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Roberto Balado-Naves, David Boto-García, José Francisco Baños-Pino

Departamento de Economía

Universidad de Oviedo

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A multisector growth model for testing the Tourism-Led Growth versus the Beach Disease hypotheses

Roberto Balado-Naves*

baladoroberto@uniovi.es

David Boto-García

botodavid@uniovi.es

José Francisco Baños-Pino

jbanos@uniovi.es

Oviedo Efficiency Group, Department of Economics, University of Oviedo

Abstract:

This paper presents a novel theoretical characterization of how tourism services stimulate (deter) economic growth that integrates both *Tourism-Led* and *Beach Disease* hypotheses. We build a multisector growth model with the appealing feature that it delivers a linear growth equation that can be easily estimated by practitioners using conventional regression methods. We therefore build a bridge between theory and empirics. Under mild assumptions, we demonstrate theoretically that GDP per capita growth rate depends on the share the tourism sector represents over total GDP, Total Factor Productivity, and other determinants of the steady state of the economy. A testable implication is that a higher specialization in tourism services yields positive GDP per capita growth rates consistent with the *Tourism-Led* growth hypothesis if and only if the tourism sector is more productive than the rest of the economy. Otherwise, greater tourism specialization results in degrowth paths that are compatible with the *Beach Disease*.

Keywords: *economic growth; tourism; tourism-led growth hypothesis; Beach disease; theorical foundation*

*Corresponding author: baladoroberto@uniovi.es

Faculty of Economics and Business, Avenida del Cristo s/n 3006. Oviedo, Asturias (Spain)

1. INTRODUCTION

The relationship between tourism development and economic growth has generated a lot of interest in the tourism economics literature (e.g., Antonakakis et al., 2014; Balaguer & Cantavella-Jordá, 2002; Brida et al., 2016; 2020; Cárdenas-García et al., 2015). Typically, scholars document a positive association between tourism demand and the log of Gross Domestic Product in levels (e.g., Cortés-Jiménez, 2008; Croes et al., 2021; Lee & Chang, 2008; Roudi et al., 2019), a finding that holds by construction since tourism is embedded within the aggregate demand of an economy. Those that go beyond and look at how tourism arrivals or expenditure influence GDP growth rates over time also find that a greater specialization in tourism services fosters economic growth (Antonakakis et al., 2014; Brau et al., 2007; Bronzini et al., 2022; Harb & Bassil, 2022; Kostakis & Theodoropoulou, 2017; Paci & Marrocu, 2014). The pioneering study on this respect by Balaguer and Cantavella-Jordá (2002) labelled this result as the *Tourism-Led Growth* hypothesis (hereafter TLG), according to which earnings from tourism (considered as a non-traded good) stimulate economic growth through multiplier effects on interrelated sectors.

Nonetheless, other scholars have shown that a high specialization in the tourism industry might place countries into worse growth paths and even lead to de-growth in the long run (Inchausti-Sintes, 2015). This result has been theoretically reconciled with Baumol's disease cost (Baumol, 1967), which states that low productivity and specialization in labor-intensive sectors dampers long-run economic growth if labor costs grow at faster rates than marginal productivity. Applied to tourism production, the so-called *Beach Disease* hypothesis (hereafter BD, also known as *Dutch Disease*) postulates that excessive tourism specialization can limit growth possibilities in the long-run due to the shift of resources from highly productive sectors (Copeland, 1991; Smeral, 2003).

Despite the extensive empirical literature on the relationship between tourism and economic growth, there remains a lack of theoretical characterizations delineating the channels and mechanisms through which increases in tourism demand lead countries into better growth paths, *ceteris paribus*. In a recent paper, Song and Wu (2022) criticize the absence of theoretical underpinnings in most related empirical studies, cautioning about the potential spurious causality between tourism and economic growth obtained from conventional Granger and time series analyses. Du et al. (2016, p.471) similarly advocate for the development of a model that not only characterizes how tourism development impacts GDP but also elucidates its connections with factors of production and technology. These authors underscore the necessity for further exploration of this nexus grounded in robust economic theory to inform empirical analyses.

This paper aims to close this gap and develops a theoretical multisector economic growth model that embraces the *Tourism-Led Growth* and the *Beach Disease* hypotheses into a single framework. Using the standard Neoclassical assumptions of Solow (1956) and Swan (1956), we characterize the steady state of an economy with two sectors (tourism and non-tourism) building upon Acemoglu and Guerrieri (2008) and Acemoglu (2009). We expand the framework proposed by these authors by incorporating the human capital stock into the model together with an alternative derivation of the stable long-run equilibrium growth paths.

The paper adds to the literature on the theoretical underpinnings of the tourism-economic growth nexus (Albadalejo-Pina & Martínez-García, 2013; Chao et al., 2013; Inchausti-Sintes, 2015; 2020a; 2020b; Liu & Wu, 2019; Nowak et al., 2007; Smeral, 2003). We expand this body of knowledge by presenting a theoretical framework for the connection between output growth rates and the relative share the tourism sector represents over national income. While most studies are rooted in the export-led growth framework (Balassa, 1978; Kruger, 1980), our model focuses on the supply side of the economy, postulating that a positive contribution of tourism to economic growth depends on i) the degree of substitutability between tourism and non-tourism sectors, and ii) a relative advantage in productivity growth. Importantly, we do not only model the dynamics of GDP per capita but also growth rates in physical and human capital accumulation. A recent line of research has started to evaluate how tourism specialization affects local employment (González & Surovtseva, 2023) and human capital (Di Giacomo & Lerch, 2023) using reduced-form models. Our growth path equations can be used by researchers to further delve into how tourism development affects physical and human capital in the long run.

In our view, an appealing and distinctive feature of our model is that we arrive at a linear equation that can be easily estimated by practitioners using conventional regression methods. Our theoretical model outlines the variables that characterize the steady-state of the economy, which provides some theory-based rationale for researchers to avoid bias from omitted variables when testing the tourism-economic growth nexus empirically. In this regard, we develop a set of recommendations and suggestions for applied researchers when estimating our model.

The remainder of the paper is structured as follows. Section 2 reviews the theoretical underpinnings of the TLG and the BD hypotheses and empirical evidence on the tourism-economic growth nexus. Section 3 presents our theoretical model together with some simulation results of the long-run GDP growth dynamics of an economy. Section 4 discusses different strategies to empirically estimate our theoretical model, including ways to tackle endogeneity from reverse causality and omitted variables. Finally, Section 5 concludes with the main insights from the study, together with some limitations and avenues for future work.

2. BACKGROUND AND RELATED LITERATURE

The *Tourism Led-Growth* hypothesis (TLG) postulates that tourism development leads to economic growth. Tourism has been considered as a non-standard type of export that positively affects economic growth through increased specialization and productivity (Balassa, 1978; Krueger, 1980). Tourism inflows have been shown to (i) bring foreign currency that allows countries to expand imports of capital goods and technology (Albadalejo-Pina & Martínez-García, 2013; Nowak et al., 2007; Santana-Gallego et al., 2011), (ii) generate employment through the expansion of non-tradable service industries (Lanzara & Minerva, 2019), and (iii) due to economies of scale, tourism even increases competitiveness and leads to efficiency gains in production (Andriotis, 2002). Moreover, tourism fosters economic growth through other channels including spillover effects on other sectors like manufacturing (Faber & Gaubert, 2019) or public services (Liu & Wu, 2019), investments in infrastructure (Brida et al., 2016), capital accumulation (Du et al., 2016), service quality improvements (Inchausti-Sintes, 2020b), drops in the size of the informal economy (Lv, 2020) and Keynesian multipliers (Sinclair & Sutcliffe, 1982). Works using quasi-experimental research designs have shown that tourism arrivals raise income, employment, and economic activity (Favero & Malisan, 2022), which rise municipal income (Nocito et al., 2023).

Balaguer and Cantavella-Jordá (2002) is among the first studies that presented empirical evidence of a positive long-run relationship between tourism development and GDP growth rates. This study was followed by a large body of research on the tourism-economic growth nexus that has considered different countries, periods, and methodologies. The positive link between tourism and economic growth appears to depend on the degree of tourism specialization (Croes et al., 2021; Pablo-Romero & Molina, 2013; Neuts, 2020; Zuo & Huang, 2018), destination attractiveness and income elasticities (Inchausti-Sintes et al., 2021), institutional quality and political stability (Sharma, 2023), financial system absorptive capacity (De Vita & Kyaw, 2017) and the degree of economic development of the countries/areas being considered (Albadalejo et al., 2023; Antonakakis et al., 2015; Cárdenas-García et al., 2015; Lin et al., 2019; Sequeira & Nunes, 2008), among others. Moreover, the strength of this relationship varies geographically (Brida et al., 2020; Shahbaz et al., 2018) and over time (Antonakakis et al., 2015; Arslanturk et al., 2011; Balcilar et al., 2014; Figini & Vici, 2010). For instance, Dogan and Zhang (2023) find that tourism stimulated economic growth in the Schengen area during 1995-2003 but negatively affected it during the 2008 global financial crisis.[1]

In sharp contrast to the TLG hypothesis, authors like Copeland (1991), Smeral (2003), Capó et al. (2007) and Inchausti-Sintes (2015) posit that tourism specialization, although it potentially stimulates aggregate demand in the short-run, can damper long-term economic growth through resource misallocation to sectors that jeopardized productivity gains in what is known as the *Beach Disease* hypothesis.[2] Tourism is a labor-intensive sector that differs from other service exports that rely more on technological progress and human capital (Inchausti-Sintes, 2020a; 2021). If capital and labour are shifted from tradable and highly productive sectors to tourism-related activities (which are typically less productive and less prone to technological progress), economic growth might be diminished in the long-run through crowding-out effects. Recent empirical evidence for Croatia (Kozic, 2019) and Italy (Di Giacomo & Lerch, 2023) shows that tourism development induces a deterioration of human capital. For Spain, González and Surovtseva (2023) document that although tourism inflows generate employment in both the tourism industry and related sectors, those increases are compensated by falls in manufacturing employment.

[1] Recent reviews of the state of art and empirical findings are Ahmad et al. (2020) and Alcalá-Ordóñez and Segarra (2023).

[2] See Dwyer et al. (2016) and Forsyth et al. (2014) for an empirical illustration of the Beach Disease in Australia.

Despite the extensive literature on the topic, up to date there is no clear consensus about whether tourism *causes* economic growth or not. Although meta-regression analyses and review papers indicate the TLG hypothesis is generally supported (Brida et al., 2016; Castro-Nuño et al., 2013), some papers do not find a significant relationship or even negative effects when tourism surpasses certain thresholds (Arslanturk et al., 2011; Deng et al., 2014a; 2014b; Sahni et al., 2023; Zuo & Huang, 2018). Part of this unconclusive evidence is due to the heterogeneity in variable definition, geographical areas covered, and periods considered (Liu et al., 2022; Nunkoo et al., 2020). On top of that, another explanation is that most empirical models lack theoretical rationale on the mechanisms behind the documented effects (Song & Wu, 2022). Since tourism is a sector that is embedded into the total GDP, a positive cointegrating relationship between GDP levels and tourism indicators would naturally arise by construction (e.g., Croes et al., 2021; Lee & Chang, 2008; Roudi et al., 2019). The key issue is whether the tourism sector contributes to GDP *growth* over time rather than GDP levels and, if so, what are the theoretical mechanisms.

Though the lens of Solow-Swan models (Solow, 1956; Swan, 1956), most studies regress indicators of economic activity (GDP or GDP per capita) on tourism demand (arrivals, expenditure, or receipts) while also controlling for other factors. Some examples are Du et al. (2016), Brau et al. (2007), Harb and Bassil (2022), Holzner (2011), Kostakis and Theodoropoulou (2017), Paci and Marrocu (2014), Zuo and Huang (2018), Sequeira and Nunes (2008) and Bronzini et al. (2022). However, as discussed in Song and Wu (2022), it is unclear and not justified (i) why tourism demand is taken as an input factor or a determinant of Total Factor Productivity in a neoclassical production function, and (ii) why tourism should determine the steady state of the economy. Scholars usually assume that tourism is a type of export that determines GDP growth in the sense of Balassa (1978). However, this argument does not apply to domestic tourism, which generally represents a nonnegligible share of total demand.

Some studies indicate that although tourism boosts the economy in the short-run, there is no significant association between tourism and long-run economic growth once income factors like capital accumulation are considered (Du et al., 2016). Similar conclusions are presented in Castro-Nuño et al. (2013): the more variables the model considers, the lower the intensity of the tourism-economic growth nexus. This issue can be reconciled with some literature that argues that there is scope for reverse causality in that it is economic growth what determines tourism development (Cárdenas-García et al., 2015; Lin et al., 2019). If so, this opens the possibility that some empirical studies that support the TLG are affected by endogeneity bias.[3]

Against this background, there is a need to develop a formal theoretical characterization of the sources of long-run economic growth that explicitly models the role played by the tourism sector.

3. A MACROECONOMIC GROWTH MODEL WITH TOURISM SERVICES

This section develops a general multisector growth model that builds upon Acemoglu and Guerrieri (2008) and Acemoglu (2009), using the standard Neoclassical assumptions of the Solow (1956) and Swan (1956) growth models, and considering human capital stock as in Mankiw et al. (1992). Our model allows for both balanced and unbalanced constant growth paths based on substitution elasticities between sectors, differences in sector factor intensity, factor endowments, and productivity growth. We start by describing the production technologies of the economy. Second, we characterize the competitive static equilibrium. Next, we describe the growth path and steady state of the economy. Afterwards, we present a stylized equation that shows how the tourism sector determines GDP, labor and human capital growth rates. Finally, we conduct a simulation exercise to illustrate the dynamics of the economy predicted by the model. The time subscript *t* is omitted for notational convenience.

3.1. Preferences, production technologies and market structure

We assume that agents in the economy demand tourism services (Y_{TR}) and a composite good from all the remaining sectors (Y_{NTR}) according to an aggregate demand function that is continuous, differentiable, and homogenous of degree 1 in both goods:[4]

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[3] Fonseca and Sánchez-Rivero (2020) present evidence of significance bias in Granger causality studies on the link between tourism and economic growth. They also show that the positive association tends to correlate with country sociodemographic characteristics and decreases in magnitude as one considers longer time horizons.

[4] The continuity and differentiability assumptions are widespread in economic growth theory since they allow for using differential calculus (Acemoglu, 2009). The assumption of homogeneity of degree 1 in both goods (or constant returns to scale, CRS) makes it possible to link the equation of final demand (1) with national accountability through the Euler's Theorem, as it will be shown later. The Euler's Theorem establishes that a function homogenous of degree 1 in vector $X = (x_1, \dots, x_N)$, defined as $f(\lambda X) = \lambda f(X)$, must satisfy the partial differential equation $f(x) = \sum_i^N \partial f / \partial x_i \, x_i$.

$$Y = F(\chi Y_{TR}, (1-\chi)\, Y_{NTR}) = C + I_K + I_H + (X - IM) \qquad (1)$$

where $\chi \in (0,1)$ is an exogenous and constant distribution parameter that measures the relative preference of tourism goods with respect to non-tourism goods. C denotes aggregate final consumption and I_K and I_H refer to gross investments in physical and human capital, respectively, and $(X - IM)$ are net exports of final goods/services. Since in equilibrium aggregate demand equals aggregate supply, Y can be also read as final gross output that exhibits constant returns to scale (hereafter CRS). Additionally, final output in (1) presents positive but decreasing marginal returns in Y_{TR} and Y_{NTR},[5] and fulfils the Inada conditions.[6] These two assumptions ensure the existence of a globally asymptotically stable steady state or long-term equilibrium (Acemoglu, 2009).

Consumption and investment decisions are carried out by a representative household (i.e., we assume households present identical characteristics), and saving preferences are constant and exogenously given. Additionally, the degree of substitutability between tourism and non-tourism goods is exogenously given by a constant elasticity of substitution $\varepsilon \in [0, \infty]$. If $\varepsilon < 1$ both sectors are gross complements. If $\varepsilon > 1$ both sectors are gross substitutes. The limit situations are $\varepsilon = 0$ and $\varepsilon \to \infty$, where both sectors are perfect complements and substitutes respectively.

Tourism services and the remaining output are produced competitively by two representative firms of each sector which combine labor (L), physical capital (K) and human capital (H) under a CRS production functions with Harrod-neutral technologies A_{TR} and A_{NTR}:[7]

$$Y_{TR} = f(A_{TR} L_{TR}, K_{TR}, H_{TR}) \qquad (2)$$

$$Y_{NTR} = g(A_{NTR} L_{NTR}, K_{NTR}, H_{NTR}) \qquad (3)$$

[5] $F'_{TR} > 0$, $F''_{TR} < 0$ and $F'_{NTR} > 0$, $F''_{NTR} < 0$, where F'_{TR} and F'_{NTR} are the first derivatives of aggregate output with respect to each sector output weighted by the distribution parameter.

[6] $\lim_{Y_{TR} \to 0} F'_{TR} = \lim_{Y_{NTR} \to 0} F'_{NTR} = \infty$, $\lim_{Y_{TR} \to \infty} F'_{TR} = \lim_{Y_{NTR} \to \infty} F'_{NTR} = 0$, and $F(0, (1-\chi)\, Y_{NTR}) = F(\chi Y_{TR}, 0) = 0$.

[7] That is, equations (2) and (3) are homogenous of degree 1 in labor, physical capital, and human capital.

Harrod-neutral technologies imply that aggregate technological progress will be purely labor-augmenting. This is a necessary condition for constant growth paths (hereafter CGP) as postulated by the Uzawa Growth Theorem (Jones & Scrimgeour, 2008; Schlicht, 2006; Uzawa, 1961). Acemoglu (2003a; 2003b) and Jones (2005) theoretically justify the purely labor-augmenting technology based on empirical evidence on the low elasticity of substitution between capital stock and labor.[8] Similar to the final gross output production function in (1), the sector production functions (2) and (3) also fulfill the Inada conditions regarding primary inputs.[9]

Aggregate labor, physical and human capital, and technology dynamics are described as follows:

$$\dot{L} = g_L L \tag{4}$$

$$\dot{K} = s_K Y - \delta_K K \tag{5}$$

$$\dot{H} = s_H Y - \delta_H H \tag{6}$$

$$\dot{A}_{TR} = g_{A_{TR}} A_{TR} \tag{7}$$

$$\dot{A}_{NTR} = g_{A_{NTR}} A_{NTR} \tag{8}$$

where $g_L \geq 0$ is an exogenous constant growth rate of labor, $s_K \geq 0$ and $s_H \geq 0$ are exogenous saving rates for physical and human capital accumulation, $\delta_K \geq 0$ and $\delta_H \geq 0$ are their respective depreciation rates, and $g_{A_{TR}} \geq 0$ and $g_{A_{TR}} \geq 0$ are exogenous constant rates of labor-augmenting technological change.

Equation (4) assumes that the labor input evolves exogenously at a constant rate over time (i.e., it is supplied inelastically).[10] Physical and human capital stock dynamics follow the fundamental equations of the Solow (1956), Swan (1956) and Mankiw et al. (1992) models,

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[8] A recent wok by Grossman et al. (2017) shows that imposing strong complementarities between physical capital and human capital, as well as raw labor with human capital, allows for a constant growth path with positive capital-augmenting and labor-augmenting technological progress.

[9] $\lim_{\mathrm{L_{TR}}\to 0} f'_{L_{TR}} = \lim_{\mathrm{L_{NTR}}\to 0} g'_{L_{NTR}} = \lim_{\mathrm{K_{TR}}\to 0} f'_{K_{TR}} = \lim_{\mathrm{K_{NTR}}\to 0} g'_{K_{NTR}} = \lim_{\mathrm{H_{TR}}\to 0} f'_{H_{TR}} = \lim_{\mathrm{H_{NTR}}\to 0} g'_{H_{NTR}} = \infty$, $\lim_{\mathrm{L_{TR}}\to \infty} f'_{L_{TR}} = \lim_{\mathrm{L_{NTR}}\to \infty} g'_{L_{NTR}} = \lim_{\mathrm{K_{TR}}\to \infty} f'_{K_{TR}} = \lim_{\mathrm{K_{NTR}}\to \infty} g'_{K_{NTR}} = \lim_{\mathrm{H_{TR}}\to \infty} f'_{H_{TR}} = \lim_{\mathrm{H_{NTR}}\to \infty} g'_{H_{NTR}} = 0.$

[10] For simplicity, we assume the labor force grows exogenously with population and adjusts perfectly to demand through wages.

respectively.[11] For the sake of parsimony, we omit the household optimization problem and use exogenous saving rates. Nevertheless, Acemoglu and Guerrieri (2008) and Acemoglu (2009) proof that the long-term equilibrium of the non-balanced multisector model is compatible with endogenous saving rates.

We also assume that all primary inputs (physical and human capital stock and labor force) are owned by the representative household and are perfectly mobile across sectors, and that markets operate competitively. Therefore, since households and firms are price takers, equilibrium prices must lead to the following market-clearing conditions:

$$L = L_{TR} + L_{NTR} \tag{9}$$

$$K = K_{TR} + K_{NTR} \tag{10}$$

$$H = H_{TR} + H_{NTR} \tag{11}$$

where the endowment or supply of each primary input at any time must equal the sum of sector demands. Consequently, inputs will be allocated more intensively to those sectors which are willing to pay higher prices until there is no excess of demand or supply.

This subsection has characterized households' preferences and behavior, technologies of production, the dynamics of labor-augmenting technologies and primary inputs. We have also set the market institutions under which resources are allocated, and the initial endowments of primary inputs. We now proceed to examine how the optimization problem of firms leads to the paths of equilibrium prices and resource allocation that clear all markets.

3.2. Static competitive equilibrium

Let us assume the final gross output Y acts as the numeraire good of the economy and therefore all prices are expressed in relative terms with respect to the price of the final good (p), which is normalized to 1 for all periods. Hence, sectoral outputs and primary inputs at any moment are valued in terms of the final good Y (i.e., in terms of expenditure on final consumption and gross investment). Gross rental prices of physical and human capital stock, as well as labor

[11] From now on, we will refer to both models as the SLS (Solow-Swan model) and the MRW (Mankiw, Romer and Weil model).

wages, are denoted by R_K, R_H and w, respectively.[12] Let us represent sectoral production prices by p_{TR} for the tourism sector and p_{NTR} for the remaining sectors. The standard competitive equilibrium is defined as the paths for prices of sectoral goods and factors on one hand $[R_K, R_H, w, p_{TR}, p_{NTR}]_{t\geq 0}$, and employment and capital allocations $[L_{TR}, L_{NTR}, K_{TR}, K_{NTR}, H_{TR}, H_{NTR}]_{t\geq 0}$ on the other, so that that firms maximize profits and markets clear at any time period $t \geq 0$.

Starting with equilibrium sector prices, national accountability establishes that the value of final gross output must equal the aggregate market value of final goods and services produced in each sector, that is:

$$Y = p_{TR}Y_{TR} + p_{NTR}Y_{NTR} \tag{12}$$

Since final output equals the aggregate demand function (1), which is homogeneous of degree 1, the Euler's theorem poses that (1) must satisfy the following equality:

$$Y = F'_{TR}Y_{TR} + F'_{NTR}Y_{NTR} \tag{13}$$

Therefore, the multisector economy where sectors only supply final goods and services to households under perfect competition must fulfil that the equilibrium sector prices equal $p_{TR} = \partial F/\partial Y_{TR} = F'_{TR}$ and $p_{NTR} = \partial F/\partial Y_{NTR} = F'_{NTR}$. That is, sector prices must equal the marginal contribution of sectoral production to the aggregate output.

Dividing the identity in (12) by final gross output Y yields a weighted sum that equals 1, with relative weights:

$$\theta = \frac{p_{TR}Y_{TR}}{Y} = \frac{F'_{TR}Y_{TR}}{Y} \tag{14}$$

$$1 - \theta = \frac{p_{NTR}Y_{NTR}}{Y} = \frac{F'_{NTR}Y_{NTR}}{Y} \tag{15}$$

[12] Note that the final overall wage would be given by w+R_H, where w denotes a baseline wage and R_H refers to a skill wage premium.

where $\theta \in [0,1]$ is the share of the market value of the tourism sector with respect to the value of aggregate gross output Y (tourism share in national income), and therefore $(1-\theta)$ the share of the market value of non-tourism production over the value of aggregate production (non-tourism share in national income). Both θ and $1-\theta$ can also be interpreted as the aggregate demand (output) elasticities with respect to the output of each sector; that is, the percentage change that aggregate demand (output) experiences after a percentage change in the output of a sector.

Profits of the representative producer of the tourism ($\Pi_{Y_{TR}}$) and non-tourism ($\Pi_{Y_{NTR}}$) outputs are given by:

$$\Pi_{Y_{TR}} = p_{TR}Y_{TR} - wL_{TR} - R_K K_{TR} - R_H H_{TR} \tag{16}$$

$$\Pi_{Y_{NTR}} = p_{NTR}Y_{NTR} - wL_{NTR} - R_K K_{NTR} - R_H H_{NTR} \tag{17}$$

where firms face the same input prices due to perfect factor mobility across sectors. Maximization of the profit functions (16) and (17) with respect to L, K and H under perfect competition yields the following inverse factor demands:

$$w = p_{TR}{f'}_{L_{TR}} = p_{NTR}{g'}_{L_{NTR}} \tag{18}$$

$$R_K = p_{TR}{f'}_{K_{TR}} = p_{NTR}{g'}_{K_{NTR}} \tag{19}$$

$$R_H = p_{TR}{f'}_{H_{TR}} = p_{NTR}{g'}_{H_{NTR}} \tag{20}$$

where ${f'}_x$ and ${g'}_x$ refer to the marginal products (first derivatives) of sectoral production functions (2) and (3) with respect to each primary input. Therefore, equations (18)-(20) show that competitive firms demand inputs until their marginal cost equals the market value of their marginal productivity.

For simplicity, assume the output elasticities in each sector with respect to labor, capital and human capital stocks are constant, exogenously given, and take the following values:

$${f'}_{L_{TR}}\frac{L_{TR}}{Y_{TR}} = 1 - \alpha_{TR} - \beta_{TR};\ {g'}_{L_{NTR}}\frac{L_{NTR}}{Y_{NTR}} = 1 - \alpha_{NTR} - \beta_{NTR} \tag{21}$$

$$f'_{K_{TR}} \frac{K_{TR}}{Y_{TR}} = \alpha_{TR};\ g'_{K_{NTR}} \frac{K_{NTR}}{Y_{NTR}} = \alpha_{NTR} \tag{22}$$

$$f'_{H_{TR}} \frac{H_{TR}}{Y_{TR}} = \beta_{TR};\ g'_{H_{NTR}} \frac{H_{TR}}{Y_{TR}} = \beta_{NTR} \tag{23}$$

with $\alpha_{TR} \in (0,1)$, $\alpha_{NTR} \in (0,1)$, $\beta_{TR} \in (0,1)$, $\beta_{NTR} \in (0,1)$, $\alpha_{TR} + \beta_{TR} \in (0,1)$, and $\alpha_{NTR} + \beta_{NTR} \in (0,1)$. Output elasticities can be different across sectors depending on how intensive each sector is in the use of a given input. Rearranging equations (14) and (15), and (18)-(23), we can express inverse demands in terms of output elasticities as follows:

$$p_{TR} = \theta \frac{Y}{Y_{TR}} \tag{24}$$

$$p_{NTR} = (1-\theta) \frac{Y}{Y_{NTR}} \tag{25}$$

$$w = \theta(1 - \alpha_{TR} - \beta_{TR}) \frac{Y}{L_{TR}} = (1-\theta)(1 - \alpha_{NTR} - \beta_{NTR}) \frac{Y}{L_{NTR}} \tag{26}$$

$$R_K = \theta\alpha_{TR} \frac{Y}{K_{TR}} = (1-\theta)\alpha_{NTR} \frac{Y}{K_{NTR}} \tag{27}$$

$$R_H = \theta\beta_{TR} \frac{Y}{H_{TR}} = (1-\theta)\beta_{NTR} \frac{Y}{H_{NTR}} \tag{28}$$

According to the inverse demands in (24)-(28), it holds that an increase in national income Y raises the willingness to pay for each unit of sectoral output Y_{TR} and Y_{NTR}, or for each unit of primary inputs L, K and H due to the corresponding increase in their marginal contributions to the expansion of aggregate gross output (scale effect). This follows from our initial assumption of positive and diminishing returns of aggregate demand in sectoral outputs, and in sectoral production regarding primary inputs. Additionally, an increase of the tourism share in national income (θ) (holding Y and the inputs fixed) raises (i) the marginal contribution of the tourism sector to aggregate demand and the corresponding willingness to pay for production from this sector Y_{TR}, and (ii) the marginal contributions of the inputs hired by the tourism sector (L_{TR}, K_{TR}, H_{TR}) to aggregate output Y. This occurs at the cost of decreasing the marginal contribution of their counterparts $(Y_{NTR}, L_{NTR}, K_{NTR}, H_{NTR})$. Accordingly, the effect of the tourism share in national income (θ) over inverse demands can be understood as a "relative market size" effect. That is, when aggregate demand is biased towards the output of one sector (e.g., tourism), a larger share of that demand will be captured by the firms producing in that sector. Therefore, those firms will be facing a relatively larger market size and potential revenues, compared to those firms producing in the other sector.

Due to the assumption of perfect factor mobility, inverse demands in (26)-(28) imply that the marginal product of each primary input must be equal across sectors. Since marginal products of inputs are decreasing in the quantity of the input, the sector with the initial highest willingness to pay will hire a larger proportion of that input until sector marginal products are set equal. Rearranging equations (26)-(28), and using the market-clearing conditions in (9)-(11), the shares of each input allocated to the tourism sector can be read as:[13]

$$\gamma_L = \frac{L_{TR}}{L} = \frac{\theta(1-\alpha_{TR}-\beta_{TR})}{1-\bar{\alpha}-\bar{\beta}} \tag{29}$$

$$\gamma_K = \frac{K_{TR}}{K} = \frac{\theta\alpha_{TR}}{\bar{\alpha}} \tag{30}$$

$$\gamma_H = \frac{H_{TR}}{H} = \frac{\theta\beta_{TR}}{\bar{\beta}} \tag{31}$$

where $\gamma_L \in [0,1]$, $\gamma_K \in [0,1]$ and $\gamma_H \in [0,1]$. It holds that $1-\gamma_L$ is the share of labor, $1-\gamma_K$ the share of physical capital and $1-\gamma_H$ the share of human capital allocated to the non-tourism sector. The parameters $\bar{\alpha}$ and $\bar{\beta}$ are average elasticities of final gross output Y with respect to physical and human capital stocks, which equal their corresponding income shares as follows:

$$\bar{\alpha} = \theta\alpha_{TR} + (1-\theta)\alpha_{NTR} = \frac{R_K K}{Y} \tag{32}$$

$$\bar{\beta} = \theta\beta_{TR} + (1-\theta)\beta_{NTR} = \frac{R_H H}{Y} \tag{33}$$

where $1-\bar{\alpha}-\bar{\beta} = wL/Y$ is the income share of labor.

Therefore, (32) and (33) show that input income shares are a weighted average of sectoral output elasticities, where the relative weights are the sector shares in national income. In this sense, if aggregate demand is more biased towards one sector or another, we would observe a change in the input income shares. For instance, if as discussed in the literature (e.g., Inchausti-

[13] Proof of (29), (30) and (31) is presented in Appendix A.1. Also, the proof that tourism allocation shares are increasing in θ can be found in Appendix A.2.

Sintes, 2020a), the tourism sector is more intensive in the use of labor ($\alpha_{TR} + \beta_{TR} < \alpha_{NTR} + \beta_{NTR}$), then any increase in the share of tourism in national income θ would lead to an increase in the share of labor in national income at the cost of a decrease in the shares of physical and human capital.

Once we have obtained the optimal decision of private firms, now we can express the sector and aggregate production functions in terms of primary inputs and output elasticities. Furthermore, we can link their growth rates to the accumulation rates of inputs and technological progress.

3.3.Dynamics of sector and aggregate production

To formally depict how sectoral and aggregate production change over time, we first obtain the final versions of the non-specified production functions. According to the tourism allocation shares in (29)-(31), primary inputs assigned to the tourism sector can be written as $L_{TR} = \gamma_L L$, $K_{TR} = \gamma_K K$, $H_{TR} = \gamma_H H$. The reasoning is symmetric for the non-tourism sector. Inserting this into the sectoral production functions (2) and (3), these expressions become:

$$Y_{TR} = f(A_{TR}\gamma_L L, \gamma_K K, \gamma_H H) \tag{34}$$

$$Y_{NTR} = g(A_{NTR}(1-\gamma_L)L, (1-\gamma_K)K, (1-\gamma_H)H) \tag{35}$$

where both Y_{TR} and Y_{NTR} are homogenous of degree 1 in private inputs L, K and H (see Appendix A.3). Furthermore, if we substitute sectoral production functions (34) and (35) into the aggregate demand/gross output in (1), we obtain:

$$Y = Q(A_{TR}, A_{NTR}, \gamma_L, \gamma_K, \gamma_H, L, K, H) \tag{36}$$

where

$$Q(\cdot) = F\big(f(A_{TR}\gamma_L L, \gamma_K K, \gamma_H H), g(A_{NTR}(1-\gamma_L)L, (1-\gamma_K)K, (1-\gamma_H)H)\big) \tag{37}$$

is the composed function $Q = F \circ (f, g)$, which is also homogeneous of degree 1 in private inputs L, K and H, hence $\lambda Y = Q(A_{TR}, A_{NTR}, \gamma_L, \gamma_K, \gamma_H, \lambda L, \lambda K, \lambda H)$ (see Appendix A.3).

Additionally, it retains the properties of diminishing returns in each private input, as well as the Inada conditions.[14]

Now, let $k = K/L$ and $h = H/L$ denote the levels of physical and human capital stock per worker, and define the increase in any of these variables as *capital deepening*. Differentiating (34) and (35) with respect to time, and dividing by Y_{TR} and Y_{NTR} respectively, yields the equilibrium growth rates of production in the tourism and non-tourism sectors:

$$\begin{gathered}\frac{\dot{Y}_{TR}}{Y_{TR}} = (1-\alpha_{TR}-\beta_{TR})g_{A_{TR}} + g_L \\ +\alpha_{TR}\frac{\dot{k}}{k} + \beta_{TR}\frac{\dot{h}}{h} + \frac{\dot{\gamma}_{TR}}{\gamma_{TR}}\end{gathered} \tag{38}$$

$$\begin{gathered}\frac{\dot{Y}_{NTR}}{Y_{NTR}} = (1-\alpha_{NTR}-\beta_{NTR})g_{A_{NTR}} + g_L \\ +\alpha_{NTR}\frac{\dot{k}}{k} + \beta_{NTR}\frac{\dot{h}}{h} - \frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}}\end{gathered} \tag{39}$$

where $\dot{x}$ is how we denote the time derivative of any variable, and $\dot{\gamma}_{TR}/\gamma_{TR}$ and $\dot{\gamma}_{NTR}/\gamma_{NTR}$ are the weighted sums of the growth rates of tourism allocation shares for each sector, which equal:

$$\frac{\dot{\gamma}_{TR}}{\gamma_{TR}} = (1-\alpha_{TR}-\beta_{TR})\frac{\dot{\gamma}_L}{\gamma_L} + \alpha_{TR}\frac{\dot{\gamma}_K}{\gamma_K} + \beta_{TR}\frac{\dot{\gamma}_H}{\gamma_H} \tag{40}$$

$$\frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}} = (1-\alpha_{NTR}-\beta_{NTR})\frac{\gamma_L}{1-\gamma_L}\frac{\dot{\gamma}_L}{\gamma_L} + \alpha_{NTR}\frac{\gamma_K}{1-\gamma_K}\frac{\dot{\gamma}_K}{\gamma_K} + \beta_{NTR}\frac{\gamma_H}{1-\gamma_H}\frac{\dot{\gamma}_H}{\gamma_H} \tag{41}$$

These rates measure the impact of the attraction of primary inputs from the non-tourism to the tourism sector on sector growth rates due to changes in the relative importance of these sectors over aggregate demand. To understand this, please recall that tourism allocation shares (29)-(31) are an increasing function of θ. This is formalized in the following proposition:

[14] Observe for any input x that $\partial^2 Y/\partial x^2 = F''_{TR}\cdot(f'_x)^2 + F'_{TR}\cdot f''_x + F''_{NTR}\cdot(g'_x)^2 + F'_{NTR}\cdot g''_x$, where the initial properties of the model defined in Section 3.1 were $F' > 0$, $F'' < 0$, $f'_x > 0$, $f''_x < 0$, $g'_x > 0$ and $g''_x < 0$. Therefore $\partial^2 Y/\partial x^2 < 0$. For the Inada conditions, recall that $\lim_{x\to 0}\partial Y/\partial x = \lim_{x\to 0}F'_{TR}\cdot\lim_{x\to 0}f'_x + \lim_{x\to 0}F'_{NTR}\cdot\lim_{x\to 0}g'_x = \infty$, $\lim_{x\to\infty}\partial Y/\partial x = \lim_{x\to\infty}F'_{TR}\cdot\lim_{x\to\infty}f'_x + \lim_{x\to\infty}F'_{NTR}\cdot\lim_{x\to\infty}g'_x = 0$.

Proposition 1: *If sectoral shares are constant,* $\dot{\theta} = 0$*, and therefore tourism allocation shares remain constant,* $\dot{\gamma}_L = \dot{\gamma}_K = \dot{\gamma}_H = 0$*, then tourism and non-tourism sectors can grow at different rates (unbalanced growth) due to differences in rates of labor-augmenting technological progress* $g_{A_{TR}} \neq g_{A_{NTR}}$*, and differences in the intensity of the use of capital stock* $\alpha_{TR} \neq \alpha_{NTR}$ *and* $\beta_{TR} \neq \beta_{NTR}$ *that do not compensate each other. If aggregate demand becomes increasingly more biased towards the tourism sector,* $\dot{\theta} > 0$*, and thus* $\dot{\gamma}_L > 0$; $\dot{\gamma}_K > 0$; $\dot{\gamma}_H > 0$*, production growth in the tourism sector will accelerate while the non-tourism sector will decelerate.* Proof in Appendix A.4.

Proposition 1 implies that, in our model, the sector with sufficiently fast technological progress can offset the negative impact of a production technology not intensive in the use of capital stock on relative sector growth. Put it differently, physical and human capital deepening act as a positive force in the expansion of both sectors, but the capital-intensive sector will benefit relatively more from it. Defining a laggard (leading) sector as that which presents slower (faster) technological progress and benefits less (more) from capital deepening, Proposition 1 also implies that any shift of aggregate demand towards the laggard sector can boost its growth at the cost of a slowdown in the leading sector due to a reallocation of production inputs across sectors.

Deriving aggregate gross output in (36) with respect to time, and dividing by Y yields the equilibrium growth rate of aggregate gross output:[15]

$$\frac{\dot{Y}}{Y} = g_L + \frac{\dot{A}}{A} + \bar{\alpha}\frac{\dot{\tilde{k}}}{\tilde{k}} + \bar{\beta}\frac{\dot{\tilde{h}}}{\tilde{h}} \tag{42}$$

where $\tilde{k} = K/(AL)$ and $\tilde{h} = H/(AL)$ denote the levels of physical and human capital stock per effective worker, and $\dot{A}/A$ is the aggregate rate of labor-augmenting technological progress that is given by:

$$\frac{\dot{A}}{A} = \frac{\theta(1 - \alpha_{TR} - \beta_{TR})g_{A_{TR}} + (1 - \theta)(1 - \alpha_{NTR} - \beta_{NTR})g_{A_{NTR}}}{\left(1 - \bar{\alpha} - \bar{\beta}\right)} \tag{43}$$

[15] Proof in Appendix A.5.

Equation (43) shows that aggregate technological progress can be biased towards sectoral technological progress, and equation (42) shows that national income growth is explained as a linear combination of population growth, aggregate technological progress, and capital deepening per effective worker. This result can be formalized using the following proposition:

Proposition 2: *As the aggregate demand is more biased towards the tourism sector* ($\theta \rightarrow 1$), *national income or aggregate gross output grows at a slower pace if the tourism sector is less intensive in the use of capital compared with the rest of the economy* ($\alpha_{TR} < \alpha_{NTR}$, $\beta_{TR} < \beta_{NTR}$)*, and labor-augmenting technological progress grows relatively slower in the tourism sector* ($g_{A_{TR}} < g_{A_{NTR}}$)*.*

Proof: since the growth rate of aggregate gross output is a weighted sum of the growth rates of sectoral production (see Appendix A.5), as $\theta \rightarrow 1$, the growth rate of national income converges to that of the tourism sector, which according to Proposition 1 will be slower than that of the non-tourism sector if $\alpha_{TR} < \alpha_{NTR}$, $\beta_{TR} < \beta_{NTR}$ and $g_{A_{TR}} < g_{A_{NTR}}$.

Proposition 2 highlights the importance of modelling national income growth as a weighted sum of sector growth rates according to their relative importance in aggregate demand. Therefore, if aggregate demand gives increasingly more importance to goods provided by the tourism sector, and we assume it as the laggard sector in terms of productivity, the economy will follow a path where national income increases at a lower rate compared to the contrafactual where the leading sector becomes dominant (i.e., *Beach Disease* hypothesis). In this sense, the laggard sector deaccelerates the economy through two different and simultaneous mechanisms: (i) a change in the composition of aggregate technological progress due to a dominance of less innovative firms; and (ii) an underuse of new batches of physical and human capital stock due to firms focusing on the production of labor-intensive goods.

3.4. Dynamics of tourism share over national income

Since unbalanced sector growth and non-unitary elasticity of substitution allows for endogenous changes in sector shares over national income, we must explore the dynamics of the tourism share over national income to study the stability of the model and properly forecast the relative importance of the value of tourism output in aggregate supply. The dynamics of the share of tourism output can be read as follows:[16]

$$\dot{\theta} = \frac{(\varepsilon - 1)}{1 - (\varepsilon - 1)[(\gamma_L - \gamma_K)(\alpha_{TR} - \alpha_{NTR}) + (\gamma_L - \gamma_H)(\beta_{TR} - \beta_{NTR})]} \frac{\dot{Z}}{Z}(1 - \theta)\theta \quad (44)$$

where $\dot{Z}/Z = \dot{Y}_{TR}/Y_{TR} - \dot{Y}_{NTR}/Y_{NTR} - \dot{\gamma}_{TR}/\gamma_{TR} - \dot{\gamma}_{NTR}/\gamma_{NTR}$ is the difference in sector output growth rates discounted from the growth rates of input allocation shares. Therefore, $\dot{Z}/Z$ measures the rate of uneven sector growth due to differences in structural factors (labor-augmenting technological progress and/or factor intensities), which is independent of changes in the share of tourism over national income θ.

Proposition 3: *As long as* $(\gamma_L - \gamma_K)(\alpha_{TR} - \alpha_{NTR}) + (\gamma_L - \gamma_H)(\beta_{TR} - \beta_{NTR}) < 1/(\varepsilon - 1)$ *is true for* $0 < \theta < 1$ *, the relative value of tourism output over gross aggregate output* θ *increases and converges asymptotically to one if both sectors are gross complements (*$\varepsilon < 1$*) and tourism is the laggard sector (*$\dot{Z}/Z < 0$*), or are gross substitutes (*$\varepsilon > 1$*) and tourism is the leading sector (*$\dot{Z}/Z > 0$*). If the contrary is true, then the relative value of tourism output over gross aggregate output* θ *decreases and converges asymptotically to zero. If the elasticity of substitution is unitary (*$\varepsilon = 1$*), or structural sector growth is even (*$\dot{Z}/Z = 0$*), the relative value of tourism output over gross aggregate output is exogenously given.* Proof in Appendix A.6.

Proposition 3 poses the dynamic equation (44) is only stable in the neighborhood of the steady state as long as $1 + \frac{1}{(\gamma_L - \gamma_K)(\alpha_{TR} - \alpha_{NTR}) + (\gamma_L - \gamma_H)(\beta_{TR} - \beta_{NTR})} > \varepsilon$. That is, if the last condition is true, for non-unitary elasticity of substitution between sectors ($\varepsilon \neq 1$) and unbalanced sector growth due to technological differences $\dot{Z}/Z \neq 0$, equation (44) converges to the steady-state value $\dot{\theta} = 0$ (Appendix A.6). Furthermore, equation (44) alongside the condition of stability, ensures that steady-state values of sector value shares remain bounded between 0 and 1 (observe that $\lim_{\theta \to 0} \dot{\theta} = \lim_{\theta \to 1} \dot{\theta} = 0$). Finally, for $\varepsilon = 1$ or $\dot{Z}/Z = 0$, the share of the value of tourism output over national income remains constant and at its initial value ($\theta = \theta(0)$) if it does not change due to an exogenous shock.

[16] See Appendix A.6.

The economic intuition behind Proposition 3 lies in the fact that changes in sector shares do not only rely on changes in relative sector output, but also on changes in relative sector prices. Under the assumption of a constant elasticity of substitution, the growth rate of relative prices evolves according to rule $\frac{\dot{p}_{TR}}{p_{TR}} - \frac{\dot{p}_{NTR}}{p_{NTR}} = -\frac{1}{\varepsilon}\left(\frac{\dot{Y}_{TR}}{Y_{TR}} - \frac{\dot{Y}_{NTR}}{Y_{NTR}}\right)$ (Appendix A.6). Hence, uneven sector growth makes the laggard sector comparatively more expensive due to its increasing relative scarcity. Therefore, as both sectors are gross complements, a 1% increase in relative output between the leading and laggard sectors would lead to a higher increase in relative prices in favor to the laggard sector. This price effect overcomes the change in relative output, leading to an increase in the share of the laggard sector over national income. On the contrary, when both sectors are gross substitutes, changes in relative output overcome changes in relative prices, fostering the share of the leading sector over national income.

Now that we have defined the structure and functioning of the two-sector economy with unbalanced growth, we proceed to examine its equilibrium in the long run. That is, can we derive any stable relationships among variables as time passes. This is what the economic growth literature defines as the *steady-state equilibrium* or *constant growth path* of an economy. We characterize it in the following subsection.

3.5. Constant growth path and steady state

A constant growth path (hereafter CGP) or steady state is defined as an equilibrium path where aggregate gross output per worker ($y = Y/L$) asymptotically grows at a constant rate, so that $lim_{t\to\infty}\dot{y}/y = g$, and is asymptotically coherent with the Kaldor (1961) stylized facts of growth. In this regard, most growth models commit themselves to the fulfilment of the Kaldor facts as a minimum requirement to yield long-term growth paths coherent with empirical evidence (Acemoglu, 2009; Acemoglu & Ventura, 2008; Duernecker et al., 2021; Herrendorf et al., 2019). These facts imply constant interest rates (i.e., $lim_{t\to\infty}R_K = R_K^*$), stable capital-output ratios (i.e., $lim_{t\to\infty}\mathrm{K/Y} = (\mathrm{K/Y})^*$, $lim_{t\to\infty}\mathrm{H/Y} = (\mathrm{H/Y})^*$), and constant capital and labor shares (i.e., $lim_{t\to\infty}R_K\mathrm{K/Y} = R_K^*(\mathrm{K/Y})^*$, $lim_{t\to\infty}\mathrm{R_H H/Y} = \mathrm{R_H^*(H/Y)^*}$ and $lim_{t\to\infty}wL/\mathrm{Y} = (wL/\mathrm{Y})^*$) along the steady-state equilibrium (Acemoglu, 2009; Barro & Sala-i-Martin, 2004).

Proposition 4: *If Proposition 3 is true, the CGP of the two-sector economy is globally stable for* $0 < \theta(0) < 1$, $\tilde{k}(0) > 0$ and $\tilde{h}(0) > 0$, *and is characterized by the following steady-state values:*[17]

$$lim_{t \to \infty} \theta = \theta^* \tag{45}$$

$$\bar{\alpha}^* = \theta^* \alpha_{TR} + (1 - \theta^*) \alpha_{NTR} \tag{46}$$

$$\bar{\beta}^* = \theta^* \beta_{TR} + (1 - \theta^*) \beta_{NTR} \tag{47}$$

$$g = \frac{\theta^*(1 - \alpha_{TR} - \beta_{TR}) g_{A_{TR}} + (1 - \theta^*)(1 - \alpha_{NTR} - \beta_{NTR}) g_{A_{NTR}}}{(1 - \bar{\alpha}^* - \bar{\beta}^*)} \tag{48}$$

$$\left(\frac{K}{Y}\right)^* = \frac{s_K}{\delta_K + g_L + g} \tag{49}$$

$$\left(\frac{H}{Y}\right)^* = \frac{s_H}{\delta_H + g_L + g} \tag{50}$$

Proposition 4 implies that the two-sector economy converges asymptotically to a stable steady state if sector output and substitution elasticities fulfill Proposition 3 (the endogenous process of sector specialization behaves properly) and the economy is not perfectly specialized in one sector and presents an initial positive endowment of private inputs. This steady state yields a constant growth path for aggregate gross output, physical and human capital stocks in per capita terms equal to the steady-state growth rate of average labor-augmenting technological progress described by (48). Additionally, the capital-output ratios in (49) and (50) are the standard ratios of the SLS and MRW models, which increase with saving rates (s_K and s_H), but decrease with capital depreciation rates (δ_K and δ_H), population growth (g_L) and average labor-augmenting technological progress (g). As in the SLS and MRW models, the existence of the steady state in capital-output ratios is due to production technologies in (1)-(3) presenting diminishing returns with respect to each private input, as well as the fulfilment of the Inada conditions.

Corollary 1: *If the tourism sector is labor-intensive ($\alpha_{TR} < \alpha_{NTR}$, $\beta_{TR} < \beta_{NTR}$), and presents relatively lower labor productivity growth ($g_{A_{TR}} < g_{A_{NTR}}$), the economy asymptotically specializes in tourism services ($\theta \to 1$) as long as the tourism and non-tourism sectors are gross complements. Then, per capita GDP growth slows down converging to the rate of labor*

[17] The proof of global stability can be found in Appendix A.7. Proof of (45) is presented in Proposition 3. Steady-state values (46)-(48) are a consequence of substituting (45) into (32), (33) and (43). Proof of (49) and (50) is presented in Appendix A.8.

productivity growth in the tourism sector, capital-output ratios increase, and private inputs are increasingly allocated to the tourism sector. If both sectors are gross substitutes, the economy asymptotically specializes in non-tourism services ($\theta \rightarrow 0$), and consequently per capita GDP growth accelerates, capital-output ratios decrease, and private inputs are increasingly allocated to the non-tourism sector. Proof: see Propositions 1-4 and Appendix A.9.

Corollary 1 summarizes the main results of the two-sector growth model applied to the tourism sector. Under the assumption of a labor-intensive and underproductive tourism sector (as compared to the rest of the economy), if aggregate demand shows strong dependence towards tourism services, the economy will follow a long-term path of overspecialization in the tourism sector due to a dominating price effect over a sector scale effect. Since the tourism sector presents lower structural growth capabilities because of its lower returns from the expansion of physical and human capital stocks and lower labor-augmenting technological progress, the relative supply of tourism services will grow slower than their demand. Due to market clearing conditions, relative sector prices evolve inversely in a way that revenues of tourism firms will increase relatively more than those for non-tourism firms. Consequently, tourism firms will expand their supply by attracting a higher share of private inputs from other sectors in the economy. As private inputs are more intensively allocated to the tourism sector (but never perfectly), aggregate gross supply asymptotically converges to the supply and dynamics of the tourism sector. The remaining sectors will nonetheless maintain a positive supply and growth to keep the economy operating (recall that gross complementarity between sectors works in both directions). Finally, given that aggregate technological progress depends on the weighted contribution of sector technological progress to aggregate supply, as the overall economy converges to the dynamics of the tourism sector, aggregate labor augmenting technological progress will do so. In this sense, steady-state capital-output ratios increase given that capital stock will grow substantially faster than aggregate output during the transitional dynamics, and this happens due to a slower evolution of labor productivity.

In the case of good possibilities of substitution between both sectors, aggregate demand will be increasingly biased towards the comparatively cheaper non-tourism sector. As the non-tourism sector presents a faster structural growth compared to the tourism sector, households will increase the demand of non-tourism goods in a way that compensates their lower prices, thus raising firm revenues. Non-tourism firms will attract most private inputs to their sector and aggregate supply will converge to the production levels and growth of the non-tourism sector.

In the long run, the tourism sector shuts down and technological progress equals that of the non-tourism sector, leading to lower capital-output ratios due to a faster labor-augmenting technology than the tourism-based economy.

3.6. Simulation of the model

After setting the main structure and major propositions of the general two-sector growth model, we now present the graphical visualization of the time evolution of GDP per capita (y), sectoral outputs per capita (y_{TR} and y_{NTR}) and the share of tourism output over aggregate GDP (θ) according to the main dynamic equations of the model (see Appendix A.11). To this end, we need to make some assumptions about the values of the parameters that characterize the equilibrium of the economy.

Let us assume that human capital saving rates equal government investment-output ratios, the non-tourism sector presents the same output elasticities as in Mankiw et al. (1992), and the tourism sector has half of them. Assume also that starting values of capital stock (K, H), unskilled labor (L), output per capita (y_{TR}, y_{NTR}, y), and productivity (A_{TR}, A_{NTR}) equal 1, and the vector of prices (p_T, p_N, w, R_K, R_H) are given by equations (24)-(28). Following the estimates presented by Liu and Wu (2019) for the Spanish economy, the rest of model parameters take the values presented in Table 1.

Table 1. Parameter values

Parameter	Name	Value	Source
s_K	Physical capital saving rate	0.168	Liu and Wu (2019)
s_H	Human capital saving rate	0.038	Liu and Wu (2019)
δ_K	Physical capital depreciation rate	0.019	Liu and Wu (2019)
δ_H	Human capital depreciation rate	0.047	Liu and Wu (2019)
g_L	Population growth rate* (real data)	0.01	Spanish Statistical Institute INE
θ	Tourism production share over total GDP	0.107	Liu and Wu (2019)
α_{TR}	Output elasticity of physical capital in the tourism sector	0.150	Assumption
α_{NTR}	Output elasticity of physical capital in the non-tourism sector	0.300	Mankiw et al. (1992)
β_{TR}	Output elasticity of human capital in the tourism sector	0.071	Liu and Wu (2019)
β_{NTR}	Output elasticity of human capital in the non-tourism sector	0.300	Mankiw et al. (1992)

Liu and Wu (2019) estimate that labor-augmenting technological progress is 2.1 percent per year in the Spanish economy. Let us assume that labor-augmenting technological progress in the tourism sector is smaller than in the rest of the economy (e.g., Inchausti-Sintes, 2020a) and equals $g_{A_T} = 0.016$, while technological progress in the non-tourism sector follows the average growth rate of per capita GDP in Spain between 1961-2022 $g_{A_{NT}} = 0.021$ (World Bank, 2024). Figures 1 and 2 plot the time evolution of per capita GDP and sectoral output, respectively, considering 100 periods. Figure 3 presents the dynamics of the tourism share in total output. Figures 4-6 plot the growth rates of per capita GDP and sectoral outputs, respectively. The underlying set of equations used are taken from the previous sections and compiled in Appendix A.11. In all cases, we consider three possible values of the elasticity of substitution between sectors ($\varepsilon = 0; 1; 20$). That is, we consider situations where the tourism and non-tourism sectors are perfect complements ($\varepsilon = 0$), neither gross complements nor gross substitutes ($\varepsilon = 1$) and gross substitutes ($\varepsilon = 20$).

Let us first focus on the case where $\varepsilon = 1$ and therefore sectoral shares are constant ($\dot{\theta} = 0$). As set in Proposition 1, we see in Figures 2, 5 and 6 that the tourism sector grows at a smaller rate than the rest of the economy due to its assumed lower labor-augmenting technological progress and output elasticities with respect to capital stocks. On the contrary, when $\varepsilon = 0$ and both sectors are perfect complements, the economy tends to specialize in the tourism sector (i.e., $\dot{\theta} > 0$, Figure 3) at a sufficiently fast rate to maintain balanced growth rates across sectors. Note that perfect complementarity implies that aggregate output (1) follows a Leontief production function ($y = \min\left(\chi y_{TR}, (1-\chi)\, y_{NTR}\right)$), where the ratio of optimal relative sector output equals $y_{TR}/y_{NTR} = (1-\chi)/\chi$) and $\chi \in (0,1)$ is the parameter that measures the relative preference of tourism goods as in equation (1). In this case, per capita tourism output growth determines not only the per capita growth of the rest of the sectors, but also of per capita GDP. Because the tourism sector is more intensive in the use of the labour input, the shares of human and physical capital over national production decrease, thereby mid-term growth slows down due to the economy benefiting less of the capital deepening process. After the economy reaches its steady state or CGP, long-term growth also slows down due to lower labor-augmenting technological progress (Figures 1 and 4).

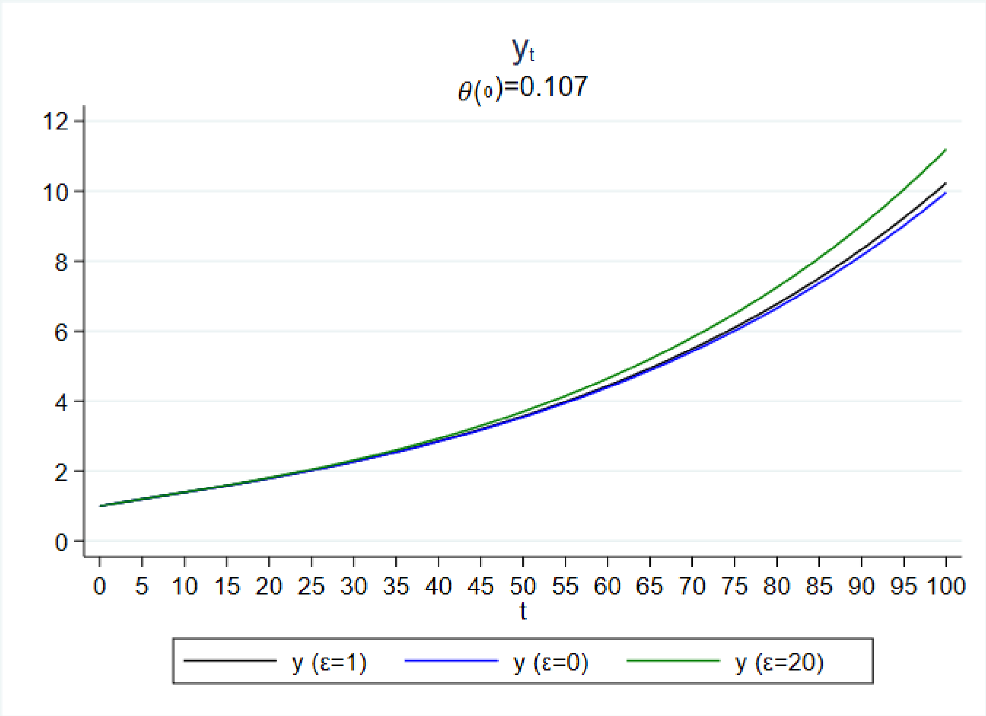

Figure 1. Time evolution of per capita GDP (y) under different elasticities of substitution

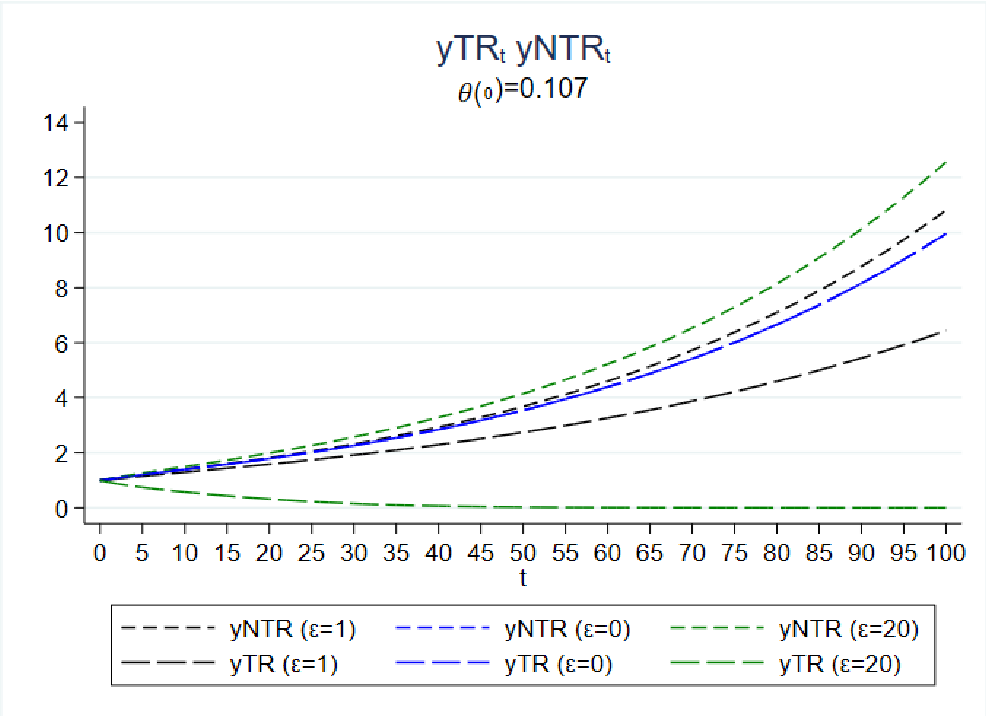

Figure 2. Time evolution of per capita sectoral output (y_{TR}, y_{NTR}) under different elasticities of substitution

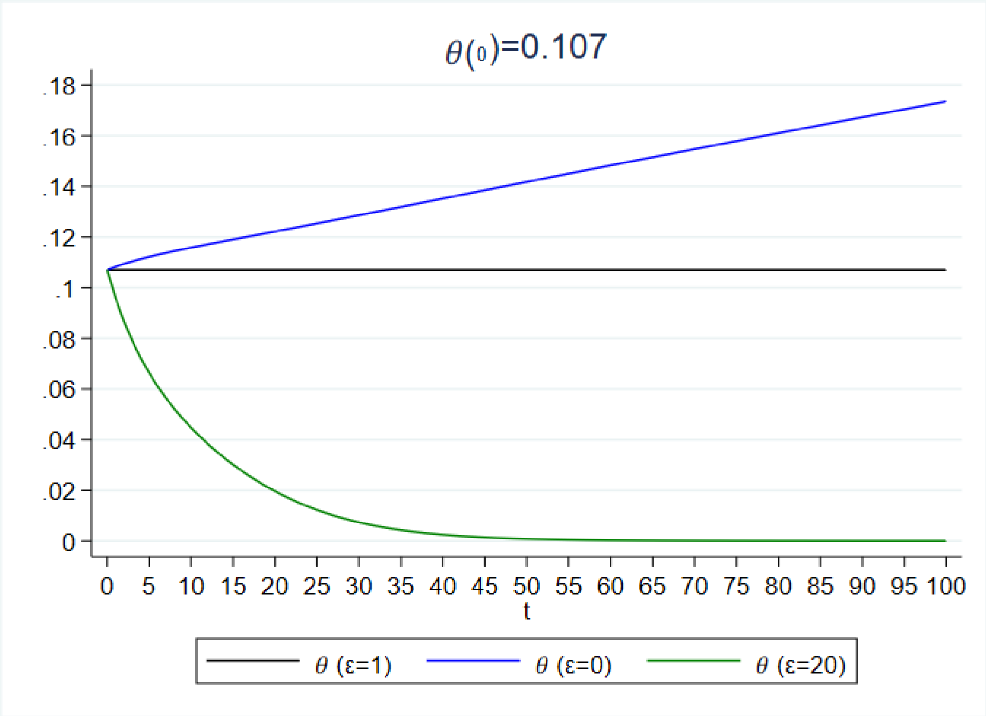

Figure 3. Time evolution of tourism share in total output (θ) under different elasticities of substitution

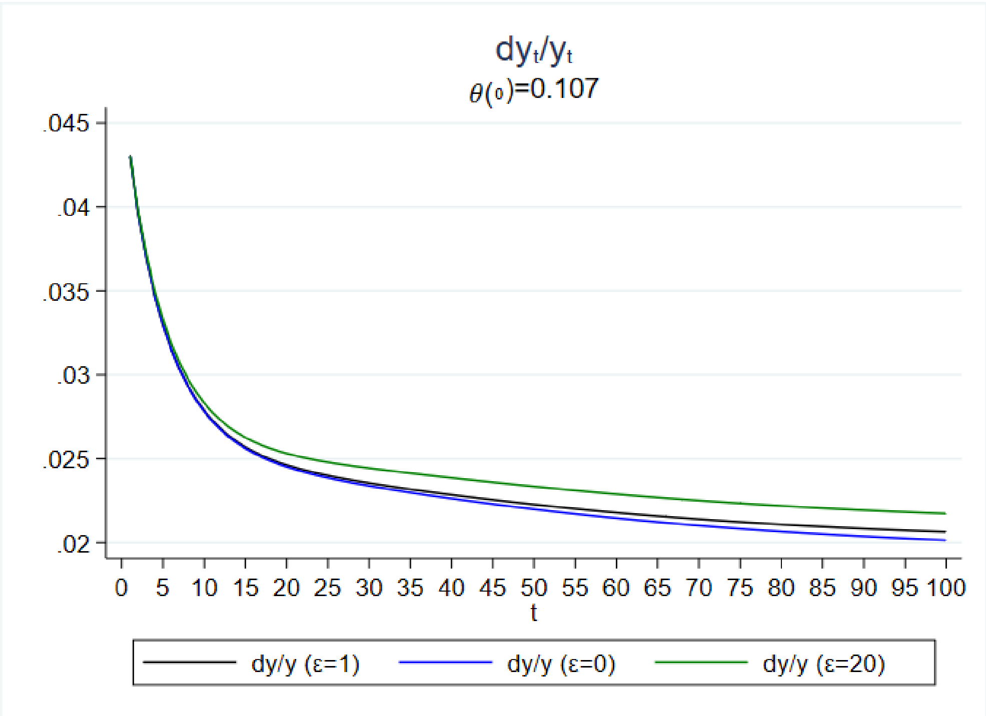

Figure 4. Time evolution of per capita GDP growth rates (dy/y) under different elasticities of substitution

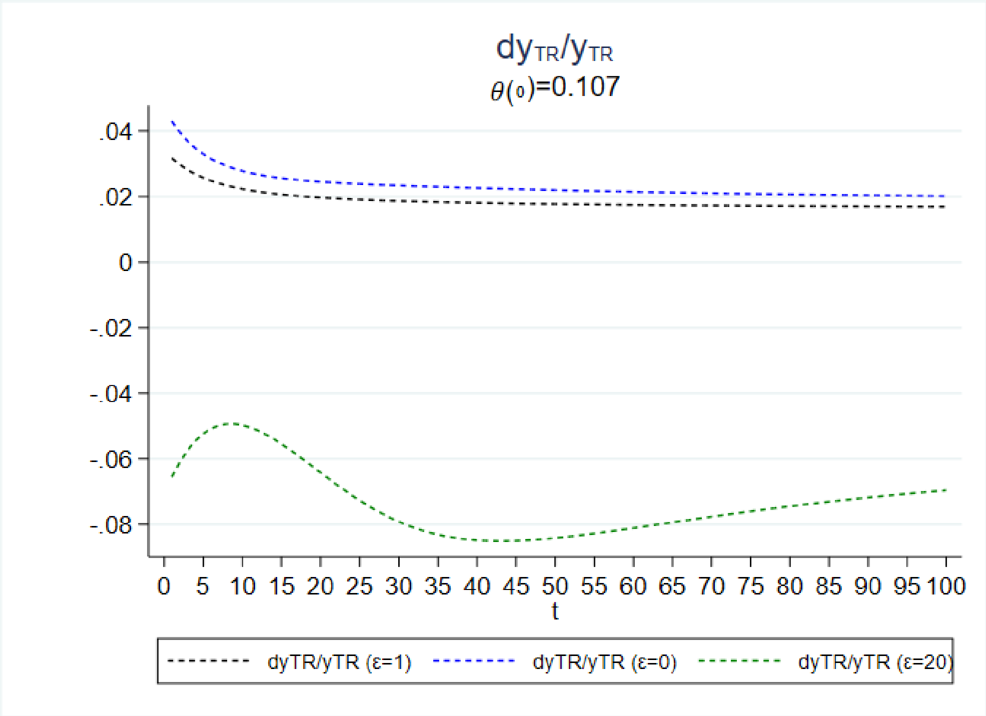

Figure 5. Time evolution of per capita tourism production growth rates (dy_{TR}/y_{TR}) under different elasticities of substitution

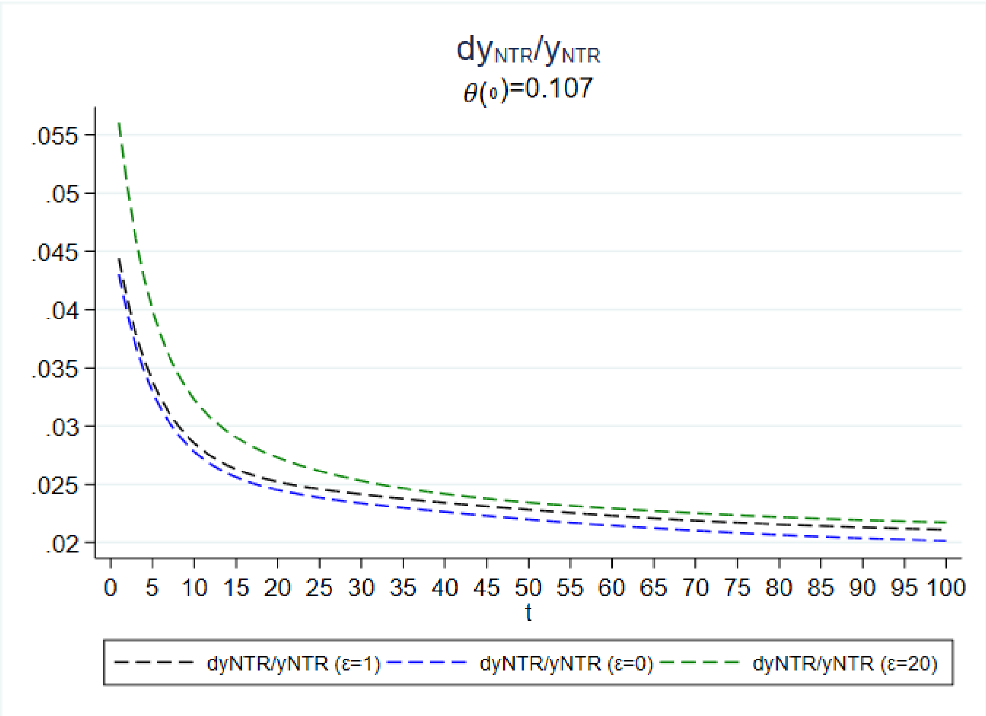

Figure 6. Time evolution of per capita non-tourism production growth rates (dy_{NTR}/y_{NTR}) under different elasticities of substitution

As ε is higher than one, the tourism sector can be easily substituted by more productive sectors (i.e., the economy can easily adjust its sectoral composition). As θ decreases, because aggregate demand shifts towards the cheaper sectors, inputs are reallocated from the tourism sector to the rest of the economy and converges towards zero (Figure 3). The rate at which θ decreases is inversely related with the elasticity of substitution ε. In the long run, the economy fully specializes into the non-tourism sector and therefore $y \rightarrow y_{NTR}$. Importantly, we can see that per capita GDP growth also increases with the elasticity of substitution (Figures 1 and 4). Because the tourism sector is less productive than the rest, the greater the substitutability between the sectors, the greater the output through a shift in resources from the least to the more productive sector.

This simulation is consistent with the *Beach Disease* hypothesis by which greater specialization in the tourism sector compromises long-term economic growth. This pattern is contingent on the differences in capital deepening and technological progress in both sectors. Importantly, if tourism were the leading sector, due to its intensity in the use of physical and human capital, along with a faster rate of technical change, then the figures would be reversed, and tourism specialization would be associated with better growth paths consistent with the *Tourism-Led* growth hypothesis.

3.7. Estimation of per capita GDP and capital growth, and their dependence on the tourism sector

Our goal is to provide a sound and relatively simple foundation for estimable equations that allow *Tourism-Led* growth against the *Beach Disease* hypotheses to be empirically tested. To this end, we derive linear equations that can be used by researchers to test whether tourism specialization hampers or fosters per capita GDP growth and per capita physical and human capital accumulation. We follow the strategy of growth regressions initiated by Barro (1991), Barro and Sala-i-Martin (1992) and Mankiw et al. (1992).

Departing from capital fundamental equations (5) and (6), and aggregate gross output production (36), the first-order Taylor expansions of per capita gross output and capital growth in the neighborhood of the steady state are given by:

$$\frac{\dot{y}}{y} \approx \rho_0 + \rho_1\theta + \rho_2 \ln k + \rho_3 \ln h - (\rho_2 + \rho_3) \ln A \tag{51}$$

$$\frac{\dot{k}}{k} \approx \eta_0 + \eta_1\theta + \eta_2 \ln k + \eta_3 \ln h - (\eta_2 + \eta_3) \ln A \tag{52}$$

$$\frac{\dot{h}}{h} \approx \phi_0 + \phi_1\theta + \phi_2 \ln k + \phi_3 \ln h - (\phi_2 + \phi_3) \ln A \tag{53}$$

where ρ_1, η_1 and ϕ_1 are the key parameters of interest, capturing the marginal effect of the share of the tourism sector over national income on output, physical and human capital growth rates. These parameters can be either positive, negative, or null depending on which sector presents a higher labor-augmenting technological progress. More precisely, if the tourism sector presents a higher potential to increase the productivity of the labor force compared to other sectors, ρ_1, η_1, and ϕ_1 should be positive, providing evidence in favor of the *Tourism-Led Growth* hypothesis. On the contrary, if they were negative, this would be a formal test in support of the *Beach Disease* hypothesis.

The coefficients associated with capital stocks must satisfy $\rho_2 < 0$, $\rho_3 < 0$, $\eta_2 < 0$, $\eta_3 > 0$, $\phi_2 > 0$ and $\phi_3 < 0$ (see Appendixes A.9 and A.10). These signs correspond to the idea of the existence of a steady state associated with diminishing returns in each private input. Accordingly, those economies with relatively low levels of capital stock are expected to grow initially faster than other economies with higher levels of capital stock and similar steady states.

Furthermore, if we assumed that differences in physical and human capital depreciation rates are minimal ($\delta_K \approx \delta_H \approx \delta$), as in Mankiw et al. (1992) and Barro and Sala-i-Martin (2004), equation (51) could be read as:

$$\frac{\dot{y}}{y} \approx \psi + \rho_1\theta + \zeta \ln \mathrm{y} - \zeta \ln A \tag{54}$$

The constant term ψ contains the determinants of the steady state of the economy, such as saving and depreciation rates, among others (Appendixes A.9 and A.10). Therefore, a proper identification of ρ_1 in equation (54) at the empirical level requires including country fixed effects, as well as exogenous regressors associated with the steady state, as in the works of Barro (1991) and Barro and Sala-i-Martin (1992, 2004).

In the following section, we provide some recommendations and suggestions for applied researchers interested in empirically testing the *Tourism-Led* against the *Beach Disease* hypothesis using Equations (52)-(54).

4. SUGGESTIONS FOR EMPIRICAL APPLICATIONS OF THE MODEL

4.1. Cross-sectional and panel specifications of the model

Suppose we have a panel dataset of N regions or countries (i=1,…, N) observed during T periods (t=1,…, T). To investigate the link between specialization in the tourism sector and economic growth during the study period, we could estimate the following linear-log regression model:

$$g_{GDPpc_i} = \alpha + \gamma \ln GDPpc_{i1} + \beta \ln \frac{TOU_{i1}}{GDP_{i1}} + \lambda X_{i1} + \epsilon_i \tag{55}$$

where g_{GDPpc_i} is the growth rate of each country i between $t = 1$ and $t = T$, α is a constant term, $GDPpc_{i1}$ is the GDP per capita at $t = 1$, $\frac{TOU_{i1}}{GDP_{i1}}$ is the share that the tourism industry represents over GDP at $t = 1$, X_{i1} are a set of control variables (see below), and ϵ_i is a normally distributed error term.[18]

Equation (55) is the empirical counterpart of Equation (54), where $g_{GDPpc_i} = \frac{\dot{y}}{y}$; $\alpha = \psi$; $\gamma = \rho_1$; $\frac{TOU_{i1}}{GDP_{i1}} = \theta$; $\gamma = \zeta$; $\ln GDPpc_{i1} = \ln y$. A similar model equation can be used for Equations (52) and (53) using physical and human capital input growth rates as dependent variables. Because of its linearity, equation (55) is a cross-sectional regression that can be easily estimated by Ordinary Least Squares (OLS). It relates the growth rate in GDP per

[18] Because the logarithm of aggregate productivity levels ($\ln A$) is typically unobserved, it would be subsumed in ϵ_i. Although endogenous growth models show that its growth rate (i.e., $\ln A\,(t) - \ln A\,(t - 1)$) is determined by the steady-state elements contained in ρ_0, η_0 and ϕ_0 in Equation (51), to get consistent estimates of the parameters we must take the assumption that $\ln A$ is orthogonal to all other variables (Acemoglu, 2009).

capita of country *i* between $t = 1$ and $t = T$ to GDP per capita, tourism specialization and other determinants of the steady state of the economy (X_{i1}), where subindex 1 refers to the first observation period. The right-hand side variables are log-transformed following common practice to consider potential non-linearities. The key parameter of interest is β, which captures how differences in tourism specialization at the baseline period across countries affect their long-run economic growth.

Equation (55) resembles the typical specification adopted in the growth literature (Barro, 1991; Barro & Sala-i-Martín, 1992). X_{i1} should include variables that determine the steady state of the economy like years of schooling, population growth rates, depreciation rate of physical capital stock, private saving rates or sociodemographic characteristics of the population. One important limitation of Equation (55) is that β might be biased due to omitted variables. The consistent estimation of β requires any growth shock ϵ_i to be uncorrelated with tourism specialization. Any variable omitted from the regression that affects economic growth and correlates with the share tourism represents over total GDP would thus lead to misleading estimates.[19] Even if we consider a rich vector of control variables in X_{i1}, it is unlikely that all relevant factors affecting ${g_{GDPpc}}_i$ are included.

To deal with this, there are different possibilities. One of them is to run the cross-sectional regression in (55) and then inspect the sensitivity of the results to unobserved confounding factors. Under the assumption that selection in observed controls is proportional to selection in unobserved factors, one can estimate the degree of selection in unobservables that makes the coefficient of interest to become zero. Some examples of this sort of sensitivity analyses are Altonji et al. (2005), Oster (2019), or Masten et al. (2023).

In case the researcher has access to long time series for the panel units (e.g., more than ten periods), a second possibility is to transform the cross-sectional regression in (55) to a panel regression so that country individual effects can be included. That is, rather than consider growth rates during long time spans, one can calculate growth rates during subintervals of the sample period (e.g., Figini & Vici, 2010). For example, if we have 15 periods, we can calculate

[19] This is the well-known Levine-Renelt critique (Levine & Renelt, 1992). These authors show that results from cross-sectional growth regressions are highly sensitive to the variables included in the conditioning set. See Sala-i-Martín (1994) for discussion.

growth rates for five-year intervals so that we end with three observations per country. Accordingly, the regression equation becomes:

$$g_{GDPpc_{it}} = \alpha_i + \gamma \ln GDPpc_{it-s} + \beta \ln \frac{TOU_{it-s}}{GDP_{it-s}} + \lambda X_{it-s} + \epsilon_{it} \qquad (56)$$

where α_i are country individual effects capturing any time-invariant unobserved factor that could explain differences in economic growth across countries, and *s* denotes the width of the subinterval over which growth rates are computed.

4.2.Time-varying confounding factors and potential solutions

Although the inclusion of country fixed effects in Equation (56) improves the precision of the estimate of β by exploiting the within-country variation in growth rates and tourism specialization, this solution does not completely rule out the bias from unobserved time-varying confounders. If the researcher wants to give β a causal interpretation, then it is highly recommended to use Instrumental Variables (IV). One needs to find a variable that is correlated with tourism specialization (relevance condition) but uncorrelated with GDP per capita growth rates (exogeneity condition). Finding this sort of variables is not an easy task; while different covariates likely correlate with the share the tourism represents over GDP, most of them also correlate with GDP growth rates through different potential channels.

Authors like Chang et al. (2012) and Zuo and Huang (2018) have used the number of World Heritage Sites and developed scenic spots per surface area, respectively, as instruments. Although these variables might fulfill the relevance condition for an instrument, their use could be problematic in panel settings whenever they exhibit reduced temporal variation. When indicators of hedonic attractiveness that are plausibly orthogonal to growth shocks do not vary sufficiently over time, they will have little capacity to correct for time-varying confounders. They could be nonetheless quite useful to deal with endogeneity for cross-sectional growth regressions like that in Equation (55).

A recent stream of applied econometrics literature has recently adopted Bartik instruments (Bartik, 1991) based on shift-share decompositions. The reader is referred to Golsdmith-Pinkham et al. (2020) and Borusyak et al. (2022) for an overview of this method. Intuitively, this consists of exploiting heterogeneity across countries in the exposure to common temporal shocks to construct an artificial instrument for plausibly endogenous covariates. This methodology has been used to get clean estimates of how arrivals affect government revenue (Mohan & Strobl, 2023), the effect of tourism inflows on human capital and migratory flows in Italy (Di Giacomo & Lerch, 2023), to investigate the effect of tourism inflows on local labour markets (González & Surovtseva, 2023), or to examine the tourism-economic growth nexus (Bronzini et al., 2022). In our view, the application of Bartik type instruments is very promising to provide credible estimates of the causal effect of tourism development on economic growth. This can be easily applied following the theoretical foundations of our macroeconomic growth model.

5. CONCLUSIONS

This paper has presented a novel theoretical model on the tourism-economic growth nexus. Based on standard neoclassical assumptions, we build upon Acemoglu (2009) and Acemoglu and Guerrieri (2008) and characterize the steady-state of a two-sector economy with tourism and non-tourism production. This model shows that in the presence of different rates of labor-augmenting technological progress and output elasticities, the two sectors can grow at different rates in the long term (unbalanced growth paths). If the tourism sector is less capital intensive (more labor intensive) and presents lower technological progress than the rest of the economy, a greater exogenous specialization in tourism services places the economy into a slower growth pace. That is, the tourism is a laggard sector that deaccelerates the economy in the long run as predicted by the *Beach Disease* hypothesis. Furthermore, this process occurs endogenously as the economy presents high rigidities in terms of substitutability between the tourism sector and the rest of the economy (i.e., the demand side and/or the supply side of the economy consider the tourism sector as an irreplaceable sector). On the contrary, if the tourism sector is more capital intensive and experiences faster technological progress, a greater share of national income from tourism activities fosters economic growth in the long run as predicted by the *Tourism-Led Growth* hypothesis.

An appealing feature of our theoretical model is that we deliver a tractable equation for empirically testing the role of tourism development on output, physical and human capital growth dynamics. Our model collapses to a linear equation that is easily estimable using standard regression methods. The empirical counterpart of the theoretical model thus allows researchers to test empirically whether tourism specialization fosters or dampers long-run economic growth. Importantly, the model provides some rationale about the determinants of the steady state of the economy that needs to be controlled for to get consistent estimates. We have also discussed some strategies to examine the robustness of the analysis to omitted variables and the usefulness of Bartik shift-share instruments to provide credible estimates of the tourism-economic growth nexus.

Our model has some limitations and caveats that we consider as valuable avenues for future research. First, as it happens with any theoretical model, our framework lies on several assumptions about the production technology, the constant elasticity of substitution between sectors, or the exogeneity of saving rates and labour-augmenting technological change. Future studies could expand our model to allow for these variables to be endogenously determined. Second, we do not consider spatial spillovers in the link between tourism and economic growth (e.g., Liu et al., 2022); we assume there are no geographical spillovers in tourism production. It would be interesting to expand the work to consider spatial complementarities. Third, we consider tourism production as an aggregate and do not distinguish between domestic and international tourism. Future studies could expand out model to consider potential differences depending on domestic vs international specialization in tourism production.

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APPENDIX

A.1 Derivation of allocation shares

Consider equations (26)-(28) and rearrange them into the relative input demand functions:

$$\frac{L_{NTR}}{L_{TR}} = \frac{(1-\theta)(1-\alpha_{NTR}-\beta_{NTR})}{\theta(1-\alpha_{TR}-\beta_{TR})} \tag{A1}$$

$$\frac{K_{NTR}}{K_{TR}} = \frac{(1-\theta)\alpha_{NTR}}{\theta\alpha_{TR}} \tag{A2}$$

$$\frac{H_{NTR}}{H_{TR}} = \frac{(1-\theta)\beta_{NTR}}{\theta\beta_{TR}} \tag{A3}$$

Now rearrange the market-clearing conditions (9)-(11) as:

$$L_{NTR} = L - L_{TR} \tag{A4}$$

$$K_{NTR} = K - K_{TR} \tag{A5}$$

$$H_{NTR} = H - H_{TR} \tag{A6}$$

Using equations (A4)-(A6) in (A1)-(A3) leads to:

$$\frac{L - L_{TR}}{L_{TR}} = \frac{(1-\theta)(1-\alpha_{NTR}-\beta_{NTR})}{\theta(1-\alpha_{TR}-\beta_{TR})} \tag{A7}$$

$$\frac{K - K_{TR}}{K_{TR}} = \frac{(1-\theta)\alpha_{NTR}}{\theta\alpha_{TR}} \tag{A8}$$

$$\frac{H - H_{TR}}{H_{TR}} = \frac{(1-\theta)\beta_{NTR}}{\theta\beta_{TR}} \tag{A9}$$

Solving (A7)-(A9) for the demand of each input by the tourism sector yields the allocation shares of (29)-(31).

A.2 Effect of sector shares on allocation shares

The derivatives of allocation shares to the tourism sector with respect to the share of that sector equal:

$$\frac{\partial \gamma_L}{\partial \theta} = \frac{(1-\alpha_{TR}-\beta_{TR})\left(1-\alpha_{NTR}-\beta_{NTR}-\theta(\alpha_{TR}+\beta_{TR}-\alpha_{NTR}-\beta_{NTR})\right)}{\left(1-\alpha_{NTR}-\beta_{NTR}-\theta(\alpha_{TR}+\beta_{TR}-\alpha_{NTR}-\beta_{NTR})\right)^2} \tag{A10}$$

$$\frac{\partial \gamma_K}{\partial \theta} = \frac{\alpha_{TR}\left(\alpha_{NTR}+\theta(\alpha_{TR}-\alpha_{NTR})\right)-\theta\alpha_{TR}(\alpha_{TR}-\alpha_{NTR})}{\left(\alpha_{NTR}+\theta(\alpha_{TR}-\alpha_{NTR})\right)^2} \tag{A11}$$

$$\frac{\partial \gamma_H}{\partial \theta} = \frac{\beta_{TR}\left(\beta_{NTR}+\theta(\beta_{TR}-\beta_{NTR})\right)-\theta\beta_{TR}(\beta_{TR}-\beta_{NTR})}{\left(\beta_{NTR}+\theta(\beta_{TR}-\beta_{NTR})\right)^2} \tag{A12}$$

These derivatives are positive if, and only if:

$$1-\alpha_{NTR}-\beta_{NTR} > 0 \tag{A13}$$

$$\alpha_{NTR} > 0 \tag{A14}$$

$$\beta_{NTR} > 0 \tag{A15}$$

which are always true since private inputs are essential for production functions (2) and (3).

A.3 Homogeneity of a composed function

Consider the following composed function homogenous of degree s in vector $X = (x_1, \dots, x_N)$

$$\lambda^s \mathrm{y}(X) = \mathrm{y}(\lambda X) \tag{A16}$$

This equation implies that increasing the elements of the X vector r times in proportion λ equals:

$$\lambda^{sr} \mathrm{y}(X) = \mathrm{y}(\lambda^r X) \tag{A17}$$

Now, assume each element of the vector X also follows a homogenous function of degree r in vector Z_i. That is:

$$\lambda^r x_i(Z_i) = x_i(\lambda Z_i) \tag{A18}$$

Using (A18) in (A17) leads to the homogenous function of degree sr in vectors Z_i:

$$\lambda^{sr}\mathrm{y}(X) = \mathrm{y}\big(x_1(\lambda Z_1), \dots, x_N(\lambda Z_N)\big) \tag{A19}$$

For instance, if both y and x_i functions were homogenous of degree 1, that is $s = 1$ and $r = 1$ (as in our case), (A19) will be homogenous of degree 1 in each element of vectors Z_i.

A.4 Proof of Proposition 1

Consider the simplest case of the difference between (38) and (39), where we assume $\dot{\gamma}_{TR} = \dot{\gamma}_{NTR} = 0$, and denote it as $\dot{Z}/Z$. That is:

$$\begin{aligned} \frac{\dot{Z}}{Z} &= \left(\frac{\dot{Y}_{TR}}{Y_{TR}} - \frac{\dot{Y}_{NTR}}{Y_{NTR}}\right)\Bigg|_{\dot{\gamma}_{TR}=\dot{\gamma}_{NTR}=0} \\ &= (1-\alpha_{TR}-\beta_{TR})g_{A_{TR}} - (1-\alpha_{NTR}-\beta_{NTR})g_{A_{NTR}} \\ &\quad +(\alpha_{TR}-\alpha_{NTR})\frac{\dot{k}}{k} + (\beta_{TR}-\beta_{NTR})\frac{\dot{h}}{h} \end{aligned} \tag{A20}$$

A positive value in (A20) requires:

$$\begin{aligned} &(1-\alpha_{TR}-\beta_{TR})g_{A_{TR}} - (1-\alpha_{NTR}-\beta_{NTR})g_{A_{NTR}} \\ &> (\alpha_{NTR}-\alpha_{TR})\frac{\dot{k}}{k} + (\beta_{NTR}-\beta_{TR})\frac{\dot{h}}{h} \end{aligned} \tag{A21}$$

Equation (A21) implies that the effective technology in the tourism sector $(1-\alpha_{TR}-\beta_{TR})g_{A_{TR}}$ must grow at a positive, and at a sufficiently faster rate compared to its counterpart in the non-tourism sector $(1-\alpha_{NTR}-\beta_{NTR})g_{A_{NTR}}$, as long as there is capital deepening in the economy ($\dot{k} > 0$, $\dot{h} > 0$) and the non-tourism sector is relatively more intensive in the use of capital according to rule:

$$\alpha_{NTR} + \frac{\dot{h}/h}{\dot{k}/k}\beta_{NTR} > \alpha_{TR} + \frac{\dot{h}/h}{\dot{k}/k}\beta_{TR} \tag{A22}$$

The tourism sector can also grow faster than the non-tourism sector even when technological progress is identical across sectors $g_{A_{TR}} = g_{A_{NTR}} = g$, if, and only if:

$$\alpha_{NTR} + \frac{g - \dot{h}/h}{g - \dot{k}/k}\beta_{NTR} > \alpha_{TR} + \frac{g - \dot{h}/h}{g - \dot{k}/k}\beta_{TR} \tag{A23}$$

If factor intensities are identical across sectors, $\alpha_{TR} = \alpha_{NTR}$, and $\beta_{TR} = \beta_{NTR}$, for faster growth in the tourism sector, its technological progress must fulfil:

$$g_{A_{TR}} > \frac{1 - \alpha_{NTR} - \beta_{NTR}}{1 - \alpha_{TR} - \beta_{TR}} g_{A_{NTR}} \tag{A24}$$

Now, if we allow for positive growth in the tourism allocation shares, thus $\dot{\gamma}_{TR} > 0$; $\dot{\gamma}_{NTR} > 0$, the difference in sector growth rates can be read as:

$$\frac{\dot{Y}_{TR}}{Y_{TR}} - \frac{\dot{Y}_{NTR}}{Y_{NTR}} = \frac{\dot{Z}}{Z} + \frac{\dot{\gamma}_{TR}}{\gamma_{TR}} + \frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}} \tag{A25}$$

In order to obtain a positive value in (A25), we need:

$$\frac{\dot{Z}}{Z} > -\left(\frac{\dot{\gamma}_{TR}}{\gamma_{TR}} + \frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}}\right) \tag{A26}$$

Since we have proven in (A21)-(A24) the requirements for $\dot{Z}/Z > 0$, it is easy to see that when the tourism sector benefits from the reallocation of inputs from the non-tourism sector, $\dot{\gamma}_{TR}/\gamma_{TR} > 0$ and $\dot{\gamma}_{NTR}/\gamma_{NTR} > 0$, the conditions that lead to $\dot{Z}/Z > 0$ are relaxed. For different rates of effective technological progress $(1 - \alpha_{TR} - \beta_{TR})g_{A_{TR}} \neq (1 - \alpha_{NTR} - \beta_{NTR})g_{A_{NTR}}$, this is formalized as:

$$\begin{aligned} &(1 - \alpha_{TR} - \beta_{TR})g_{A_{TR}} - (1 - \alpha_{NTR} - \beta_{NTR})g_{A_{NTR}} \\ &> (\alpha_{NTR} - \alpha_{TR})\frac{\dot{k}}{k} + (\beta_{NTR} - \beta_{TR})\frac{\dot{h}}{h} - \left(\frac{\dot{\gamma}_{TR}}{\gamma_{TR}} + \frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}}\right) \end{aligned} \tag{A27}$$

for identical rates of technological progress $g_{A_{TR}} = g_{A_{NTR}} = g$

$$\alpha_{NTR} + \frac{g - \dot{h}/h}{g - \dot{k}/k}\beta_{NTR} > \alpha_{TR} + \frac{g - \dot{h}/h}{g - \dot{k}/k}\beta_{TR} - \left(\frac{\dot{\gamma}_{TR}}{\gamma_{TR}} + \frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}}\right) \tag{A28}$$

and for identical factor intensities $\alpha_{TR} = \alpha_{NTR}$ and $\beta_{TR} = \beta_{NTR}$

$$g_{A_{TR}} > \frac{1 - \alpha_{NTR} - \beta_{NTR}}{1 - \alpha_{TR} - \beta_{TR}} g_{A_{NTR}} - \left(\frac{\dot{\gamma}_{TR}}{\gamma_{TR}} + \frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}}\right) \tag{A29}$$

A.5 Derivation of growth rates for aggregate gross output

Consider the time derivative of equation (1), and divide by Y which equals

$$\frac{\dot{Y}}{Y} = \frac{F'_{TR}}{Y}\dot{Y}_{TR} + \frac{F'_{NTR}}{Y}\dot{Y}_{NTR} \tag{A30}$$

Now, (A30) can be rewritten as

$$\frac{\dot{Y}}{Y} = \frac{F'_{TR}Y_{TR}}{Y}\frac{\dot{Y}_{TR}}{Y_{TR}} + \frac{F'_{NTR}Y_{NTR}}{Y}\frac{\dot{Y}_{NTR}}{Y_{NTR}} \tag{A31}$$

Recalling (14) and (15), we have:

$$\frac{\dot{Y}}{Y} = \theta\frac{\dot{Y}_{TR}}{Y_{TR}} + (1-\theta)\frac{\dot{Y}_{NTR}}{Y_{NTR}} \tag{A32}$$

Now, if we substitute (38) and (39) in (A32), we obtain:

$$\begin{aligned}\frac{\dot{Y}}{Y} &= \theta\left((1-\alpha_{TR}-\beta_{TR})g_{A_{TR}} + g_L + \frac{\dot{\gamma}_{TR}}{\gamma_{TR}} + \alpha_{TR}\frac{\dot{k}}{k} + \beta_{TR}\frac{\dot{h}}{h}\right)\\ &+(1-\theta)\left((1-\alpha_{NTR}-\beta_{NTR})g_{A_{NTR}} + g_L - \frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}} + \alpha_{NTR}\frac{\dot{k}}{k} + \beta_{NTR}\frac{\dot{h}}{h}\right)\end{aligned} \tag{A33}$$

Rearranging (A33), and using (32) and (33) yields:

$$\begin{aligned}\frac{\dot{Y}}{Y} &= g_L + \theta(1-\alpha_{TR}-\beta_{TR})g_{A_{TR}} + (1-\theta)(1-\alpha_{NTR}-\beta_{NTR})g_{A_{NTR}}\\ &+ \bar{\alpha}\frac{\dot{k}}{k} + \bar{\beta}\frac{\dot{h}}{h} + \theta\frac{\dot{\gamma}_{TR}}{\gamma_{TR}} - (1-\theta)\frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}}\end{aligned} \tag{A34}$$

Now, we focus on $\theta\frac{\dot{\gamma}_{TR}}{\gamma_{TR}} - (1-\theta)\frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}}$. Using (40) and (41), and rearranging, this equals:

$$\theta\frac{\dot{\gamma}_{TR}}{\gamma_{TR}}-(1-\theta)\frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}}=\left(\theta(1-\alpha_{TR}-\beta_{TR})-(1-\theta)(1-\alpha_{NTR}-\beta_{NTR})\frac{\gamma_L}{1-\gamma_L}\right)\frac{\dot{\gamma}_L}{\gamma_L}+\left(\theta\alpha_{TR}-(1-\theta)\alpha_{NTR}\frac{\gamma_K}{1-\gamma_K}\right)\frac{\dot{\gamma}_K}{\gamma_K}+\left(\theta\beta_{TR}-(1-\theta)\beta_{NTR}\frac{\gamma_H}{1-\gamma_H}\right)\frac{\dot{\gamma}_H}{\gamma_H} \tag{A35}$$

Substitute (29)-(31) in (A35) to obtain:

$$\theta\frac{\dot{\gamma}_{TR}}{\gamma_{TR}}-(1-\theta)\frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}}=\left(\theta(1-\alpha_{TR}-\beta_{TR})-(1-\theta)(1-\alpha_{NTR}-\beta_{NTR})\frac{\theta(1-\alpha_{TR}-\beta_{TR})}{1-\bar{\alpha}-\bar{\beta}-\theta(1-\alpha_{TR}-\beta_{TR})}\right)\frac{\dot{\gamma}_L}{\gamma_L}+\left(\theta\alpha_{TR}-(1-\theta)\alpha_{NTR}\frac{\theta\alpha_{TR}}{\bar{\alpha}-\theta\alpha_{TR}}\right)\frac{\dot{\gamma}_K}{\gamma_K}+\left(\theta\beta_{TR}-(1-\theta)\beta_{NTR}\frac{\theta\beta_{TR}}{\bar{\beta}-\theta\beta_{TR}}\right)\frac{\dot{\gamma}_H}{\gamma_H} \tag{A36}$$

Now use (32) and (33) in (A36). This yields:

$$\theta\frac{\dot{\gamma}_{TR}}{\gamma_{TR}}-(1-\theta)\frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}}=0 \tag{A37}$$

Using (A37) in (A34), and multiplying and dividing $\theta(1-\alpha_{TR}-\beta_{TR})g_{A_{TR}}+(1-\theta)(1-\alpha_{NTR}-\beta_{NTR})g_{A_{NTR}}$ by $1-\bar{\alpha}-\bar{\beta}$, leads to (42) and (43).

A.6 Dynamics of sector shares over national income

The elasticity of substitution between two goods is defined as the negative percentage change in the ratio of both goods when the ratio of prices increases by 1%, that is:

$$\varepsilon=-\frac{\Delta\%(Y_{TR}/Y_{NTR})}{\Delta\%(p_{TR}/p_{NTR})} \tag{A38}$$

Since we are interested in changes over time, (A38) can be rewritten in terms of percentage changes throughout time, that is:

$$\varepsilon=-\frac{\frac{\dot{Y}_{TR}}{Y_{TR}}-\frac{\dot{Y}_{NTR}}{Y_{NTR}}}{\frac{\dot{p}_{TR}}{p_{TR}}-\frac{\dot{p}_{NTR}}{p_{NTR}}} \tag{A39}$$

Taking logs of (24) and (25) and deriving with respect to time yields:

$$\frac{\dot{p}_{TR}}{p_{TR}} - \frac{\dot{p}_{NTR}}{p_{NTR}} = \left(\frac{1}{1-\theta}\right)\frac{\dot{\theta}}{\theta} - \left(\frac{\dot{Y}_{TR}}{Y_{TR}} - \frac{\dot{Y}_{NTR}}{Y_{NTR}}\right) \tag{A40}$$

Using (A40) in (A39), and rearranging we obtain:

$$\dot{\theta} = \left(1 - \frac{1}{\varepsilon}\right)\left(\frac{\dot{Y}_{TR}}{Y_{TR}} - \frac{\dot{Y}_{NTR}}{Y_{NTR}}\right)(1-\theta)\theta \tag{A41}$$

Now, since $\frac{\dot{Y}_{TR}}{Y_{TR}}$ and $\frac{\dot{Y}_{NTR}}{Y_{NTR}}$ are functions of the growth rates of sector allocation shares (40) and (41), which at the same time are functions of the growth rates of sector income shares, we focus first on the difference in sector growth rates. Use first (A25), and substitute (40) and (41) in it. We have then:

$$\frac{\dot{Y}_{TR}}{Y_{TR}} - \frac{\dot{Y}_{NTR}}{Y_{NTR}} = \frac{\dot{Z}}{Z} + \frac{1}{1-\theta}\left((1-\alpha_{TR}-\beta_{TR})\frac{\dot{\gamma}_L}{\gamma_L} + \alpha_{TR}\frac{\dot{\gamma}_K}{\gamma_K} + \beta_{TR}\frac{\dot{\gamma}_H}{\gamma_H}\right) \tag{A42}$$

Now, the growth rates of (29)-(31) equal:

$$\frac{\dot{\gamma}_L}{\gamma_L} = \frac{\dot{\theta}}{\theta} + \frac{\dot{\bar{\alpha}} + \dot{\bar{\beta}}}{1-\bar{\alpha}-\bar{\beta}} \tag{A43}$$

$$\frac{\dot{\gamma}_K}{\gamma_K} = \frac{\dot{\theta}}{\theta} - \frac{\dot{\bar{\alpha}}}{\bar{\bar{\alpha}}} \tag{A44}$$

$$\frac{\dot{\gamma}_H}{\gamma_H} = \frac{\dot{\theta}}{\theta} - \frac{\dot{\bar{\beta}}}{\bar{\bar{\beta}}} \tag{A45}$$

Substituting (A43)-(A45) in (A42) yields:

$$\frac{\dot{Y}_{TR}}{Y_{TR}} - \frac{\dot{Y}_{NTR}}{Y_{NTR}} = \frac{\dot{Z}}{Z} + \frac{1}{1-\theta}\left(\frac{\dot{\theta}}{\theta} + (1-\alpha_{TR}-\beta_{TR})\frac{\dot{\bar{\alpha}} + \dot{\bar{\beta}}}{1-\bar{\alpha}-\bar{\beta}} - \alpha_{TR}\frac{\dot{\bar{\alpha}}}{\bar{\bar{\alpha}}} - \beta_{TR}\frac{\dot{\bar{\beta}}}{\bar{\bar{\beta}}}\right) \tag{A46}$$

The dynamics of (32)-(33) equal:

$$\dot{\bar{\alpha}} = (\alpha_T - \alpha_N)\dot{\theta} \tag{A47}$$

$$\dot{\bar{\beta}} = (\beta_T - \beta_N)\dot{\theta} \tag{A48}$$

Finally, (A46) equals:

$$\frac{\dot{Y}_{TR}}{Y_{TR}} - \frac{\dot{Y}_{NTR}}{Y_{NTR}} = \frac{\dot{Z}}{Z} + \frac{1 + (\gamma_L - \gamma_K)(\alpha_{TR} - \alpha_{NTR}) + (\gamma_L - \gamma_H)(\beta_{TR} - \beta_{NTR})}{1-\theta}\frac{\dot{\theta}}{\theta} \tag{A49}$$

Substituting (A49) in (A41) and rearranging yields:

$$\dot{\theta} = \frac{(\varepsilon - 1)}{1 - (\varepsilon - 1)[(\gamma_L - \gamma_K)(\alpha_{TR} - \alpha_{NTR}) + (\gamma_L - \gamma_H)(\beta_{TR} - \beta_{NTR})]} \frac{\dot{Z}}{Z}(1 - \theta)\theta \quad \text{(A50)}$$

According to (A50), it is straightforward to see that for balanced sector growth $\dot{Z}/Z = 0$, or unitary elasticity of substitution $\varepsilon = 1$, sector shares are constant. When we have unbalanced growth, (A50) is different than zero as long as the elasticity of substitution is different than 1 and $0 < \theta < 1$. It converges asymptotically to zero as the economy specializes perfectly in one sector. In this sense, when both sectors are gross complements ($\varepsilon < 1$), the dynamics in (A50) are positive (negative) if the non-tourism sector grows faster (slower) than the tourism sector, until $\theta = 1$ ($\theta = 0$). When both sectors are gross substitutes ($\varepsilon > 1$), the dynamics in (A50) are positive (negative) as long as the non-tourism sector grows slower (faster) than the tourism sector, until $\theta = 1$ ($\theta = 0$).

It is important to highlight that (A50) only works properly as long as $(\gamma_L - \gamma_K)(\alpha_{TR} - \alpha_{NTR}) + (\gamma_L - \gamma_H)(\beta_{TR} - \beta_{NTR}) < \frac{1}{\varepsilon - 1}$ is true in the neighborhood of the steady state. Otherwise, the denominator in (A50) equals 0, and the result is undetermined, or takes a negative value, and the equation no longer follows the logics of the model. To see the latter, consider for instance the non-tourism sector grows faster than the tourism sector in the long term ($\dot{Z}/Z < 0$), and the sector shares equal the distribution parameters ($\theta = \chi$). Now, recall that aggregate gross output grows according to the weighted sum:

$$\frac{\dot{Y}}{Y} = \theta \frac{\dot{Y}_{TR}}{Y_{TR}} + (1 - \theta) \frac{\dot{Y}_{NTR}}{Y_{NTR}} \quad \text{(A51)}$$

When goods are perfect complements ($\varepsilon = 0$) or substitutes ($\varepsilon \to \infty$), the technology of aggregate gross output in equilibrium can be described as:

$$\lim_{t \to \infty} Y = \min(\chi Y_{TR}, (1 - \chi) Y_{NTR}) \; if \; \varepsilon = 0 \quad \text{(A52)}$$

$$\lim_{t \to \infty} Y = \max(\chi Y_{TR}, (1 - \chi) Y_{NTR}) \; if \; \varepsilon \to \infty \quad \text{(A53)}$$

Similarly, the growth rate of gross aggregate output in each situation can be read as:

$$\lim_{t \to \infty} \frac{\dot{Y}}{Y} = \min(g_{TR}, g_{NTR}) \; if \; \varepsilon = 0 \quad \text{(A54)}$$

$$\lim_{t \to \infty} \frac{\dot{Y}}{Y} = \max(g_{TR}, g_{NTR}) \; if \; \varepsilon \to \infty \quad \text{(A55)}$$

where g_{TR} and g_{NTR} are the long-term growth rates of each sector, which are independent of θ. Now, since we assumed $\dot{Z}/Z < 0$, then $g_{TR} < g_{NTR}$, (A54) and (A55) equal:

$$\lim_{t\to\infty} \frac{\dot{Y}}{Y} = g_{TR} \; if \; \varepsilon = 0 \tag{A56}$$

$$\lim_{t\to\infty} \frac{\dot{Y}}{Y} = g_{NTR} \; if \; \varepsilon \to \infty \tag{A57}$$

Therefore, if we compare (A56) and (A57) with (A51), we know that the following must be true:

$$\lim_{t\to\infty} \theta = 1 \; if \; \varepsilon = 0 \tag{A59}$$

$$\lim_{t\to\infty} \theta = 0 \; if \; \varepsilon \to \infty \tag{A60}$$

In this sense, we need (A50) to be positive (negative) in the neighborhood of the steady state for $\varepsilon = 0$ ($\varepsilon \to \infty$). Since the numerator in (A50) already fulfills these conditions, the denominator must be positive to achieve a stable steady state.

A.7 Proof of stability of the system of dynamic equations

The present two-sector growth model faces the following system of dynamic equations:[20]

$$\dot{\theta} = \frac{(\varepsilon - 1)}{1 - (\varepsilon - 1)[(\gamma_L - \gamma_K)(\alpha_{TR} - \alpha_{NTR}) + (\gamma_L - \gamma_H)(\beta_{TR} - \beta_{NTR})]} \frac{\dot{Z}}{Z}(1 - \theta)\theta \tag{A61}$$

$$\dot{\tilde{k}} = s_K \, \tilde{y} - \left(\delta_K + g_L + \frac{\dot{A}}{A}\right)\tilde{k} \tag{A62}$$

$$\dot{\tilde{h}} = s_H \, \tilde{y} - \left(\delta_H + g_L + \frac{\dot{A}}{A}\right)\tilde{h} \tag{A63}$$

which can be linearized according to the Taylor's first-order expansion in the neighborhood of the steady state, that is:

$$\dot{\theta} \approx \frac{\partial \dot{\theta}}{\partial \theta}(*)(\theta - \theta^*) \tag{A64}$$

[20] The SLS and MRW fundamental equations (5) and (6) in terms of effective worker can be obtained from $\dot{\tilde{k}}/\tilde{k} = \dot{K}/K - g_L - \dot{A}/A$ and $\dot{\tilde{h}}/\tilde{h} = \dot{H}/H - g_L - \dot{A}/A$.

$$\dot{\tilde{k}} \approx \frac{\partial \dot{\tilde{k}}}{\partial \theta}(*)(\theta - \theta^*) + \frac{\partial \dot{\tilde{k}}}{\partial \tilde{k}}(*)\left(\tilde{k} - \tilde{k}^*\right) + \frac{\partial \dot{\tilde{k}}}{\partial \tilde{h}}(*)\left(\tilde{h} - \tilde{h}^*\right) \tag{A65}$$

$$\dot{\tilde{h}} \approx \frac{\partial \dot{\tilde{h}}}{\partial \theta}(*)(\theta - \theta^*) + \frac{\partial \dot{\tilde{h}}}{\partial \tilde{k}}(*)\left(\tilde{k} - \tilde{k}^*\right) + \frac{\partial \dot{\tilde{h}}}{\partial \tilde{h}}(*)\left(\tilde{h} - \tilde{h}^*\right) \tag{A66}$$

where $(*) = \left(\theta^*, \tilde{k}^*, \tilde{h}^*\right)$,[21] and:

$$\frac{\partial \dot{\theta}}{\partial \theta}(*) = \frac{(\varepsilon - 1)(\theta^*)(1 - 2\theta^*)\ \frac{\dot{Z}}{Z}}{1 - (\varepsilon - 1)[(\gamma_L^* - \gamma_K^*)(\alpha_{TR} - \alpha_{NTR}) + (\gamma_L^* - \gamma_H^*)(\beta_{TR} - \beta_{NTR})]} \tag{A67}$$

$$\frac{\partial \dot{\tilde{k}}}{\partial \theta}(*) = -\frac{(1 - \alpha_{TR} - \beta_{TR})\left(g_{A_{TR}} - g\right) + (1 - \alpha_{NTR} - \beta_{NTR})\left(g - g_{A_{NTR}}\right)}{1 - \theta^*(\alpha_{TR} + \beta_{TR}) - (1 - \theta^*)(\alpha_{NTR} + \beta_{NTR})}\tilde{k}^* \tag{A68}$$

$$\frac{\partial \dot{\tilde{k}}}{\partial \tilde{k}}(*) = -(1 - \bar{\alpha}^*)(\delta_K + g_L + g) \tag{A69}$$

$$\frac{\partial \dot{\tilde{k}}}{\partial \tilde{h}}(*) = \bar{\beta}^* \frac{s_K}{s_H}(\delta_H + g_L + g) \tag{A70}$$

$$\frac{\partial \dot{\tilde{h}}}{\partial \theta}(*) = -\frac{(1 - \alpha_{TR} - \beta_{TR})\left(g_{A_{TR}} - g\right) + (1 - \alpha_{NTR} - \beta_{NTR})\left(g - g_{A_{NTR}}\right)}{1 - \theta^*(\alpha_{TR} + \beta_{TR}) - (1 - \theta^*)(\alpha_{NTR} + \beta_{NTR})}\tilde{h}^* \tag{A71}$$

$$\frac{\partial \dot{\tilde{h}}}{\partial \tilde{k}}(*) = \bar{\alpha}^* \frac{s_H}{s_K}(\delta_K + g_L + g) \tag{A72}$$

$$\frac{\partial \dot{\tilde{h}}}{\partial \tilde{h}}(*) = -\left(1 - \bar{\beta}^*\right)(\delta_H + g_L + g) \tag{A73}$$

which can be rewritten into the matrix equation:

$$\dot{x} = Ex + B \tag{A74}$$

$$\text{Where } E = \begin{pmatrix} \frac{\partial \dot{\theta}}{\partial \theta}(*) & 0 & 0 \\ \frac{\partial \dot{\tilde{k}}}{\partial \theta}(*) & \frac{\partial \dot{\tilde{k}}}{\partial \tilde{k}}(*) & \frac{\partial \dot{\tilde{k}}}{\partial \tilde{h}}(*) \\ \frac{\partial \dot{\tilde{h}}}{\partial \theta}(*) & \frac{\partial \dot{\tilde{h}}}{\partial \tilde{k}}(*) & \frac{\partial \dot{\tilde{h}}}{\partial \tilde{h}}(*) \end{pmatrix} \tag{A75}$$

$$x = \begin{pmatrix} \theta \\ \tilde{k} \\ \tilde{h} \end{pmatrix} \tag{A76}$$

[21] Use (43) and A20. Additionally, from (36) and (37), output per effective worker can be read as $\tilde{y} = F\left(f\left(\frac{A_{TR}}{A}\gamma_L, \gamma_K\tilde{k}, \gamma_H\tilde{h}\right), g\left(\frac{A_{NTR}}{A}(1 - \gamma_L), (1 - \gamma_K)\tilde{k}, (1 - \gamma_H)\tilde{h}\right)\right)$, with $\partial\tilde{y}/\partial\tilde{k} = \partial Y/\partial K$ and $\partial\tilde{y}/\partial\tilde{h} = \partial Y/\partial H$ due to $F(\cdot)$ being a homogenous function of degree 1 in L, K, H.

$$B = \begin{pmatrix} -\theta^* \frac{\partial\dot{\theta}}{\partial\theta}(*) \\ -\left(\theta^* \frac{\partial\dot{\tilde{k}}}{\partial\theta}(*) + \tilde{k}^* \frac{\partial\dot{\tilde{k}}}{\partial\tilde{k}}(*) + \tilde{h}^* \frac{\partial\dot{\tilde{k}}}{\partial\tilde{h}}(*)\right) \\ -\left(\theta^* \frac{\partial\dot{\tilde{h}}}{\partial\theta}(*) + \tilde{k}^* \frac{\partial\dot{\tilde{h}}}{\partial\tilde{k}}(*) + \tilde{h}^* \frac{\partial\dot{\tilde{h}}}{\partial\tilde{h}}(*)\right) \end{pmatrix} \tag{A77}$$

To examine the stability of this system of differential equations we must examine the eigenvalues ε associated with matrix E. These values are obtained according to rule:

$$\det(E - \varepsilon I) = \det \begin{pmatrix} \frac{\partial\dot{\theta}}{\partial\theta}(*) - \varepsilon & 0 & 0 \\ \frac{\partial\dot{\tilde{k}}}{\partial\theta}(*) & \frac{\partial\dot{\tilde{k}}}{\partial\tilde{k}}(*) - \varepsilon & \frac{\partial\dot{\tilde{k}}}{\partial\tilde{h}}(*) \\ \frac{\partial\dot{\tilde{h}}}{\partial\theta}(*) & \frac{\partial\dot{\tilde{h}}}{\partial\tilde{k}}(*) & \frac{\partial\dot{\tilde{h}}}{\partial\tilde{h}}(*) - \varepsilon \end{pmatrix} = 0 \tag{A78}$$

This equals:

$$\left(\frac{\partial\dot{\theta}}{\partial\theta}(*) - e\right)\left[\left(\frac{\partial\dot{\tilde{k}}}{\partial\tilde{k}}(*) - e\right)\left(\frac{\partial\dot{\tilde{h}}}{\partial\tilde{h}}(*) - e\right) - \frac{\partial\dot{\tilde{h}}}{\partial\tilde{k}}(*)\frac{\partial\dot{\tilde{k}}}{\partial\tilde{h}}(*)\right] = 0 \tag{A79}$$

From this equation, it is straightforward to see the first eigenvalue equals:

$$e_1 = \frac{\partial\dot{\theta}}{\partial\theta}(*) < 0 \tag{A80}$$

which is always negative as long as $\dot{Z}/Z \neq 0$ and $\varepsilon \neq 1$ (recall that for $\dot{Z}/Z > 0$ and $\varepsilon > 1$, $\theta^* = 1$; for $\dot{Z}/Z < 0$ and $\varepsilon > 1$, $\theta^* = 0$; for $\dot{Z}/Z > 0$ and $\varepsilon < 1$, $\theta^* = 0$; for $\dot{Z}/Z < 0$ and $\varepsilon < 1$, $\theta^* = 1$). The two remaining eigenvalues are obtained from rearranging (A79) as the following quadratic equation:

$$e^2 - \left(\frac{\partial\dot{\tilde{k}}}{\partial\tilde{k}}(*) + \frac{\partial\dot{\tilde{h}}}{\partial\tilde{h}}(*)\right)e + \frac{\partial\dot{\tilde{k}}}{\partial\tilde{k}}(*)\frac{\partial\dot{\tilde{h}}}{\partial\tilde{h}}(*) - \frac{\partial\dot{\tilde{h}}}{\partial\tilde{k}}(*)\frac{\partial\dot{\tilde{k}}}{\partial\tilde{h}}(*) = 0 \tag{A81}$$

Equation (A81) corresponds with the quadratic equation of the original MRW model with a shifter parameter θ^* which does not violate the basic assumptions of their model (constant returns to scale in production, diminishing returns and Inada conditions in private inputs, constant and exogenous productivity growth rates). According to Acemoglu (2008), the MRW model is globally stable. Therefore, the eigenvalues associated with the positive and negative roots of (A81) must be real and strictly negative (Barro and Sala-i-Martin, 2004).

Since $e_1 < 0$, $e_2 < 0$, and $e_3 < 0$ the system is guaranteed to be globally stable. Therefore, for any $0 < \theta(0) < 1$, $\tilde{k}(0) > 0$ and $\tilde{h}(0) > 0$, the system converges asymptotically to its steady state.

A.8 Proof of steady-state values of capital-output ratios

The CGP is characterized by $lim_{t\to\infty}\dot{Y}/Y = g + g_L$, as well as constant capital-output ratios $lim_{t\to\infty} K/Y = (K/Y)^*$ and $lim_{t\to\infty} H/Y = (H/Y)^*$, which implies

$$lim_{t\to\infty}\dot{Y}/Y = lim_{t\to\infty}\dot{K}/K = lim_{t\to\infty}\dot{H}/H = g_L + g \tag{A82}$$

According to equation (A82), capital per effective worker must also be constant in the CGP, implying that (A62) and (A63) must be zero in the steady state. This yields the steady-state ratios of capital per aggregate gross output.

A.9 Log-linearization of per capita gross income growth

Recall that any variable can be rewritten as $x = \exp(\ln x)$. Therefore, any no-linear differential equation $\dot{x} = f(x)$ can be expressed as $\dot{x} = f(\exp(\ln x))$, and log-linearized taking a first-order Taylor expansion of the form $\dot{x} \approx \dot{x}(x^*) + \partial f/\partial x(x^*)x^*(\ln x - \ln x^*)$. Using this fact in (A65) and (A66), and dividing by their respective capital stocks per effective worker $\tilde{k}$ and $\tilde{h}$, yields their log-linear approximations in the neighborhood of the steady state:

$$\begin{aligned}\frac{\dot{\tilde{k}}}{\tilde{k}} \approx \frac{\partial\dot{\tilde{k}}}{\partial\theta}(*)(\theta-\theta^*) + \frac{\partial\dot{\tilde{k}}}{\partial\tilde{k}}(*)\left(\ln\tilde{k} - \ln\tilde{k}^*\right)\\ + \frac{\partial\dot{\tilde{k}}}{\partial\tilde{h}}(*)\frac{\tilde{h}^*}{\tilde{k}^*}\left(\ln\tilde{h} - \ln\tilde{h}^*\right)\end{aligned} \tag{A83}$$

$$\begin{aligned}\frac{\dot{\tilde{h}}}{\tilde{h}} \approx \frac{\partial\dot{\tilde{h}}}{\partial\theta}(*)(\theta-\theta^*) + \frac{\partial\dot{\tilde{h}}}{\partial\tilde{k}}(*)\frac{\tilde{k}^*}{\tilde{h}^*}\left(\ln\tilde{k} - \ln\tilde{k}^*\right)\\ + \frac{\partial\dot{\tilde{h}}}{\partial\tilde{h}}(*)\left(\ln\tilde{h} - \ln\tilde{h}^*\right)\end{aligned} \tag{A84}$$

Using (43), the linear approximation of technological progress in the neighborhood of the steady state equals:

$$\frac{\dot{A}}{A} \approx g + \frac{\partial \dot{A}/A}{\partial \theta}(*)(\theta - \theta^*) \tag{A85}$$

With

$$\frac{\partial \dot{A}/A}{\partial \theta}(*) = \frac{(1 - \alpha_{TR} - \beta_{TR})\left(g_{A_{TR}} - g\right) + (1 - \alpha_{NTR} - \beta_{NTR})\left(g - g_{A_{NTR}}\right)}{1 - \theta^*(\alpha_{TR} + \beta_{TR}) - (1 - \theta^*)(\alpha_{NTR} + \beta_{NTR})} \tag{A86}$$

According to the steady-state capital-output ratios (49) and (50), capital stocks per effective worker in the CGP can be written as $\tilde{k}^* = (K/Y)^*\tilde{y}^*$ and $\tilde{h}^* = (H/Y)^*\tilde{y}^*$. Therefore, the ratio of capital stocks in the steady state equals:

$$\frac{\tilde{k}^*}{\tilde{h}^*} = \frac{s_K}{s_H}\frac{\delta_H + g_L + g}{\delta_K + g_L + g} \tag{A87}$$

Substituting (A83)-(A85) in equation (42) yields the following approximation of per capita GDP growth:

$$\begin{aligned} \frac{\dot{y}}{y} \approx g &+ \left[\frac{\partial \dot{A}/A}{\partial \theta}(*) + \bar{\alpha}^* \frac{\partial \dot{\tilde{k}}}{\partial \theta}(*) + \bar{\beta}^* \frac{\partial \dot{\tilde{h}}}{\partial \theta}(*)\right](\theta - \theta^*) \\ &+ \left[\bar{\alpha}^* \frac{\partial \dot{\tilde{k}}}{\partial \tilde{k}}(*) + \bar{\beta}^* \frac{\partial \dot{\tilde{h}}}{\partial \tilde{k}}(*)\frac{\tilde{k}^*}{\tilde{h}^*}\right]\left(\ln \tilde{k} - \ln \tilde{k}^*\right) \\ &+ \left[\bar{\alpha}^* \frac{\partial \dot{\tilde{k}}}{\partial \tilde{h}}(*)\frac{\tilde{h}^*}{\tilde{k}^*} + \bar{\beta}^* \frac{\partial \dot{\tilde{h}}}{\partial \tilde{h}}(*)\right]\left(\ln \tilde{h} - \ln \tilde{h}^*\right) \end{aligned} \tag{A88}$$

Using (A68)-(A73) and (A86)-(A87) in (A88) yields:

$$\frac{\dot{y}}{y} \approx \rho_0 + \rho_1\theta + \rho_2 \ln k + \rho_3 \ln h - (\rho_2 + \rho_3) \ln A \tag{A89}$$

where

$$\rho_0 = g - \rho_1\theta^* - \rho_2 \ln \tilde{k}^* - \rho_3 \ln \tilde{h}^* \tag{A90}$$

$$\rho_1 = (1 - \alpha_{TR} - \beta_{TR})\left(g_{A_{TR}} - g\right) + (1 - \alpha_{NTR} - \beta_{NTR})\left(g - g_{A_{NTR}}\right) \tag{A91}$$

$$\rho_2 = -\bar{\alpha}^*\left[(1 - \bar{\alpha}^*)(\delta_K + g_L + g) - \bar{\beta}^*(\delta_H + g_L + g)\right] \tag{A92}$$

$$\rho_3 = -\bar{\beta}^*\left[\left(1 - \bar{\beta}^*\right)(\delta_H + g_L + g) - \bar{\alpha}^*(\delta_K + g_L + g)\right] \tag{A93}$$

Parameters ρ_2 and ρ_3 are negative due to the global stability of the MRW model (Acemoglu, 2008), and the parameter ρ_1 is zero if $g_{A_{TR}} = g_{A_{NTR}}$, positive if $g_{A_{TR}} > g_{A_{NTR}}$, and negative if $g_{A_{TR}} < g_{A_{NTR}}$. To see this consider first that for $g_{A_{TR}} > g$, equation (43) must lead to:

$$\frac{\theta^*(1-\alpha_{TR}-\beta_{TR})g_{A_{TR}} + (1-\theta^*)(1-\alpha_{NTR}-\beta_{NTR})g_{A_{NTR}}}{1-\theta^*(\alpha_{TR}+\beta_{TR})-(1-\theta^*)(\alpha_{NTR}+\beta_{NTR})} < g_{A_{TR}} \tag{A94}$$

which, after rearranging, yields:

$$g_{A_{TR}} > g_{A_{NTR}} \tag{A95}$$

Symmetrically, for $g_{A_{TR}} < g$, we know the following must be true:

$$g_{A_{TR}} < g_{A_{NTR}} \tag{A96}$$

Repeating the same process for $g_{A_{NTR}} > g$ and $g_{A_{NTR}} < g$, we obtain $g_{A_{NTR}} > g_{A_{TR}}$ for $g_{A_{NTR}} > g$, and $g_{A_{NTR}} < g_{A_{TR}}$ for $g_{A_{NTR}} < g$. Therefore,

$$\begin{aligned} g_{A_{TR}} > g > g_{A_{NTR}}\ if\ g_{A_{TR}} > g_{A_{NTR}} \\ g_{A_{NTR}} > g > g_{A_{TR}}\ if\ g_{A_{TR}} < g_{A_{NTR}} \end{aligned} \tag{A97}$$

Now, (A91) is positive if and only if:

$$g_{A_{TR}} - g > \frac{1-\alpha_{NTR}-\beta_{NTR}}{1-\alpha_{TR}-\beta_{TR}}\left(g_{A_{NTR}} - g\right) \tag{A98}$$

Therefore, according to (A97), (A98) will be only true as long as $g_{A_{TR}} > g_{A_{NTR}}$ (note that if the contrary is true, the LHS of (A98) is negative, and the RHS is positive, which violates the direction of the inequality symbol). Symmetrically, (A91) is negative if and only if:

$$g_{A_{NTR}} - g > \frac{1-\alpha_{TR}-\beta_{TR}}{1-\alpha_{NTR}-\beta_{NTR}}\left(g_{A_{TR}} - g\right) \tag{A99}$$

which is only true as long as $g_{A_{TR}} < g_{A_{NTR}}$. This proves that $\rho_1 > 0$ if $g_{A_{TR}} > g_{A_{NTR}}$, and $\rho_1 < 0$ if $g_{A_{TR}} < g_{A_{NTR}}$. Therefore, the impact of the share of the tourism sector in per capita GDP growth depends on the differences between sector labor-augmenting technological progress $g_{A_{TR}}$ and $g_{A_{NTR}}$.

If we assumed that $\delta_K \approx \delta_H \approx \delta$ in (A92) and (A93), this would have led to:

$$\frac{\dot{y}}{y} \approx g - \rho_1\theta^* + \rho_1\theta$$
$$-\left(1 - \bar{\alpha}^* - \bar{\beta}^*\right)(\delta + g_L + g)\left(\bar{\alpha}^*\left(\ln\tilde{k} - \ln\tilde{k}^*\right) + \bar{\beta}^*\ln\left(\ln\tilde{h} - \ln\tilde{h}^*\right)\right) \tag{A100}$$

Additionally, from equations (36) and (37) we know that the logarithm of GDP per effective worker in the neighborhood of the steady state must equal:

$$\ln\tilde{y} \approx \ln\tilde{y}^* + \bar{\alpha}^*\left(\ln\tilde{k} - \ln\tilde{k}^*\right) + \bar{\beta}^*\left(\ln\tilde{h} - \ln\tilde{h}^*\right) \tag{A101}$$

Using (A101) in (A100) leads to:

$$\frac{\dot{y}}{y} \approx \psi + \rho_1\theta + \zeta\ln \mathrm{y} - \zeta\ln A \tag{A102}$$

where $\psi = g - \rho_1\theta^* - \zeta\ln\tilde{y}^*$ and $\zeta = -\left(1 - \bar{\alpha}^* - \bar{\beta}^*\right)(\delta + g_L + g)$.

A.10 Log-linearization of per capita capital stocks growth

Since growth rates of per capita capital stocks can be written as $\dot{k}/k = \dot{A}/A + \dot{\tilde{k}}/\tilde{k}$ and $\dot{h}/h = \dot{A}/A + \dot{\tilde{h}}/\tilde{h}$, using (A83)-(A85) their log-linearization of growth in capital stocks per capita equal:

$$\frac{\dot{k}}{k} \approx g + \frac{\partial\dot{\tilde{k}}}{\partial\tilde{k}}(*)\left(\ln\tilde{k} - \ln\tilde{k}^*\right) + \frac{\partial\dot{\tilde{k}}}{\partial\tilde{h}}(*)\frac{\tilde{h}^*}{\tilde{k}^*}\left(\ln\tilde{h} - \ln\tilde{h}^*\right) \tag{A103}$$

$$\frac{\dot{h}}{h} \approx g + \frac{\partial\dot{\tilde{h}}}{\partial\tilde{k}}(*)\frac{\tilde{k}^*}{\tilde{h}^*}\left(\ln\tilde{k} - \ln\tilde{k}^*\right) + \frac{\partial\dot{\tilde{h}}}{\partial\tilde{h}}(*)\left(\ln\tilde{h} - \ln\tilde{h}^*\right) \tag{A104}$$

Additionally, recall that from (42), gross output per capita can be written as:

$$\frac{\dot{y}}{y} = \left(1 - \bar{\alpha} - \bar{\beta}\right)\frac{\dot{A}}{A} + \bar{\alpha}\frac{\dot{k}}{k} + \bar{\beta}\frac{\dot{h}}{h} \tag{A105}$$

Rearranging equation (A105), both physical and human capital growth rates can also be derived from:

$$\frac{\dot{k}}{k} = \frac{1}{\bar{\alpha}}\left[\frac{\dot{y}}{y} - \left(1 - \bar{\alpha} - \bar{\beta}\right)\frac{\dot{A}}{A} - \bar{\beta}\frac{\dot{h}}{h}\right] \tag{A106}$$

$$\frac{\dot{h}}{h} = \frac{1}{\bar{\beta}}\left[\frac{\dot{y}}{y} - \left(1 - \bar{\alpha} - \bar{\beta}\right)\frac{\dot{A}}{A} - \bar{\alpha}\frac{\dot{k}}{k}\right] \tag{A107}$$

Using equations (A88), (A103) and (104) in (A106) and (A107) yields alternative log-linear approximations of physical and human capital growth rates:

$$\begin{aligned}\frac{\dot{k}}{k} &= g + \left(1 + \frac{\bar{\beta}^*}{\bar{\alpha}^*}\right)\left(1 - \bar{\alpha}^* - \bar{\beta}^*\right)\frac{\partial \dot{A}/A}{\partial \theta}(*)(\theta - \theta^*) \\ &+\bar{\alpha}^*\frac{\partial \dot{\tilde{k}}}{\partial \tilde{k}}(*)\left(\ln \tilde{k} - \ln \tilde{k}^*\right) + \bar{\alpha}^*\frac{\partial \dot{\tilde{k}}}{\partial \tilde{h}}(*)\frac{\tilde{h}^*}{\tilde{k}^*}\left(\ln \tilde{h} - \ln \tilde{h}^*\right)\end{aligned} \tag{A108}$$

$$\begin{aligned}\frac{\dot{h}}{h} &= g + \left(1 + \frac{\bar{\alpha}^*}{\bar{\beta}^*}\right)\left(1 - \bar{\alpha}^* - \bar{\beta}^*\right)\frac{\partial \dot{A}/A}{\partial \theta}(*)(\theta - \theta^*) \\ &+\bar{\beta}^*\frac{\partial \dot{\tilde{h}}}{\partial \tilde{k}}(*)\frac{\tilde{k}^*}{\tilde{h}^*}\left(\ln \tilde{k} - \ln \tilde{k}^*\right) + \bar{\beta}^*\frac{\partial \dot{\tilde{h}}}{\partial \tilde{h}}(*)\left(\ln \tilde{h} - \ln \tilde{h}^*\right)\end{aligned} \tag{A109}$$

Using (A68)-(A73) and (A86)-(A87) in (A108)-(A109) leads to:

$$\frac{\dot{k}}{k} = \eta_0 + \eta_1\theta + \eta_2 \ln k + \eta_3 \ln h - (\eta_2 + \eta_3)\ln A \tag{A110}$$

$$\frac{\dot{h}}{h} = \phi_0 + \phi_1\theta + \phi_2 \ln k + \phi_3 \ln h - (\phi_2 + \phi_3)\ln A \tag{A111}$$

Where:

$$\eta_0 = g - \eta_1\theta^* - \eta_2 \ln \tilde{k}^* - \eta_3 \ln \tilde{h}^* \tag{A112}$$

$$\begin{aligned}\eta_1 = \left(1 + \frac{\bar{\beta}^*}{\bar{\alpha}^*}\right)&\left[(1 - \alpha_{TR} - \beta_{TR})\left(g_{A_{TR}} - g\right)\right. \\ &\left.+ (1 - \alpha_{NTR} - \beta_{NTR})\left(g - g_{A_{NTR}}\right)\right]\end{aligned} \tag{A113}$$

$$\eta_2 = -\bar{\alpha}^*(1 - \bar{\alpha}^*)(\delta_K + g_L + g) \tag{A114}$$

$$\eta_3 = \bar{\alpha}^*\bar{\beta}^*(\delta_K + g_L + g) \tag{A115}$$

$$\phi_0 = g - \phi_1\theta^* - \phi_2 \ln \tilde{k}^* - \phi_3 \ln \tilde{h}^* \tag{A116}$$

$$\begin{aligned}\phi_1 = \left(1 + \frac{\bar{\alpha}^*}{\bar{\beta}^*}\right)&\left[(1 - \alpha_{TR} - \beta_{TR})\left(g_{A_{TR}} - g\right)\right. \\ &\left.+ (1 - \alpha_{NTR} - \beta_{NTR})\left(g - g_{A_{NTR}}\right)\right]\end{aligned} \tag{A117}$$

$$\phi_2 = \bar{\alpha}^*\bar{\beta}^*(\delta_H + g_L + g) \tag{A118}$$

$$\phi_3 = -\bar{\beta}^*(1-\bar{\beta}^*)(\delta_H + g_L + g) \quad \text{(A119)}$$

A.11 Main dynamic equations for model simulation

Per capita GDP dynamics can be obtained by subtracting the exogenous population growth rate g_L from equation (42). This equals:

$$\dot{y} = \left[(1-\bar{\alpha}-\bar{\beta})\frac{\dot{A}}{A} + \bar{\alpha}\frac{\dot{k}}{k} + \bar{\beta}\frac{\dot{h}}{h}\right]y \quad \text{(A120)}$$

where average factor shares equal (equations (32)-(33)):

$$\bar{\alpha} = \theta\alpha_{TR} + (1-\theta)\alpha_{NTR} \quad \text{(A121)}$$

$$\bar{\beta} = \theta\beta_{TR} + (1-\theta)\beta_{NTR} \quad \text{(A122)}$$

The dynamics of labor-augmenting productivity are obtained from the equation of technological progress (43):

$$\dot{A} = \frac{\theta(1-\alpha_{TR}-\beta_{TR})g_{A_{TR}} + (1-\theta)(1-\alpha_{NTR}-\beta_{NTR})g_{A_{NTR}}}{(1-\bar{\alpha}-\bar{\beta})}A \quad \text{(A123)}$$

The dynamics of capital stocks per capita are obtained by subtraction of g_L from equations (5)-(6), and dividing the RHS of (5)-(6) by L:

$$\dot{k} = s_K y - (\delta_K + g_L)k \quad \text{(A124)}$$

$$\dot{h} = s_H y - (\delta_H + g_L)h \quad \text{(A125)}$$

The dynamics of the tourism sector share equal (use (44)):

$$\dot{\theta} = \frac{(\varepsilon-1)}{1-(\varepsilon-1)[(\gamma_L-\gamma_K)(\alpha_{TR}-\alpha_{NTR}) + (\gamma_L-\gamma_H)(\beta_{TR}-\beta_{NTR})]}\frac{\dot{Z}}{Z}(1-\theta)\theta \quad \text{(A126)}$$

where tourism allocation shares equal (use (29)-(31)):

$$\gamma_L = \frac{\theta(1-\alpha_{TR}-\beta_{TR})}{1-\bar{\alpha}-\bar{\beta}} \quad \text{(A127)}$$

$$\gamma_K = \frac{\theta\alpha_{TR}}{\bar{\alpha}} \quad \text{(A128)}$$

$$\gamma_H = \frac{\theta\beta_{TR}}{\bar{\beta}} \tag{A129}$$

and the growth rate in structural differences between sectors equals (use A20):

$$\begin{aligned}\frac{\dot{Z}}{Z} &= (1-\alpha_{TR}-\beta_{TR})g_{A_{TR}} - (1-\alpha_{NTR}-\beta_{NTR})g_{A_{NTR}} \\ &+(\alpha_{TR}-\alpha_{NTR})\frac{\dot{k}}{k} + (\beta_{TR}-\beta_{NTR})\frac{\dot{h}}{h}\end{aligned} \tag{A130}$$

Finally, per capita sector output dynamics can be obtained by subtracting the exogenous population growth rate g_L from equations (38)-(39):

$$\dot{y}_{TR} = \left[(1-\alpha_{TR}-\beta_{TR})g_{A_{TR}} + \alpha_{TR}\frac{\dot{k}}{k} + \beta_{TR}\frac{\dot{h}}{h} + \frac{\dot{\gamma}_{TR}}{\gamma_{TR}}\right]y_{TR} \tag{A131}$$

$$\dot{y}_{NTR} = \left[(1-\alpha_{NTR}-\beta_{NTR})g_{A_{NTR}} + \alpha_{NTR}\frac{\dot{k}}{k} + \beta_{NTR}\frac{\dot{h}}{h} - \frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}}\right]y_{NTR} \tag{A132}$$

where (use equations (40)-(41)):

$$\frac{\dot{\gamma}_{TR}}{\gamma_{TR}} = (1-\alpha_{TR}-\beta_{TR})\frac{\dot{\gamma}_L}{\gamma_L} + \alpha_{TR}\frac{\dot{\gamma}_K}{\gamma_K} + \beta_{TR}\frac{\dot{\gamma}_H}{\gamma_H} \tag{A133}$$

$$\frac{\dot{\gamma}_{NTR}}{\gamma_{NTR}} = (1-\alpha_{NTR}-\beta_{NTR})\frac{\gamma_L}{1-\gamma_L}\frac{\dot{\gamma}_L}{\gamma_L} + \alpha_{NTR}\frac{\gamma_K}{1-\gamma_K}\frac{\dot{\gamma}_K}{\gamma_K} + \beta_{NTR}\frac{\gamma_H}{1-\gamma_H}\frac{\dot{\gamma}_H}{\gamma_H} \tag{A134}$$

and (use (A43)-(A45) and (A47)-(A48)):

$$\dot{\gamma}_L = \frac{\dot{\theta}}{\theta}\left(1+\theta\frac{(\alpha_T-\alpha_N)+(\beta_T-\beta_N)}{1-\bar{\alpha}-\bar{\beta}}\right)\gamma_L \tag{A135}$$

$$\dot{\gamma}_K = \frac{\dot{\theta}}{\theta}\left(1-\theta\frac{(\alpha_T-\alpha_N)}{\bar{\alpha}}\right)\gamma_K \tag{A136}$$

$$\dot{\gamma}_H = \frac{\dot{\theta}}{\theta}\left(1-\theta\frac{(\beta_T-\beta_N)}{\bar{\beta}}\right)\gamma_H \tag{A137}$$