

Bridging Theory and Empirics: A Growth Equation for Tourism-Driven Economies

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Abstract

This paper presents a theoretical characterization of how tourism sector specialization stimulates (deters) economic growth that integrates both Tourism-Led and Beach Disease hypotheses. We develop a multisector growth model with tourism and non-tourism production from which we derive a growth equation that can be easily estimated by practitioners using conventional regression methods, building 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. We also conduct simulation exercises illustrating the differential impacts of demand- and supply-side policies on long-term economic growth using calibrated parameters for Spain, a large economy in which more than 10% of GDP is generated by tourism-related activities.

Keywords: economic growth; Tourism-Led Growth hypothesis; Beach disease hypothesis; theoretical foundation; supply-side policies; demand-side policies.

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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.*, 2015; Balaguer & Cantavella-Jordá, 2002; Brida *et al.*, 2016; 2020; Cárdenas-García *et al.*, 2015). Typically, scholars document a positive association between indicators of tourism demand and the log of Gross Domestic Product in levels (e.g., Croes *et al.*, 2021; Lee & Chang, 2008), a finding that holds by construction since tourism is embedded within the aggregate demand of an economy. Those studies examining how tourism arrivals or expenditure influence GDP growth rates over time also find that a greater tourism specialization fosters economic growth (Antonakakis *et al.*, 2015; Bronzini *et al.*, 2022; Harb & Bassil, 2022; Kostakis & Theodoropoulou, 2017). 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 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 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, equivalent to the 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. 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) 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 supply-led 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 develop a simplified version of the unbalanced growth model proposed by these authors to an economy with tourism and non-tourism production with two important novel aspects. Firstly, we incorporate human capital into the model and derive stable long-run equilibrium growth paths. Secondly, our model characterizes the long-run physical and human capital accumulation paths of the economy depending on the relative productivity and elasticities of substitution between the tourism and the non-tourism sectors.

The paper adds to the literature on the theoretical underpinnings of the tourism-economic growth nexus (Albadalejo-Pina & Martínez-García, 2013; Chu *et al.*, 2024; Inchausti-Sintes, 2015; 2020a; 2020b; Liu & Wu, 2019; Pérez-Montiel *et al.*, 2021; Smeral, 2003). We contribute to 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), the model presented here 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. After presenting our model, we perform some simulation exercises to illustrate the growth paths of an economy in the long run depending on these two dimensions. This is done for Spain, a leading destination with a high reliance on tourism services.

A major novel aspect of our model is that it fully collapses the Tourism-led Growth versus the Beach Disease hypotheses into a single general framework with limited assumptions. We arrive at a linear equation that can be easily estimated using conventional regression methods, thereby allowing researchers to test one hypothesis against the other using real data. Our theoretical model outlines the variables that characterize the steady-state of the economy, providing some theory-based rationale for researchers to avoid bias from omitted variables when testing the tourism-economic growth nexus empirically.

A second contribution is that we do not only model the dynamics of GDP per capita but also growth rates in physical and human capital accumulation. In this regard, a recent line of research has started to evaluate how tourism specialization affects local employment (González & Surovtseva, 2025) and human capital (Di Giacomo & Lerch, 2025) using reduced-form models. Our growth path equations can be seen as a structural theory-based foundation that can be used by researchers to further delve into how tourism development affects physical and human capital in the long run.

A third contribution is that we provide an illustration on how demand-side (e.g., marketing campaigns, public subsidies for travel) and supply-side (e.g., public investment in tourism infrastructure, improvements in workforce human capital) public policies affect the economy's long-run growth path according to our model. These exercises show that policies aimed at increasing the tourism sector's share of total GDP may backfire in the long run if not implemented together with supply-side measures focused on enhancing tourism productivity.

In sum, the model is designed to examine how sectoral heterogeneity affects aggregate growth and structural transformation. Specifically, we assess three key hypotheses: (i) productivity shocks in one sector can propagate non-linearly to others through input–output linkages; (ii) differences in sectoral physical and human capital intensity influence the aggregate and sector growth paths; and (iii) policy interventions that temporarily alter relative sector demand or supply can have protracted effects on structural convergence and growth. These hypotheses guide the theoretical and quantitative analysis that follows.

The remainder of the article is structured as follows. Section 2 reviews the related literature and the theoretical arguments that scholars have put forward to explain how tourism development affects economic development. Section 3 develops the theoretical model. Section 4 presents some model simulations aimed at characterizing long-run growth paths under different scenarios. Finally, Section 5 concludes with the main takeaways from the study.

2. Background and related literature

The Tourism Led-Growth hypothesis (TLG) postulates that tourism development leads to economic growth. Under this framework, tourism is considered as a non-standard type of export that positively affects economic growth through increased specialization and productivity (Balassa, 1978; Krueger, 1980). Tourism inflows bring foreign currency that allows countries to expand imports of capital goods and technology (e.g., Albadalejo-Pina & Martínez-García, 2013), and due to economies of scale, they increase competitiveness and lead to efficiency gains in production (Andriotis, 2002). Moreover, according to the TLG hypothesis, tourism fosters economic growth through other channels including i) spillover effects on other sectors like manufacturing (Faber & Gaubert, 2019) or public services (Liu &

Wu, 2019), ii) investments in infrastructure (Brida *et al.*, 2016), iii) capital accumulation (Du *et al.*, 2016), or iv) service quality improvements (Inchausti-Sintes, 2020b).

The study by Balaguer and Cantavella-Jordá (2002) is among the first that presented empirical evidence of a positive long-run relationship between tourism development and GDP growth rates. This article was followed by a large body of research that has considered different countries, periods, and methodologies. This literature has documented that the positive link between tourism and economic growth depends on the degree of tourism specialization (Croes *et al.*, 2021; Pablo-Romero & Molina, 2013; Zuo & Huang, 2018), destination attractiveness and income elasticities (Inchausti-Sintes *et al.*, 2021), 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; Sequeira & Nunes, 2008), amongst others. Nonetheless, various studies have indicated that the relationship is non-linear (e.g., Tavares & Damásio, 2025), and that the positive impact of tourism on economic growth vanishes and even turns out to be negative when tourism development surpasses certain thresholds (Enilov & Wang, 2022; Zuo & Huang, 2018). The reader is referred to Alcalá-Ordóñez and Segarra (2023) for a recent detailed review of the state of art on the TLG hypothesis.

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, a pattern known as the Beach Disease hypothesis. That is, short-term gains through expansions in aggregate demand can compromise long-term growth. Tourism is a labor-intensive sector that significantly differs from other service exports that rely more on technological progress and human capital (Inchausti-Sintes, 2020a). 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.

Accordingly, the TLG and the Beach Disease hypotheses predict substantially different impacts of tourism specialization on economic development. While an extensive body of empirical research has evaluated the link between tourism and economic development, there is yet 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 (Alcalá-Ordóñez *et al.*, 2024a; Brida *et al.*, 2016; Castro-Nuño *et al.*, 2013), other studies do not find a significant relationship or even negative effects in some cases (Deng *et al.*, 2014a; 2014b; Zuo & Huang, 2018). Part of this inconclusive evidence is due to the heterogeneity in variable definition, geographical areas, and periods considered (Liu *et al.*, 2022; Nunkoo *et al.*, 2020). On top of that, most empirical specifications lack theoretical rationale (Song & Wu, 2022), creating a potential problem of misspecification and biased estimates.

We can distinguish two main streams of empirical research on the tourism-economic growth nexus. The first uses time series methods, and particularly Granger causality tests, to evaluate the connection between indicators of tourism demand and income (Alcalá-Ordóñez *et al.*, 2024b; Antonakakis *et al.*, 2015; Arslanturk *et al.*, 2011; Brida & Risso, 2009; Enilov & Wang, 2022; Roudi *et al.*, 2019; Portella-Carbó *et al.*, 2023). These studies are predominantly empirical, and the specifications adopted are generally 'ad hoc' not based on any specific theoretical model. Since tourism is a sector that is embedded into the total GDP (i.e., tourism is a sector of the economy whose added value enters additively into GDP), a positive cointegrating relationship between GDP levels and tourism indicators typically arises by construction (e.g., Croes *et al.*, 2021; Lee & Chang, 2008). As such, finding that GDP and tourism arrivals are cointegrated says very 'little' about whether tourism development causes sustained economic growth over time. Granger causality implies predictive precedence but not true causality. In this respect,

Fonseca and Sánchez-Rivero (2020) provide evidence of a relevant statistical significance bias in the studies using Granger causality to establish the connection between tourism and income. According to these authors, the widely documented positive link tends to vanish as the temporal span grows, casting doubts about the credibility of Granger-based evidence when using short temporal windows.

Through the lens of Solow-Swan models (Solow, 1956; Swan, 1956), a second body of empirical research typically regresses indicators of economic activity (GDP or GDP per capita) on tourism demand (arrivals, expenditure, or receipts) while also controlling for other factors that determine long-term economic growth according to neoclassical growth theory (Bronzini *et al.*, 2022; Deng *et al.*, 2024; Dogan & Zhang, 2023; Du *et al.*, 2016; Harb & Bassil, 2022; Kostakis & Theodoropoulou, 2017; Sequeira & Nunes, 2008; Zuo & Huang, 2018). In this case, empirical specifications are based on growth equations along the lines of Barro (1991) and Barro and Sala-i-Martin (1992). Scholars adopting the TLG hypothesis usually assume that tourism is a type of export that determines GDP growth à la Balassa (1978). However, this argument does not apply to domestic tourism, which generally represents a nonnegligible share of total demand and can also stimulate economic growth through other channels.

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. Du *et al.* (2016) find 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. 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. Accordingly, there is the risk that the positive relationship between tourism and economic growth documented by some studies is driven by omitted variables that jointly determine both tourism and economic development.

Moreover, tourism development can affect economic growth indirectly through its impact on input accumulation. Most Granger-based empirical literature focuses on the direct effects of tourism development on aggregate demand but does not consider its impact on the level and quality of input factors. Some recent empirical studies have shown that tourism specialization could lead to a deterioration in human capital by negatively affecting students' enrollment in university studies (Di Giacomo & Lerch, 2025; Kozic, 2019; Rossi & d'Addona, 2025). Additionally, excessive tourism growth can incentivize international emigration (e.g., Mikulic *et al.*, 2024), which represents an additional threat for human capital development. Chu *et al.* (2024) show that tourism shocks increase labor demand and tend to reallocate workers from the production to the service sector, which may reduce production and innovation. Despite this, most theoretical and empirical studies on the tourism-economic growth nexus neglect the effect of tourism development on input accumulation. 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 through input accumulation channels.

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). The model allows for both balanced and unbalanced constant growth paths based on 1) substitution elasticities between sectors, 2) differences in sector factor intensity, 3) factor endowments, and 4) productivity growth. 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:

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

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, 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. 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.

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} , and fulfils the Inada conditions. These two assumptions ensure the existence of a globally asymptotically stable steady state or long-term equilibrium (Acemoglu, 2009). Please note that $F'_{TR} > 0$, $F''_{TR} < 0$ 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.

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 $\varepsilon \rightarrow \infty$, 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 that combine labor (L), physical capital (K) and human capital (H) under a CRS production functions with Harrod-neutral technologies A_{TR} and A_{NTR} :

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

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

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 (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. Like the final gross output production function in (1), the sector production functions (2) and (3) also fulfill the Inada conditions regarding primary inputs.

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

$$\dot{L} = g_L L \quad (4)$$

$$\dot{K} = s_K Y - \delta_K K \quad (5)$$

$$\dot{H} = s_H Y - \delta_H H \quad (6)$$

$$\dot{A}_{TR} = g_{ATR} A_{TR} \quad (7)$$

$$\dot{A}_{NTR} = g_{ANTR} A_{NTR} \quad (8)$$

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 $g_{ATR} \geq 0$ and $g_{ANTR} \geq 0$ are exogenous constant rates of labor-augmenting technological change.

Equation (4) assumes that the labor input evolves exogenously at a constant rate over time. Physical and human capital stock dynamics follow the fundamental equations of the Solow (1956), Swan (1956) and Mankiw *et al.* (1992) models. 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 i) all primary inputs (physical and human capital stock and labor force) are owned by the representative household, ii) they are perfectly mobile across sectors, and iii) markets operate competitively. Therefore, since households and firms are price takers, equilibrium prices must lead to the following market-clearing conditions:

$$L = L_{TR} + L_{NTR} \quad (9)$$

$$K = K_{TR} + K_{NTR} \quad (10)$$

$$H = H_{TR} + H_{NTR} \quad (11)$$

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 the market clears.

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. In the following subsection we 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 wages, are denoted by R_K , R_H and w , respectively. The final overall wage would be given by $w + R_H$, where w denotes a baseline wage and R_H is a skill wage premium.

Let us also represent sectoral production prices by p_{TR} for the tourism sector and p_{NTR} for the (composite) non-tourism sector. 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:

$$Y = p_{TR}Y_{TR} + p_{NTR}Y_{NTR} \quad (12)$$

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

$$Y = F'_{TR}Y_{TR} + F'_{NTR}Y_{NTR} \quad (13)$$

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:

$$\theta = \frac{p_{TR}Y_{TR}}{Y} = \frac{F'_{TR}Y_{TR}}{Y} \quad (14)$$

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

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 $(1 - \theta)$ is 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:

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

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

where firms face the same input prices due to the assumption of 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:

$$w = p_{TR}f'_{L_{TR}} = p_{NTR}g'_{L_{NTR}} \quad (18)$$

$$R_K = p_{TR}f'_{K_{TR}} = p_{NTR}g'_{K_{NTR}} \quad (19)$$

$$R_H = p_{TR} f'_{H_{TR}} = p_{NTR} g'_{H_{NTR}} \quad (20)$$

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, with $x = L, K, H$. 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:

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

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

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

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:

$$p_{TR} = \theta \frac{Y}{Y_{TR}} \quad (24)$$

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

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

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

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

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 both 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:

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

$$\gamma_K = \frac{K_{TR}}{K} = \frac{\theta\alpha_{TR}}{\bar{\alpha}} \quad (30)$$

$$\gamma_H = \frac{H_{TR}}{H} = \frac{\theta\beta_{TR}}{\bar{\beta}} \quad (31)$$

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

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:

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

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

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. If, as discussed in the literature (e.g., Inchausti-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, the following step is to express the sector and aggregate production functions in terms of primary inputs and output elasticities. Furthermore, in the following subsection, we will 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:

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

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

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:

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

where

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

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.

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:

$$\begin{aligned} \frac{\dot{Y}_{TR}}{Y_{TR}} &= (1 - \alpha_{TR} - \beta_{TR})g_{A_{TR}} + g_L \\ &+ \alpha_{TR}\frac{\dot{k}}{k} + \beta_{TR}\frac{\dot{h}}{h} + \frac{\dot{Y}_{TR}}{Y_{TR}} \end{aligned} \quad (38)$$

$$\begin{aligned} \frac{\dot{Y}_{NTR}}{Y_{NTR}} &= (1 - \alpha_{NTR} - \beta_{NTR})g_{A_{NTR}} + g_L \\ &+ \alpha_{NTR}\frac{\dot{k}}{k} + \beta_{NTR}\frac{\dot{h}}{h} - \frac{\dot{Y}_{NTR}}{Y_{NTR}} \end{aligned} \quad (39)$$

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

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

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

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:

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 $g_{ATR} \neq g_{ANTR}$, 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 the model, the sector with sufficiently fast technological progress can offset the negative impact of a production technology that is not intensive in the use of capital stock on relative sector growth. In other words, 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 (see Appendix A.5.):

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

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:

$$\frac{\dot{A}}{A} = \frac{\theta(1 - \alpha_{TR} - \beta_{TR})g_{ATR} + (1 - \theta)(1 - \alpha_{NTR} - \beta_{NTR})g_{ANTR}}{(1 - \bar{\alpha} - \bar{\beta})} \quad (43)$$

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 ($g_{ATR} < g_{ANTR}$).

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 $g_{ATR} < g_{ANTR}$.

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 is the laggard sector in terms of productivity, the economy will follow a path where national income increases at a lower rate compared to the counterfactual where the leading sector becomes dominant (i.e., Beach Disease hypothesis). In this sense, the laggard sector decelerates 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. Please note that, even in this case, the economy may still experience growth, albeit at a lower rate than in a counterfactual scenario where it specializes in the (most productive) non-tourism sector.

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 (see Appendix A.6.):

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

where $\dot{Z}/Z = \dot{Y}_{TR}/Y_{TR} - \dot{Y}_{NTR}/Y_{NTR} - \dot{Y}_{TR}/Y_{TR} - \dot{Y}_{NTR}/Y_{NTR}$ 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 $\hat{\theta} = 0$ (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 $\lim_{\theta \rightarrow 0} \hat{\theta} = \lim_{\theta \rightarrow 1} \hat{\theta} = 0$). 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.

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. This is what the economic growth literature defines as the steady-state equilibrium or constant growth path of an economy.

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 $\lim_{t \rightarrow \infty} \dot{y}/y = g$, 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). These facts imply constant interest rates (i.e., $\lim_{t \rightarrow \infty} R_K = R_K^*$), stable capital-output ratios (i.e., $\lim_{t \rightarrow \infty} K/Y = (K/Y)^*$, $\lim_{t \rightarrow \infty} H/Y = (H/Y)^*$), and constant capital and labor shares (i.e., $\lim_{t \rightarrow \infty} R_K K/Y = R_K^* (K/Y)^*$, $\lim_{t \rightarrow \infty} R_H H/Y = R_H^* (H/Y)^*$ and $\lim_{t \rightarrow \infty} wL/Y = (wL/Y)^*$) 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:*

$$\lim_{t \rightarrow \infty} \theta = \theta^* \quad (45)$$

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

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

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

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

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

See Appendix A.7. for the proof of global stability. 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.

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 Solow-Swan and Mankiw-Romer-Weil 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 Solow-Swan (Solow, 1956; Swan, 1956) and Mankiw-Romer-Weil (Mankiw et al., 1992) 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 ($g_{ATR} < g_{ANTR}$), the economy asymptotically specializes in tourism services ($\theta \rightarrow 1$) 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 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), the 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 for 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.

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:

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

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

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

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.

Equations (51)-(53) are the main takeaway from all the above characterization. Under mild assumptions, the model postulates that output and input growth rates depend on 1) tourism specialization (measured through θ), 2) input factors ($\ln k$ and $\ln h$), and 3) Total Factor Productivity ($\ln A$). These equations can be easily estimated using real data utilizing conventional regression methods. 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. If they were negative, this would be a formal test in support of the Beach Disease hypothesis. Accordingly, Equation (51)-(53) are a theory-based empirical equations for testing one hypothesis against the other.

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 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:

$$\frac{\dot{y}}{y} \approx \psi + \rho_1 \theta + \zeta \ln y - \zeta \ln A \quad (54)$$

The constant term ψ contains the determinants of the steady state of the economy, such as saving and depreciation rates, amongst others (Appendixes A.9 and A.10).

4. Simulation of the model

4.1. General framework

This section presents a 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). For this purpose, we simulate the production dynamics of the Spanish economy, the second most visited country in the world and a country for whom the tourism sector represented an average of 10.7% of its GDP during the 2010-2016 period (INE, 2025).

Table 1 presents the model parameters used for this exercise. We extract information on the average output elasticities of the physical capital for the tourism and non-tourism sectors in the 2010-2016 period from EU-KLEMS database. Following Mankiw *et al.* (1992), we assume the output elasticity of human capital in the non-tourism sector is 0.3, the depreciation rate of physical capital is 0.019 following Burriel *et al.* (2010), and the rest of model parameters are defined based on the calibration exercise conducted by Liu and Wu (2019). We also assume 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).

Liu and Wu (2019) estimate that labor-augmenting technological progress is 2.1 per cent 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 $g_{AT} = 0.016$, while technological progress in the non-tourism sector follows the average growth rate of per capita GDP in Spain between 1961-2022 $g_{ANT} = 0.021$ (World Bank, 2024).

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	Burriel <i>et al.</i> (2010)
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	0.297	EU-KLEMS (2010-2016)
α_{NTR}	Output elasticity of physical capital in the non-tourism sector	0.378	EU-KLEMS (2010-2016)
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 <i>et al.</i> (1992)

Figures 1 and 2 plot the time evolution of per capita GDP and sectoral output, respectively, considering 100 periods. Here periods are defined in an abstract sense so that they can refer to months, quarters, or years. 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 ($\varepsilon = 0; 1; 10$). 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 ($\varepsilon = 10$).

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 (black line) grows at a smaller rate than the rest of the economy (black dashed line) 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., $\dot{\theta} > 0$, blue line in Figure 3) at a sufficiently fast rate to maintain balanced growth rates across sectors. Note that perfect complementarity implies that aggregate output in Equation (1) follows a Leontief production function ($y = \min(\chi y_{TR}, (1 - \chi) y_{NTR})$), 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 (CGP), long-term growth also slows down due to lower labor-augmenting technological progress (blue lines in Figures 1 and 4).

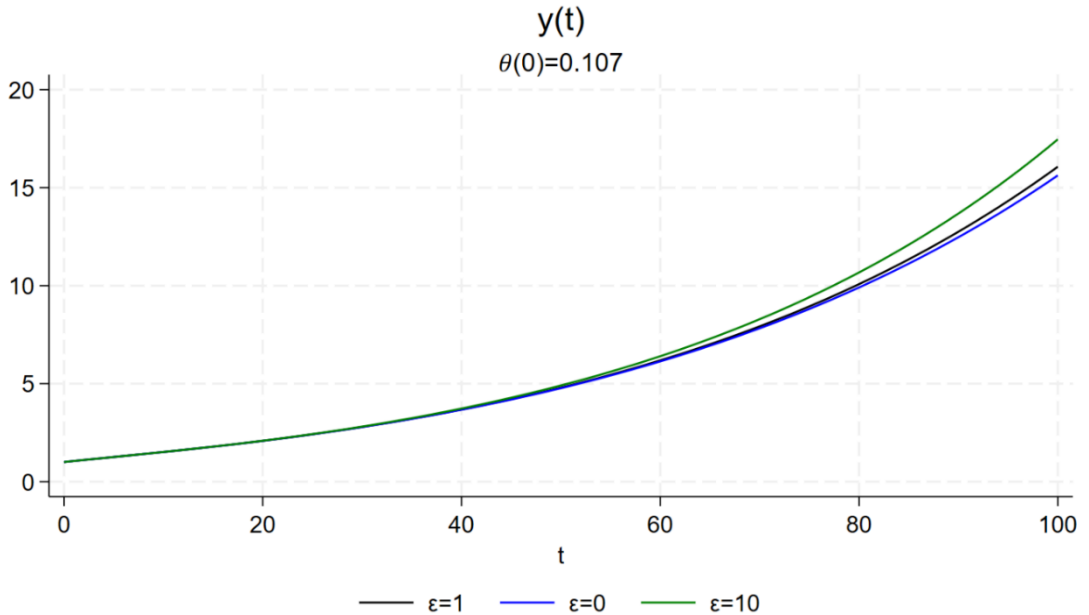


Figure 1. Time evolution of per capita GDP (y) under different elasticities of substitution.

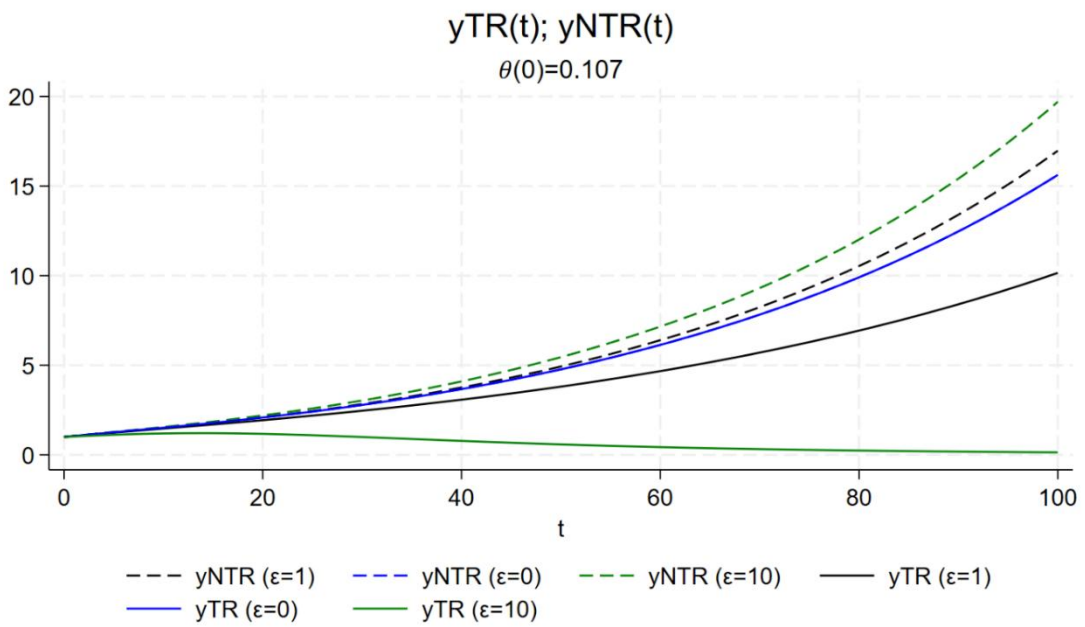


Figure 2. Time evolution of per capita sectoral output (y_{TR}, y_{NTR}) under different elasticities of substitution.

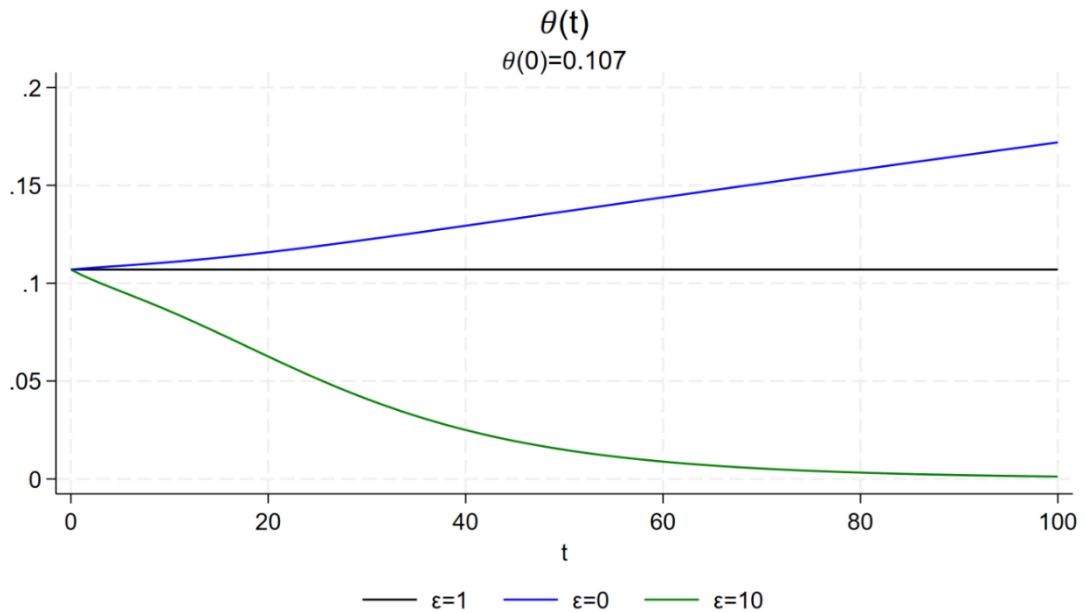


Figure 3. Time evolution of tourism share in total output (θ) under different elasticities of substitution.

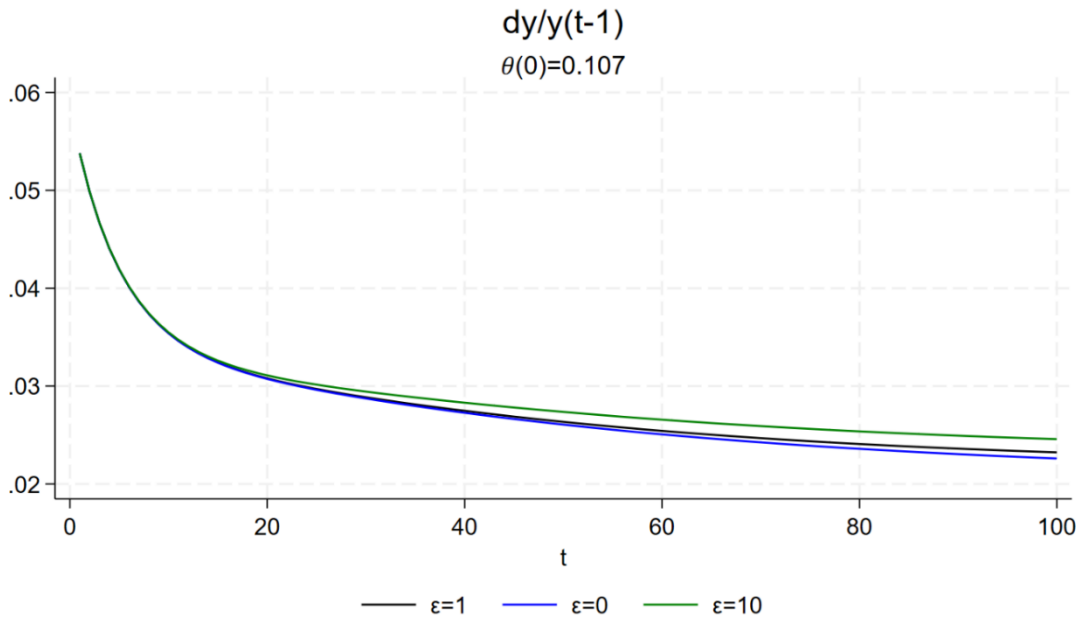


Figure 4. Time evolution of per capita GDP growth rates (dy/y) under different elasticities of substitution.

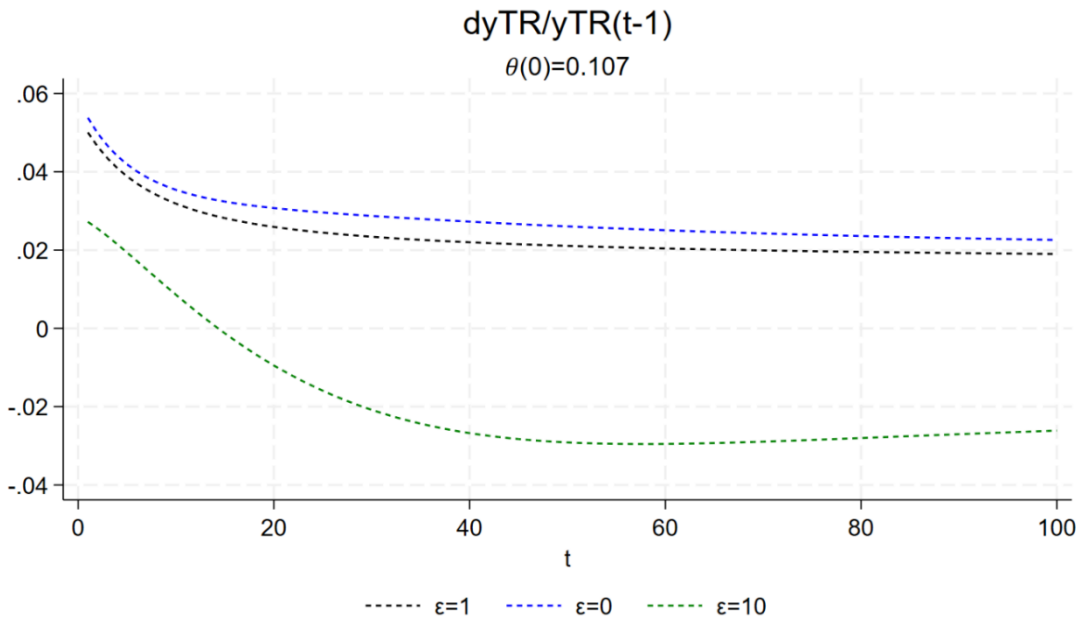


Figure 5. Time evolution of per capita tourism production growth rates (dy_{TR}/y_{TR}) under different elasticities of substitution.

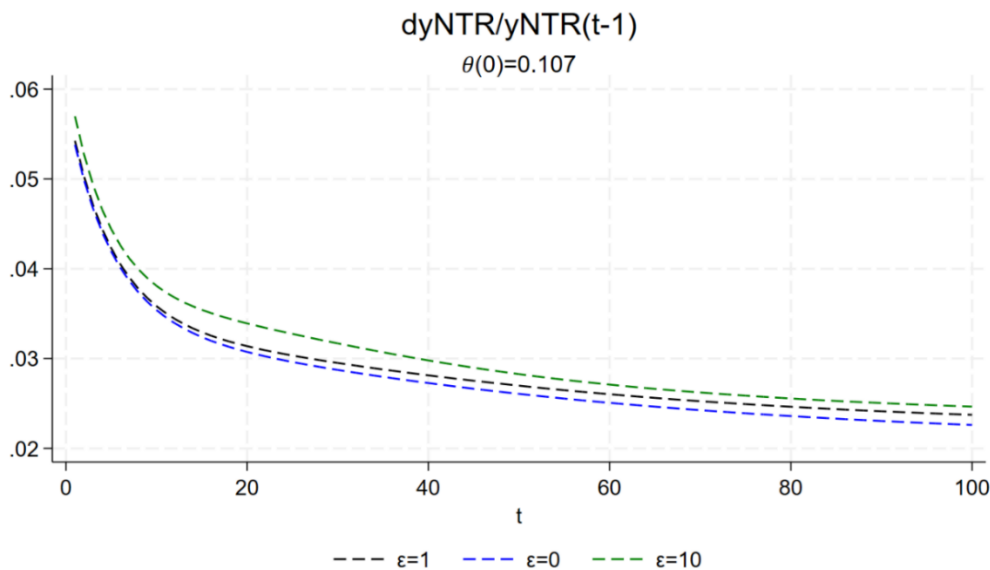


Figure 6. Time evolution of per capita non-tourism production growth rates ($\frac{dy_{NTR}}{y_{NTR}}$) under different elasticities of substitution.

Finally, when ε is higher than one (in our simulation $\varepsilon = 10$), the tourism sector can be easily substituted by more productive sectors (i.e., the economy can easily adjust its sectoral composition). As θ decreases (green line in Figure 3), because aggregate demand shifts towards the cheaper sectors, inputs are reallocated from the tourism sector to the rest of the economy, and this is the reason why θ 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.

4.2. Tourism policy shocks: demand- vs. supply-driven shocks in a Neoclassical framework

Except for the models by Faber and Gaubert (2019) and Inchausti-Sintes (2020), most previous studies have focused on the long-term and economic-wide consequences of shocks in the tourism sector from a demand-driven perspective (e.g., Schubert *et al.*, 2011; Inchausti-Sintes, 2015; Pérez-Montiel *et al.*, 2021). These approaches typically attribute positive impacts on GDP growth to improvements in net exports and the multiplier effects resulting from increased indirect demand for non-tourism goods. However, such results rely on the assumption of idle productive capacity and a fully adaptable production structure in the long term.

In contrast, the proposed non-balanced growth model – nested within the Neoclassical framework – posits that, depending on the long-term characteristics of the supply side (such as sectoral differences

in capital intensity, labor-augmenting productivity growth, and the degree of complementarity or interdependence between sectors), an exogenous shock to tourism demand can steer the economy either toward a Beach Disease scenario or a Tourism-Led growth path. Our approach emphasizes the importance of balancing demand-side shocks with supply-side shocks. To this end, we illustrate how disregarding Neoclassical assumptions may lead to misinterpretations of the long-term effects of demand-biased policies targeting the tourism sector.

4.2.1. A positive shock to tourism demand

Suppose the economy experiences a sudden and temporary positive demand shock to the tourism sector. In particular, assume this temporary exogenous increase occurs in period 10 and amounts to 1 percentage point. This could be the result of large-scale marketing campaigns that make destinations more attractive (e.g., Contu & Pau, 2022), public subsidies to consumers for stimulating travelling (e.g., Matsuura & Saito, 2022) or the emergence of low-cost carriers that facilitate mobility (e.g., Vergori & Arima, 2022). In the above simulation for the Spanish economy, this corresponds to an increase in the share of tourism services in aggregate supply from 0.107 to 0.117 points (i.e., a rightward shift in the tourism demand curve, offset by a downward shift in the demand for other goods). How would this impact the growth dynamics of the economy according to our model?

Given the short-term constraint on factor availability, this demand bias toward tourism services induces an instantaneous reallocation of production factors from the non-tourism sector to tourism (increases in γ_L , γ_K and γ_H). In terms of our model, “instantaneous” means “within” or “during” the span of time existing between the start and end of period t (i.e., a fraction of the chosen unit of time, which can be months if t is a year indicator). These changes are captured in our model by a one-time increase in the tourism sector's share of aggregate GDP, θ . Importantly, the model does not predict an immediate increase in overall GDP because of this demand shock. Instead, it describes a reallocation of resources across sectors—consistent with the Neoclassical assumption that all production factors are fully utilized in the long term.

Assuming a low productivity growth of the tourism sector in Spain, a temporary increase in θ generates a distorted economic signal that slows the accumulation of physical and human capital. This distortion hampers effective economic growth and persists until both the counterfactual and baseline economies converge to the same steady-state GDP growth rate (see Proposition 2).

In the Cobb-Douglas case ($\varepsilon = 1$) with θ held constant after the shock, the model shows an initial decline of over 0.005% in potential GDP in the period immediately following the positive demand shock, and a cumulative long-term loss exceeding 0.01% (see Figure 7). Moreover, the magnitude of this accumulated loss increases as sectoral interdependence intensifies (i.e., as $\varepsilon \rightarrow 0$), underscoring the risk of demand-side policies that favor tourism. This is particularly important given the tourism sector's high reliance on the domestic production of complementary goods and services.

4.2.2. A positive shock to tourism supply

Now consider the case of a positive shock to the tourism sector that raises its productivity and absorptive capacity. This could result from public policies aimed at improving the human capital of the tourism workforce (e.g., Stauvermann & Kumar, 2017), modernizing tourism infrastructure such as adopting smart technologies for improving production efficiency (e.g., Baños-Pino *et al.*, 2025), or subsidies supporting tourism firms' innovation (e.g., Mei *et al.*, 2012), amongst others. What are the predicted effects of these supply-side shocks on the temporal dynamics of GDP per capita from our model?

Figure 8 shows the potential gains following the implementation of this sort of temporary supply-side policies that raise productivity growth in the tourism sector by 1 percentage point, alongside a 1 pp increase in the saving rates of physical and human capital for the entire economy. In the Cobb-Douglas scenario, the economy experiences an initial gain of over 0.07% in potential GDP immediately after the supply shock, tapering to approximately 0.02% in the long term. These accumulated gains are amplified as sectoral interdependence increases ($\varepsilon \rightarrow 0$), since the previously lagging sector (which ultimately governs long-term aggregate growth) becomes more productive due to a temporarily accelerated improvement in labor skills and cheaper access to production factors.

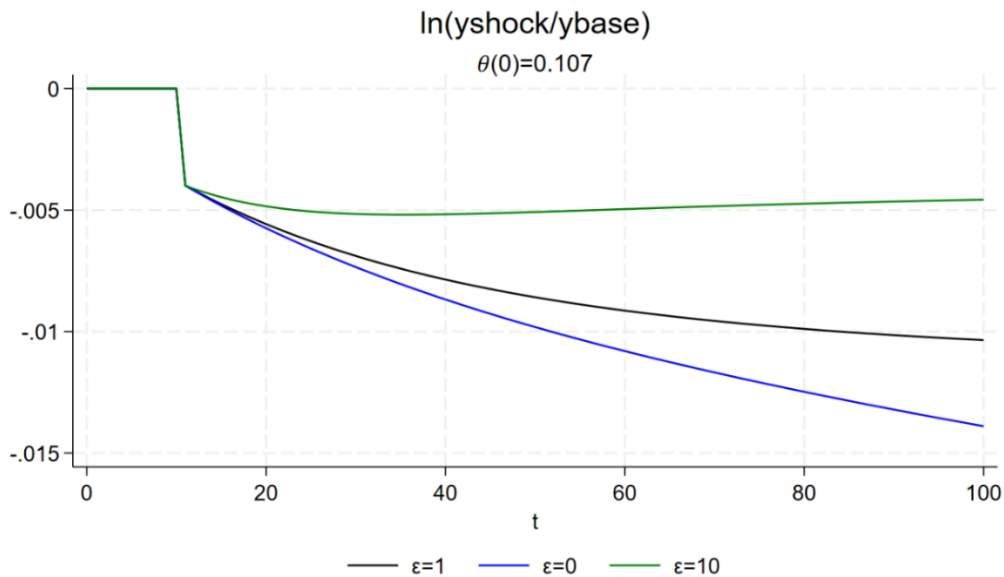


Figure 7. Time evolution of per capita GDP deviations (%) after demand shock

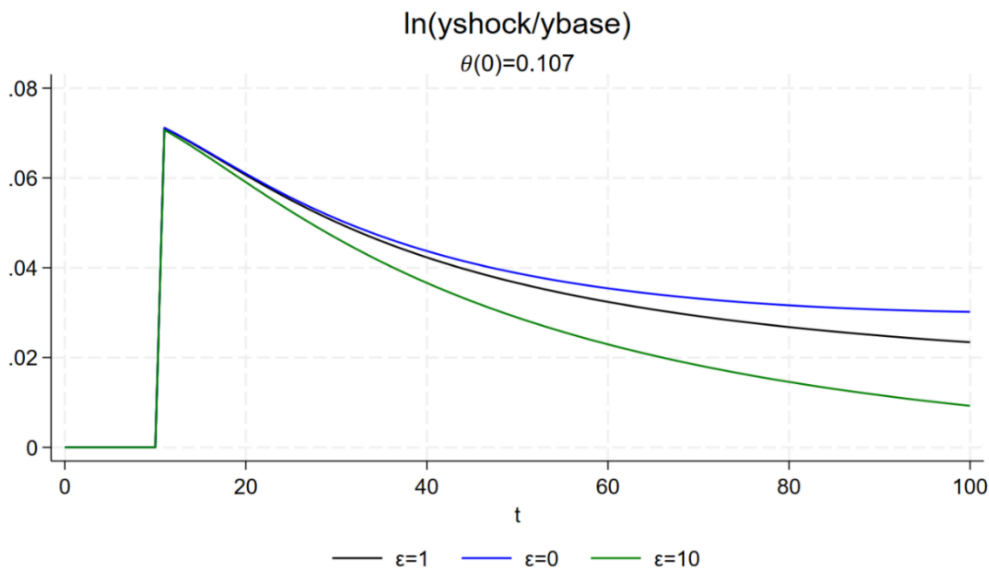


Figure 8. Time evolution of per capita GDP deviations (%) after supply shock.

Figure 9 illustrates the combined effects of both demand- and supply-side policies. The corresponding accumulated gains and losses in per capita GDP are derived algebraically Appendix A.12.

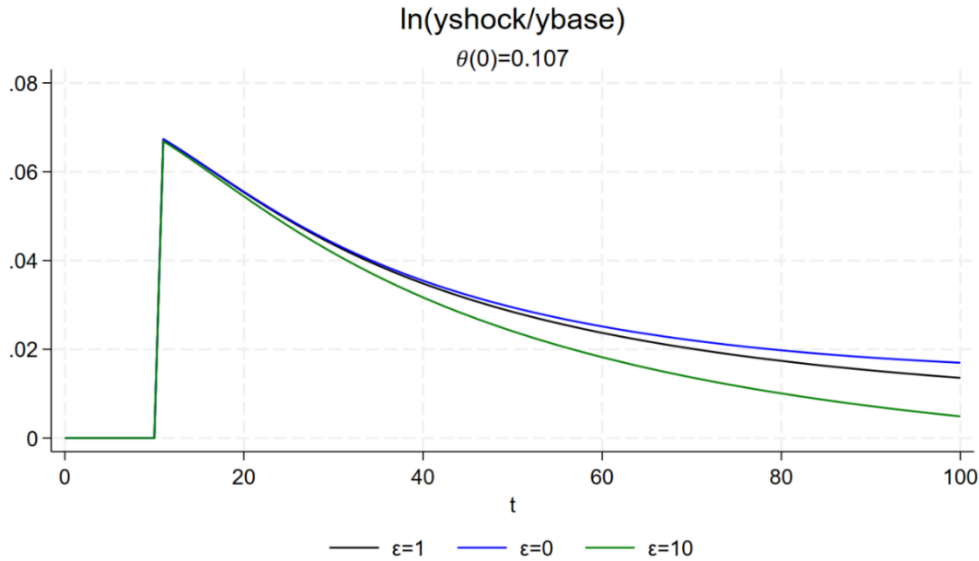


Figure 9. Time evolution of per capita GDP deviations (%) after supply accommodation of demand shock.

5. Discussion and conclusions

This paper has presented a theoretical framework to better understand the long-term relationship between tourism specialization and economic growth. By building on the neoclassical growth literature, and adapting the models by Acemoglu (2009) and Acemoglu and Guerrieri (2008), we construct a two-sector model (tourism and non-tourism) that allows for differences in productivity, capital intensity, and substitutability between sectors.

A key insight from the model is that tourism's contribution to growth is not universally positive or negative—it depends critically on structural characteristics of the economy. If the tourism sector is less capital-intensive and experiences slower technological progress than other sectors, an expansion in tourism's share of the economy leads to slower long-term growth, in line with the Beach Disease hypothesis. Conversely, if tourism is relatively productive, capital-deepening, and technologically dynamic, then increasing specialization in tourism supports long-run growth, validating the Tourism-Led Growth hypothesis.

What distinguishes our paper from previous approaches is that these contrasting scenarios are not treated as mutually exclusive or contradictory. Instead, they are unified within a single, tractable model that explains why and when tourism acts as a growth driver or a drag. The proposed framework provides a linear, empirically testable equation that is easily estimable by regression methods that links GDP per capita growth to tourism's economic weight, sector productivity, and factor accumulation. This creates a useful bridge between theory and empirics, offering researchers a rigorous foundation for more credible estimation strategies. 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.

Beyond its theoretical appeal, the model has direct policy relevance. After characterizing the long-term growth paths of the economy, we simulate how different policy interventions can lead to divergent

outcomes, using calibrated parameters for Spain. We show that demand-side tourism policies that increase tourism's GDP share without boosting its productivity (e.g., promotional campaigns that attract more tourists) may lead to slower long-term growth, especially when tourism is less capital-intensive. In contrast, supply-side interventions (e.g., policies aimed at enhancing productivity in the tourism sector like infrastructure or innovation investments or improving tourism workers' human capital) can yield durable economic gains, particularly when inter-sector linkages are strong (higher elasticity of substitution).

Tourism is often promoted as a growth engine without sufficient attention to its structural limitations. By modelling these dynamics explicitly, our theoretical model offers a tool for both researchers and policymakers to better assess the long-term consequences of tourism specialization. We hope that this framework will inspire future empirical research and inform more balanced, evidence-based tourism development strategies. For many economies where tourism is deeply embedded in the national income, understanding these dynamics is essential for sustainable economic planning.

Like any theoretical framework, this model involves simplifying assumptions. First, we treat sectoral productivity growth and saving rates as exogenous, assume a constant elasticity of substitution between sectors, and abstract away from micro-level heterogeneity. Future research could endogenize these dynamics, especially technological progress and capital allocation decisions. Second, our model abstracts from spatial dimensions. In reality, tourism growth in one region may spill over into neighbouring areas through labour markets, infrastructure, or supply chains (e.g., Liu *et al.*, 2022). Incorporating geographic spillovers and regional interdependence would be a valuable extension. Finally, we treat tourism as a single aggregate sector. Yet, the growth effects of domestic vs. international tourism, or low-cost vs. high-value tourism, may differ significantly. Future studies could build on our framework to explore sectoral composition and segmentation in greater detail.

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Declaration of interests: NONE

Appendices

A.1 Derivation of allocation shares

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

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

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

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

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

$$L_{NTR} = L - L_{TR} \quad (A4)$$

$$K_{NTR} = K - K_{TR} \quad (A5)$$

$$H_{NTR} = H - H_{TR} \quad (A6)$$

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

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

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

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

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:

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

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

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

These derivatives are positive if, and only if:

$$1 - \alpha_{NTR} - \beta_{NTR} > 0 \quad (A13)$$

$$\alpha_{NTR} > 0 \quad (A14)$$

$$\beta_{NTR} > 0 \quad (A15)$$

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 $X = (x_1, \dots, x_N)$

$$\lambda^s y(X) = y(\lambda X) \quad (A16)$$

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

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

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

That is:

$$\lambda^r x_i(Z_i) = x_i(\lambda Z_i) \quad (A18)$$

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

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

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 $\dot{Y}_{TR} = \dot{Y}_{NTR} = 0$, and denote it as $\dot{Z}/Z$. That is:

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

A positive value in (A20) requires:

$$(1 - \alpha_{TR} - \beta_{TR})g_{ATR} - (1 - \alpha_{NTR} - \beta_{NTR})g_{ANTR} \quad (A21)$$

$$> (\alpha_{NTR} - \alpha_{TR}) \frac{\dot{k}}{k} + (\beta_{NTR} - \beta_{TR}) \frac{\dot{h}}{h}$$

Equation (A21) implies that the effective technology in the tourism sector $(1 - \alpha_{TR} - \beta_{TR})g_{ATR}$ must grow at a positive, and at a sufficiently faster rate compared to its counterpart in the non-tourism sector $(1 - \alpha_{NTR} - \beta_{NTR})g_{ANTR}$, 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:

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

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

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

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:

$$g_{ATR} > \frac{1 - \alpha_{NTR} - \beta_{NTR}}{1 - \alpha_{TR} - \beta_{TR}} g_{ANTR} \quad (A24)$$

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:

$$\frac{\dot{Y}_{TR}}{Y_{TR}} - \frac{\dot{Y}_{NTR}}{Y_{NTR}} = \frac{\dot{Z}}{Z} + \frac{\dot{Y}_{TR}}{\gamma_{TR}} + \frac{\dot{Y}_{NTR}}{\gamma_{NTR}} \quad (A25)$$

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

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

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, $\dot{Y}_{TR}/\gamma_{TR} > 0$ and $\dot{Y}_{NTR}/\gamma_{NTR} > 0$, the conditions that lead to $\dot{Z}/Z > 0$ are relaxed. For different rates of effective technological progress $(1 - \alpha_{TR} - \beta_{TR})g_{ATR} \neq (1 - \alpha_{NTR} - \beta_{NTR})g_{ANTR}$, this is formalized as:

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

for identical rates of technological progress $g_{ATR} = g_{ANTR} = g$

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

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

$$g_{ATR} > \frac{1 - \alpha_{NTR} - \beta_{NTR}}{1 - \alpha_{TR} - \beta_{TR}} g_{ANTR} - \left(\frac{\dot{Y}_{TR}}{\gamma_{TR}} + \frac{\dot{Y}_{NTR}}{\gamma_{NTR}} \right) \quad (A29)$$

A.5 Derivation of growth rates for aggregate gross output

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

$$\frac{\dot{Y}}{Y} = \frac{F'_{TR}}{Y} \dot{Y}_{TR} + \frac{F'_{NTR}}{Y} \dot{Y}_{NTR} \quad (A30)$$

Now, (A30) can be rewritten as

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

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

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

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

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

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

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

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

$$\begin{aligned} \theta \frac{\dot{Y}_{TR}}{\gamma_{TR}} - (1 - \theta) \frac{\dot{Y}_{NTR}}{\gamma_{NTR}} = & \left(\theta(1 - \alpha_{TR} - \beta_{TR}) - (1 - \theta)(1 - \alpha_{NTR} - \beta_{NTR}) \frac{\gamma_L}{1 - \gamma_L} \right) \frac{\dot{Y}_L}{\gamma_L} + \\ & \left(\theta \alpha_{TR} - (1 - \theta) \alpha_{NTR} \frac{\gamma_K}{1 - \gamma_K} \right) \frac{\dot{Y}_K}{\gamma_K} + \left(\theta \beta_{TR} - (1 - \theta) \beta_{NTR} \frac{\gamma_H}{1 - \gamma_H} \right) \frac{\dot{Y}_H}{\gamma_H} \end{aligned} \quad (A35)$$

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

$$\begin{aligned} \theta \frac{\dot{Y}_{TR}}{Y_{TR}} - (1 - \theta) \frac{\dot{Y}_{NTR}}{Y_{NTR}} = & \left(\theta(1 - \alpha_{TR} - \beta_{TR}) - (1 - \theta)(1 - \alpha_{NTR} - \right. \\ & \left. \beta_{NTR}) \frac{\theta(1 - \alpha_{TR} - \beta_{TR})}{1 - \bar{\alpha} - \bar{\beta} - \theta(1 - \alpha_{TR} - \beta_{TR})} \right) \frac{\dot{Y}_L}{Y_L} + \left(\theta \alpha_{TR} - (1 - \theta) \alpha_{NTR} \frac{\theta \alpha_{TR}}{\bar{\alpha} - \theta \alpha_{TR}} \right) \frac{\dot{Y}_K}{Y_K} + \left(\theta \beta_{TR} - \right. \\ & \left. (1 - \theta) \beta_{NTR} \frac{\theta \beta_{TR}}{\bar{\beta} - \theta \beta_{TR}} \right) \frac{\dot{Y}_H}{Y_H} \end{aligned} \quad (A36)$$

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

$$\theta \frac{\dot{Y}_{TR}}{Y_{TR}} - (1 - \theta) \frac{\dot{Y}_{NTR}}{Y_{NTR}} = 0 \quad (A37)$$

Using (A37) in (A34), and multiplying and dividing $\theta(1 - \alpha_{TR} - \beta_{TR})g_{ATR} + (1 - \theta)(1 - \alpha_{NTR} - \beta_{NTR})g_{ANTR}$ 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:

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

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

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

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

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

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

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

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:

$$\frac{\dot{Y}_{TR}}{Y_{TR}} - \frac{\dot{Y}_{NTR}}{Y_{NTR}} = \frac{\dot{Z}}{Z} + \frac{1}{1 - \theta} \left((1 - \alpha_{TR} - \beta_{TR}) \frac{\dot{Y}_L}{Y_L} + \alpha_{TR} \frac{\dot{Y}_K}{Y_K} + \beta_{TR} \frac{\dot{Y}_H}{Y_H} \right) \quad (A42)$$

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

$$\frac{\dot{\gamma}_L}{\gamma_L} = \frac{\dot{\theta}}{\theta} + \frac{\dot{\bar{\alpha}} + \dot{\bar{\beta}}}{1 - \bar{\alpha} - \bar{\beta}} \quad (\text{A43})$$

$$\frac{\dot{\gamma}_K}{\gamma_K} = \frac{\dot{\theta}}{\theta} - \frac{\dot{\bar{\alpha}}}{\bar{\alpha}} \quad (\text{A44})$$

$$\frac{\dot{\gamma}_H}{\gamma_H} = \frac{\dot{\theta}}{\theta} - \frac{\dot{\bar{\beta}}}{\bar{\beta}} \quad (\text{A45})$$

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

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

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

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

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

Finally, (A46) equals:

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

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:

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

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

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

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

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

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

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

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:

$$\lim_{t \rightarrow \infty} \frac{\dot{Y}}{Y} = g_{TR} \text{ if } \varepsilon = 0 \quad (A56)$$

$$\lim_{t \rightarrow \infty} \frac{\dot{Y}}{Y} = g_{NTR} \text{ if } \varepsilon \rightarrow \infty \quad (A57)$$

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

$$\lim_{t \rightarrow \infty} \theta = 1 \text{ if } \varepsilon = 0 \quad (A59)$$

$$\lim_{t \rightarrow \infty} \theta = 0 \text{ if } \varepsilon \rightarrow \infty \quad (A60)$$

In this sense, we need (A50) to be positive (negative) in the neighborhood of the steady state for $\varepsilon = 0$ ($\varepsilon \rightarrow \infty$). 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:

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

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

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

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 $\dot{\tilde{h}}/\tilde{h} = \dot{H}/H - g_L - \dot{A}/A$.

Equations (A61)-(A63) can be linearized according to the Taylor's first-order expansion in the neighbourhood of the steady state, that is:

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

$$\dot{\tilde{k}} \approx \frac{\partial \dot{\tilde{k}}}{\partial \theta} (*) (\theta - \theta^*) + \frac{\partial \dot{\tilde{k}}}{\partial \tilde{k}} (*) (\tilde{k} - \tilde{k}^*) + \frac{\partial \dot{\tilde{k}}}{\partial \tilde{h}} (*) (\tilde{h} - \tilde{h}^*) \quad (\text{A65})$$

$$\dot{\tilde{h}} \approx \frac{\partial \dot{\tilde{h}}}{\partial \theta} (*) (\theta - \theta^*) + \frac{\partial \dot{\tilde{h}}}{\partial \tilde{k}} (*) (\tilde{k} - \tilde{k}^*) + \frac{\partial \dot{\tilde{h}}}{\partial \tilde{h}} (*) (\tilde{h} - \tilde{h}^*) \quad (\text{A66})$$

where $(*) = (\theta^*, \tilde{k}^*, \tilde{h}^*)$, and:

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

$$\frac{\partial \dot{\tilde{k}}}{\partial \theta} (*) = - \frac{(1 - \alpha_{TR} - \beta_{TR})(g_{ATR} - g) + (1 - \alpha_{NTR} - \beta_{NTR})(g - g_{ANTR})}{1 - \theta^*(\alpha_{TR} + \beta_{TR}) - (1 - \theta^*)(\alpha_{NTR} + \beta_{NTR})} \tilde{k}^* \quad (\text{A68})$$

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

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

$$\frac{\partial \dot{\tilde{h}}}{\partial \theta} (*) = - \frac{(1 - \alpha_{TR} - \beta_{TR})(g_{ATR} - g) + (1 - \alpha_{NTR} - \beta_{NTR})(g - g_{ANTR})}{1 - \theta^*(\alpha_{TR} + \beta_{TR}) - (1 - \theta^*)(\alpha_{NTR} + \beta_{NTR})} \tilde{h}^* \quad (\text{A71})$$

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

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

To get $(*) = (\theta^*, \tilde{k}^*, \tilde{h}^*)$, use (43) and A2o. 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 .

The previous set of equations can be rewritten into the matrix equation:

$$\dot{x} = Ex + B \quad (A74)$$

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

$$x = \begin{pmatrix} \theta \\ \tilde{k} \\ \tilde{h} \end{pmatrix} \quad (A76)$$

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

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:

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

This equals:

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

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

$$e_1 = \frac{\partial\dot{\theta}}{\partial\theta}(\ast) < 0 \quad (A80)$$

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:

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

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

$$\lim_{t \rightarrow \infty} \dot{Y}/Y = \lim_{t \rightarrow \infty} \dot{K}/K = \lim_{t \rightarrow \infty} \dot{H}/H = g_L + g \quad (\text{A82})$$

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:

$$\begin{aligned} \frac{\dot{\tilde{k}}}{\tilde{k}} &\approx \frac{\partial \dot{\tilde{k}}}{\partial \theta} (*) (\theta - \theta^*) + \frac{\partial \dot{\tilde{k}}}{\partial \tilde{k}} (*) (\ln \tilde{k} - \ln \tilde{k}^*) \\ &\quad + \frac{\partial \dot{\tilde{k}}}{\partial \tilde{h}} (*) \frac{\tilde{h}^*}{\tilde{k}^*} (\ln \tilde{h} - \ln \tilde{h}^*) \end{aligned} \quad (\text{A83})$$

$$\begin{aligned} \frac{\dot{\tilde{h}}}{\tilde{h}} &\approx \frac{\partial \dot{\tilde{h}}}{\partial \theta} (*) (\theta - \theta^*) + \frac{\partial \dot{\tilde{h}}}{\partial \tilde{k}} (*) \frac{\tilde{k}^*}{\tilde{h}^*} (\ln \tilde{k} - \ln \tilde{k}^*) \\ &\quad + \frac{\partial \dot{\tilde{h}}}{\partial \tilde{h}} (*) (\ln \tilde{h} - \ln \tilde{h}^*) \end{aligned} \quad (\text{A84})$$

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

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

With

$$\frac{\partial \dot{A}/A}{\partial \theta} (*) = \frac{(1 - \alpha_{TR} - \beta_{TR})(g_{ATR} - g) + (1 - \alpha_{NTR} - \beta_{NTR})(g - g_{ANTR})}{1 - \theta^*(\alpha_{TR} + \beta_{TR}) - (1 - \theta^*)(\alpha_{NTR} + \beta_{NTR})} \quad (\text{A86})$$

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:

$$\frac{\tilde{k}^*}{\tilde{h}^*} = \frac{s_K \delta_H + g_L + g}{s_H \delta_K + g_L + g} \quad (\text{A87})$$

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

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

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

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

where:

$$\rho_0 = g - \rho_1 \theta^* - \rho_2 \ln \tilde{k}^* - \rho_3 \ln \tilde{h}^* \quad (\text{A90})$$

$$\rho_1 = (1 - \alpha_{TR} - \beta_{TR})(g_{ATR} - g) + (1 - \alpha_{NTR} - \beta_{NTR})(g - g_{ANTR}) \quad (\text{A91})$$

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

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

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 $g_{ATR} = g_{ANTR}$, positive if $g_{ATR} > g_{ANTR}$, and negative if $g_{ATR} < g_{ANTR}$. To see this consider first that for $g_{ATR} > g$, equation (43) must lead to:

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

which, after rearranging, yields:

$$g_{ATR} > g_{ANTR} \quad (A95)$$

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

$$g_{ATR} < g_{ANTR} \quad (A96)$$

Repeating the same process for $g_{ANTR} > g$ and $g_{ANTR} < g$, we obtain $g_{ANTR} > g_{ATR}$ for $g_{ANTR} > g$, and $g_{ANTR} < g_{ATR}$ for $g_{ANTR} < g$. Therefore,

$$\begin{aligned} g_{ATR} > g > g_{ANTR} & \text{ if } g_{ATR} > g_{ANTR} \\ g_{ANTR} > g > g_{ATR} & \text{ if } g_{ATR} < g_{ANTR} \end{aligned} \quad (A97)$$

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

$$g_{ATR} - g > \frac{1 - \alpha_{NTR} - \beta_{NTR}}{1 - \alpha_{TR} - \beta_{TR}}(g_{ANTR} - g) \quad (A98)$$

Therefore, according to (A97), (A98) will be only true as long as $g_{ATR} > g_{ANTR}$ (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:

$$g_{ANTR} - g > \frac{1 - \alpha_{TR} - \beta_{TR}}{1 - \alpha_{NTR} - \beta_{NTR}}(g_{ATR} - g) \quad (A99)$$

which is only true as long as $g_{ATR} < g_{ANTR}$. This proves that $\rho_1 > 0$ if $g_{ATR} > g_{ANTR}$, and $\rho_1 < 0$ if $g_{ATR} < g_{ANTR}$. 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_{ATR} and g_{ANTR} .

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

$$\begin{aligned} \frac{\dot{y}}{y} & \approx g - \rho_1 \theta^* + \rho_1 \theta \\ & - (1 - \bar{\alpha}^* - \bar{\beta}^*)(\delta + g_L + g)(\bar{\alpha}^*(\ln \tilde{k} - \ln \tilde{k}^*) + \bar{\beta}^*(\ln \tilde{h} - \ln \tilde{h}^*)) \end{aligned} \quad (A100)$$

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:

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

Using (A101) in (A100) leads to:

$$\frac{\dot{y}}{y} \approx \psi + \rho_1 \theta + \zeta \ln y - \zeta \ln A \quad (A102)$$

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

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:

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

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

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

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

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

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

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

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

$$\frac{\dot{k}}{k} = g + \left(1 + \frac{\bar{\beta}^*}{\bar{\alpha}^*} \right) (1 - \bar{\alpha}^* - \bar{\beta}^*) \frac{\partial \dot{A}/A}{\partial \theta} (*) (\theta - \theta^*) \quad (\text{A108})$$

$$+ \bar{\alpha}^* \frac{\partial \dot{\tilde{k}}}{\partial \tilde{k}} (*) (\ln \tilde{k} - \ln \tilde{k}^*) + \bar{\alpha}^* \frac{\partial \dot{\tilde{k}}}{\partial \tilde{h}} (*) \frac{\tilde{h}^*}{\tilde{k}^*} (\ln \tilde{h} - \ln \tilde{h}^*)$$

$$\frac{\dot{h}}{h} = g + \left(1 + \frac{\bar{\alpha}^*}{\bar{\beta}^*} \right) (1 - \bar{\alpha}^* - \bar{\beta}^*) \frac{\partial \dot{A}/A}{\partial \theta} (*) (\theta - \theta^*) \quad (\text{A109})$$

$$+ \bar{\beta}^* \frac{\partial \dot{\tilde{h}}}{\partial \tilde{k}} (*) \frac{\tilde{k}^*}{\tilde{h}^*} (\ln \tilde{k} - \ln \tilde{k}^*) + \bar{\beta}^* \frac{\partial \dot{\tilde{h}}}{\partial \tilde{h}} (*) (\ln \tilde{h} - \ln \tilde{h}^*)$$

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

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

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

Where:

$$\eta_0 = g - \eta_1 \theta^* - \eta_2 \ln \tilde{k}^* - \eta_3 \ln \tilde{h}^* \quad (\text{A112})$$

$$\eta_1 = \left(1 + \frac{\bar{\beta}^*}{\bar{\alpha}^*}\right) [(1 - \alpha_{TR} - \beta_{TR})(g_{ATR} - g) + (1 - \alpha_{NTR} - \beta_{NTR})(g - g_{ANTR})] \quad (A113)$$

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

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

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

$$\phi_1 = \left(1 + \frac{\bar{\alpha}^*}{\bar{\beta}^*}\right) [(1 - \alpha_{TR} - \beta_{TR})(g_{ATR} - g) + (1 - \alpha_{NTR} - \beta_{NTR})(g - g_{ANTR})] \quad (A117)$$

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

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

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:

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

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

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

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

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

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

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 :

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

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

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

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

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

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

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

$$\gamma_H = \frac{\theta \beta_{TR}}{\bar{\beta}} \quad (\text{A129})$$

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

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

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

$$\dot{y}_{TR} = \left[(1 - \alpha_{TR} - \beta_{TR})g_{ATR} + \alpha_{TR}\frac{\dot{k}}{k} + \beta_{TR}\frac{\dot{h}}{h} + \frac{\dot{y}_{TR}}{y_{TR}} \right] y_{TR} \quad (\text{A131})$$

$$\dot{y}_{NTR} = \left[(1 - \alpha_{NTR} - \beta_{NTR})g_{ANTR} + \alpha_{NTR}\frac{\dot{k}}{k} + \beta_{NTR}\frac{\dot{h}}{h} - \frac{\dot{y}_{NTR}}{y_{NTR}} \right] y_{NTR} \quad (\text{A132})$$

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

$$\frac{\dot{y}_{TR}}{y_{TR}} = (1 - \alpha_{TR} - \beta_{TR})\frac{\dot{y}_L}{y_L} + \alpha_{TR}\frac{\dot{y}_K}{y_K} + \beta_{TR}\frac{\dot{y}_H}{y_H} \quad (\text{A133})$$

$$\frac{\dot{y}_{NTR}}{y_{NTR}} = (1 - \alpha_{NTR} - \beta_{NTR})\frac{\dot{y}_L}{1 - \gamma_L y_L} + \alpha_{NTR}\frac{\dot{y}_K}{1 - \gamma_K y_K} + \beta_{NTR}\frac{\dot{y}_H}{1 - \gamma_H y_H} \quad (\text{A134})$$

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

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

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

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

A.12 Accumulated gains and losses in GDP per capita from supply- and demand-side policies

Consider y_t^S and y_t^B as per capita GDP derived from the post-shock and base growth paths. Consider g_t^S and g_t^B as their respective growth rates at period $t \in [0, T]$. Taking $t^* < T$ as the last period of time before the beginning of the steady state of the economy, then $g_{t+t^*}^S = g_{t+t^*}^B = g^* \forall t \neq 0$. Assuming that t only takes non-negative integers ($t=0,1,2,\dots, T$), then the accumulated value of each scenario at T can be described as follows:

$$\ln y_T - C = \int_0^T \frac{d \ln y_t}{dt} dt = g_0 + \int_1^{t^*} g_t dt + \int_{t^*}^T g^* dt \quad (\text{A138})$$

where $C = \ln y_0$ for $T = 0$. Equation (55) can be rearranged as:

$$\ln y_T = \ln y_0 + g_0 + (T - t^*)g^* + \int_1^{t^*} g_t dt \quad (\text{A139})$$

Accordingly, the accumulated deviation from the baseline economy after a demand or supply shock can be read as:

$$\ln y_T^S - \ln y_T^B = g_0^S - g_0^B + \int_1^{t^*} (g_t^S - g_t^B) dt \quad (\text{A140})$$

which depends on the initial difference of growth rates due to the shock, $g_0^S - g_0^B$, and the decreasing differential in pre-steady-state growth rates, $\int_1^{t^*} (g_t^S - g_t^B) dt$. To understand this result, please note that the derivative of $\int_1^{t^*} (g_t^S - g_t^B) dt$ with respect to t^* equals $\frac{d \int_1^{t^*} (g_t^S - g_t^B) dt}{dt^*} = g_{t^*}^S - g_{t^*}^B$, which is approximately 0 due to the proximity to the steady-state growth path, i.e. $g_{t^*}^S \approx g^*$; $g_{t^*}^B \approx g^*$.

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