more people, higher amenity, produces more goods and services, and employs more inputs. The other two regions have less people, lower amenity, produce less goods and services, and reduce the two inputs. The national output and capital employed by the economy are augmented. The wealth rises initially and falls in the long term.

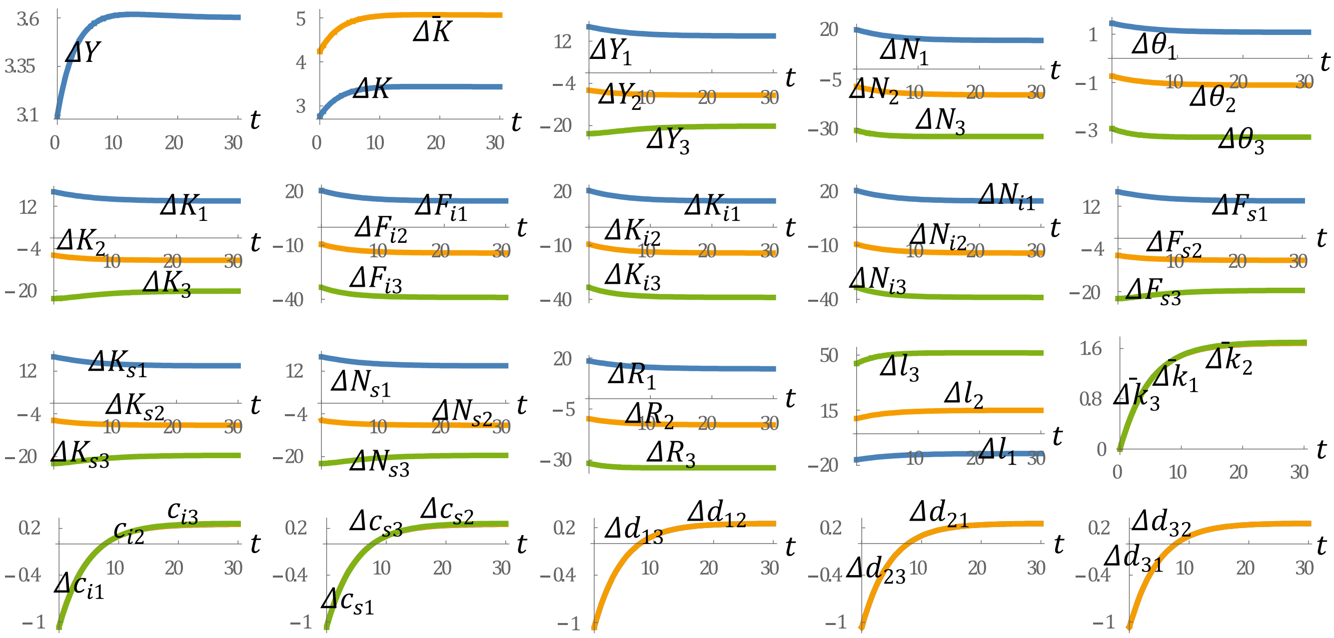

Figure 6. A Rise in the Propensity to Save

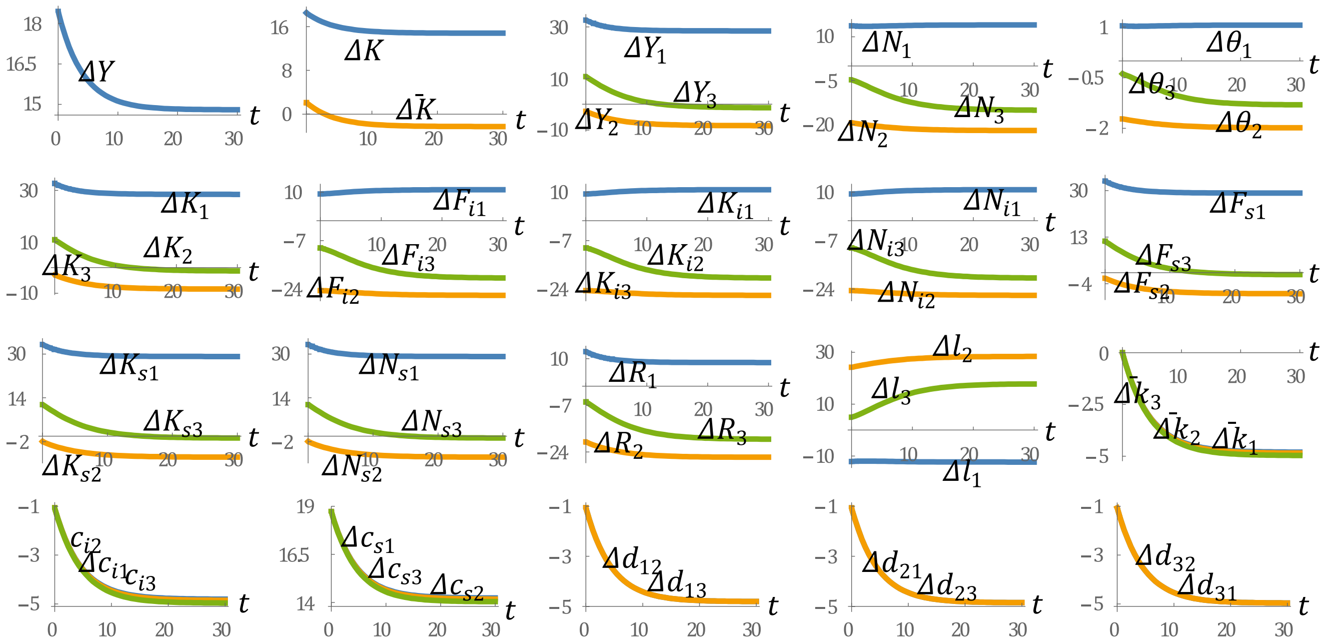

Figure 7. A Rise in the Propensity to Consume Regional Services

A rise in the propensity to consume housing

We now study the effects of a rise in the propensity to consume housing as follows: η_0: 0.07 $\Rightarrow$ 0.075 The time-independent variables are not affected (Figure 8). The per capital wealth is reduced in all the regions. The household of each region consumes less commodity and less services. The household in each region spends less on tourism. Region 1 has more people, higher amenity, produces more goods and services, and employs more inputs initially, and these variables are reduced in the long term. Initially the other two regions have more people, higher amenity, produce more goods and services, and augment the two inputs. In the long terms some of these variables are reduced and the others are enhanced. The national output, wealth and capital employed by the economy are reduced.

Conclusions

This paper built a neoclassical economic growth model of a multi-regional small open economy. The economy freely trades with foreign economies in a perfectly competitive economic environment. Different from almost all the multi-country models with endogenous wealth accumulation with microeconomic foundation, this paper treats interregional and international tourism. The national

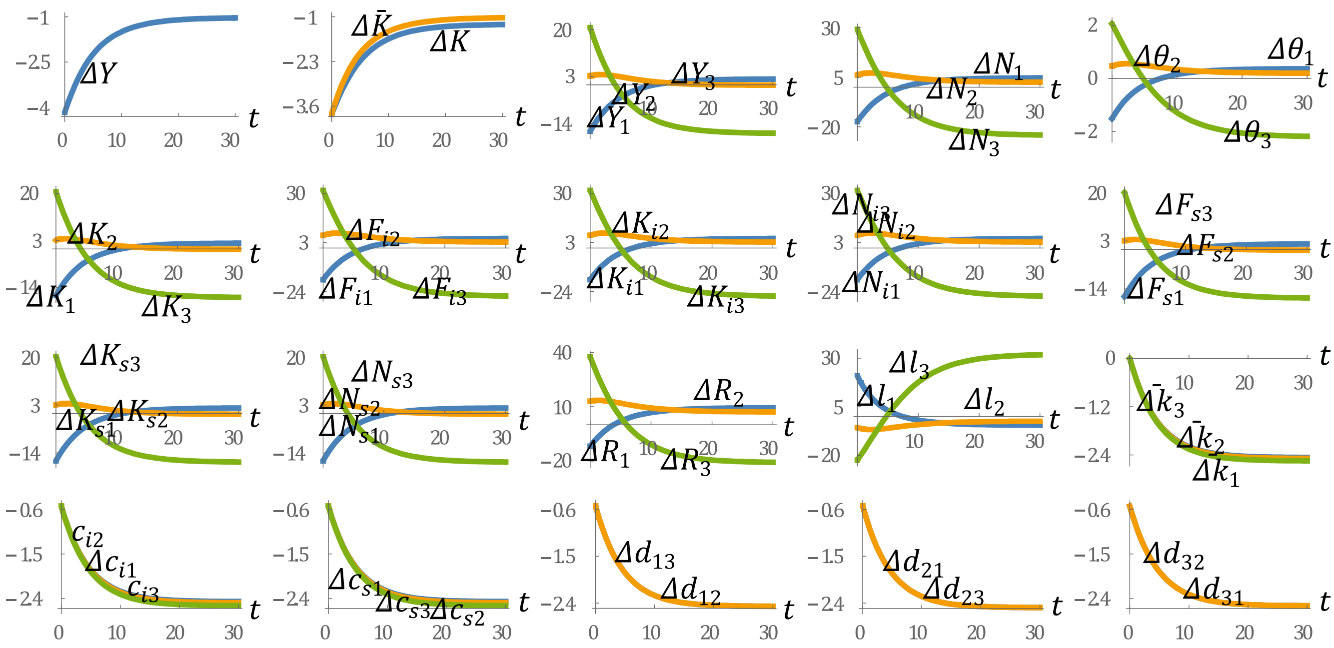

Figure 8. A Rise in the Propensity to Consume Housing

economy consists of multiple regions and each region has three – industrial, service and housing – sectors. 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 the utility function proposed by Zhang to determine saving and consumption with utility optimization without leading to a higher dimensional dynamic system like by the traditional approaches. Households move freely between regions, equalizing utility level between regions by choosing housing, goods, tourist patterns, and savings. A region's amenity is endogenous, depending on the region's population. We explicitly solved the dynamics of the multi-regional economy. The system has a unique stable equilibrium point. We simulated the motion of the model and examined the effects of changes in the rate of interest, foreigners' preference for touring a region, a region 's total productivity of the service sector, domestic consumers' preference for touring a region, the propensity to save, the propensity to consume regional services, and the propensity to consume housing. The comparative dynamic analysis provides some insights. For instance, when domestic consumers' preference for touring region 3 is enhanced, we have the following impacts on the regional and national economic growth: all the consumers have less wealth and consume less goods and services; the economy's total income, total wealth, and total capital employed are increased initially and reduced in the long term; region 1's and 2's total incomes are increased initially and reduced in the long term; region 3's total income is reduced initially and increased reduced in the long term; region 1's and 2's population, amenity levels, output levels, and two input factors total incomes are increased initially and reduced in the long term; and region 3's population, amenity levels, output levels, and two input factors total income are reduced initially and augmented in the long term. As the model is built within a comprehensive general equilibrium dynamic framework, we may extend and generalize the model in different ways. We may analyze behavior of the model with other forms of production or utility functions. There are multiple production sectors and households are not homogenous. We can extend the dynamic equilibrium framework proposed in this study to deal with issues related to tax competition between regions. It is important to generalize model to include the case that domestic households travel to other countries. Monetary issues such as exchange rates and inflation policies are important for understanding trade issues.

Appendix: Proving the lemma

We now prove the lemma. From (1) and (2) we have

$$k_{ij} \equiv \frac{K_{ij}}{N_{ij}} = (\frac{\alpha_{ij}\, A_{ij}}{r^* + \delta_{kj}})^{\frac{1}{\beta_{ij}}}. \tag{A1}$$

From (A1) and (2)

$$w_j \; = \; \beta_{ij}\, A_{qj}\, k_{ij}^{\alpha_{ij}}. \tag{A2}$$

From (A2) we have

$$k_{sj} \equiv \frac{K_{sj}}{N_{sj}} = \frac{\alpha_{sj}\, w_j}{(r^* + \delta_{kj})\beta_{sj}}. \tag{A3}$$

From (A2) we solve

$$p_j = \frac{w_j}{\beta_{sj}\, A_{sj}\, k_{sj}^{\alpha_{sj}}}. \tag{A4}$$

We see that k_{ij}, w_j, k_{sj}, p_j, and D_j are determined as functions of r^* which is fixed in the international market. Hence, we treat them as constants in the dynamic analysis.

According to the definition of $\hat{y}_j$ we obtain

$$\hat{y}_j = (1 + r^*)\bar{k}_j + w_j, j = 1, \cdots, J. \tag{A5}$$

As r^* and w_j are independent of t we see that $\hat{y}_j$ in region j is linearly related to $\bar{k}_j$ and is independent of any other time-dependent variables. From $s_j = \lambda_j \hat{y}_j$ and (11), we have

$$\dot{\bar{k}}_j = \lambda_j\, \hat{y}_j - \bar{k}_j, j = 1,2, \cdots, J. \tag{A6}$$

Substituting (A5) into equations (A6) yields

$$\dot{\bar{k}}_j = \lambda_j\, w_j - \bar{\lambda}_j\, \bar{k}_j, j = 1, \cdots, J. \tag{A7}$$

where Note that each equation is unconnected to the rest of the equations in (A7). Solve (A7)

$$\bar{k}_j(t) = (\,\bar{k}_j(0) - \frac{\lambda_j\, w_j}{\bar{\lambda}_j})\; e^{-\lambda^* t} + \frac{\lambda_j\, w_j}{\bar{\lambda}_j}, j = 1, \cdots, J. \tag{A8}$$

By (A5) we solve $\hat{y}_j$. By (8) we solve

$$c_{ij} = \xi_j\, \hat{y}_j, c_{sj} = \frac{\gamma_j\, \hat{y}_j}{p_j},\; s_j = \lambda_j\, \hat{y}_j,$$

$$d_{jq} = \frac{\varepsilon_{jq}\, y_j}{p_q},\; q \neq j, j, q = 1, \ldots. J. \tag{A9}$$

Substitute (8), (9), and $l_j = L_j/N_j$ into the utility function (7)

$$U_j = \phi_j N_j^{b-\eta_0}, \tag{A10}$$

where

$$\phi_j \equiv \bar{\theta}_j\, L_j^{\eta_0}\, \xi_j^{\xi_0}\, \lambda_j^{\lambda_0}\, (\frac{\gamma_j}{p_j})^{\gamma_0} \prod_{q \rightleftarrows \rightleftarrows \neq j}^{J} (\frac{\varepsilon_q}{p_q})^{\varepsilon_{0q}}\, \hat{y}_j^{\lambda_0 + \xi_0 + \gamma_0 + \bar{\varepsilon}_j},$$

$$\bar{\varepsilon}_j = \sum_{q \rightleftarrows \rightleftarrows \neq j}^{J} \varepsilon_{0q}.$$

Inserting (A10) into (12), we get

$$n_j = \left(\frac{\phi_j}{\phi_1}\right)^{1/(b-\eta_0)}, j = 2, \cdots, J, \qquad \text{(A11)}$$

where $n_j(t) \equiv N_j(t)/N_1(t)$ From (A11) and (19), we have

$$N_1 = \frac{N}{1 + \sum_{j=2}^{J} n_j}, N_j = n_j\, N_1. \qquad \text{(A12)}$$

From (13) and (1) we have

$$N_{sj} = \left(N_j\, c_{sj} + \sum_{q \neq j}^{J} d_{qj}\, N_q + D_j \right) \frac{1}{A_{sj}\, k_{sj}^{\alpha_{sj}}}. \qquad \text{(A13)}$$

By (A13) and (A3) we have $K_{sj} = N_{sj} k_{sj}$ From (15) and (A13)

$$N_{ij} = N_j - N_{sj}. \qquad \text{(A14)}$$

From (A1) we have $K_{ij} = K_{ij} k_{ij}$ From the definitions we determine F_{qj}

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