Dynamic Effects of Tourism Shocks on Innovation in an Open-Economy Schumpeterian Growth Model

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Abstract

This study explores the dynamic effects of tourism shocks in an open-economy Schumpeterian growth model with endogenous market structure. A tourism shock affects the economy via a *reallocation* effect and an *employment* effect. A positive tourism shock increases employment, which raises the level of production and the growth rate of domestic output in the short run. However, a positive tourism shock also reallocates labor from production to service for tourists, which reduces production and growth in domestic output. Which effect dominates depends on leisure preference. If leisure preference is weak, the reallocation effect dominates, and the short-run effect of positive tourism shocks is monotonically negative. If leisure preference is strong, the employment effect dominates initially, and the short-run effect of tourism shocks becomes inverted-U. We use cross-country data to provide evidence for this inverted-U relationship. Finally, permanent tourism shocks do not affect long-run economic growth in our scale-invariant model.

JEL classification: O30, O40, Z32
Keywords: tourism shocks, innovation, endogenous market structure

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1 Introduction

The COVID-19 pandemic has led to international travel restrictions, which drastically reduce the number of tourists. Some economies are affected severely by this negative tourism shock.[1] To explore the dynamic effects of tourism shocks on economic growth, this study develops an open-economy Schumpeterian growth model with endogenous market structure and a tourism sector. Our results can be summarized as follows.

A tourism shock affects the economy via two effects. On the one hand, a positive tourism shock raises the level of employment. This *employment* effect increases the level of production and the growth rate of domestic output in the short run. On the other hand, a positive tourism shock also reallocates labor from the production sector to the service sector for tourists. This *reallocation* effect reduces production and short-run growth in domestic output.

Whether the reallocation or employment effect dominates depends on leisure preference. If leisure preference is weak, then the reallocation effect dominates, and the short-run effect of positive tourism shocks is negative. If leisure preference is strong, then the employment effect dominates initially. In this case, a small tourism shock raises production and short-run growth, whereas a large tourism shock reduces production and short-run growth. So, the effect of tourism shocks becomes inverted-U, and we use cross-country data to provide evidence for this inverted-U relationship. Finally, permanent tourism shocks do not affect long-run economic growth in our scale-invariant Schumpeterian model with endogenous market structure.

This study relates to the literature on innovation and economic growth. The pioneering study by Romer (1990) develops the seminal R&D-based growth model with variety-expanding innovation (i.e., the invention of new products). Another early study by Aghion and Howitt (1992) develops the Schumpeterian growth model with quality-improving innovation (i.e., the quality improvement of products). Recent studies apply these early R&D-based growth models to explore the effects of tourism on growth and innovation; see for example, Albaladejo and Martinez-Garcia (2015), Barrera and Garrido (2018) and Hamaguchi (2020) for representative studies. This study contributes to this interesting branch of the literature by introducing a tourism sector to a recent vintage of the Schumpeterian model that features both variety-expanding and quality-improving innovation. This so-called second-generation Schumpeterian growth model originates from Smulders and van de Klundert (1995), Peretto (1998, 1999) and Howitt (1999) and has the advantage of endogenous market structure removing the scale effect of labor on long-run growth.[2] The variant that we use is from Peretto (2007, 2011). We preserve its tractable transition dynamics and derive analytically the complete transitional effects of tourism shocks, instead of focusing on long-run growth.

2 A Schumpeterian model with a tourism sector

The Schumpeterian model with in-house R&D and endogenous market structure is from Peretto (2007, 2011). We develop an open-economy version and incorporate a tourism sector to explore the dynamic effects of tourism shocks.

[1] For example, the economy of Macau, which relies heavily on tourism, contracted by 56.3% in 2020.

[2] See Laincz and Peretto (2006) for a discussion of the scale effect and Ha and Howitt (2007), Madsen (2008) and Ang and Madsen (2011) for evidence that supports the second-generation Schumpeterian growth model.

2.1 Household

There is a representative household in the economy. Its utility function is

$$U = \int_0^\infty e^{-\rho t} \left[\ln c_t + \sigma \iota_t + \delta \ln(1 - l_t)\right] dt,$$

where $\rho > 0$ is the subjective discount rate. c_t denotes consumption of a domestically produced final good, which is the numeraire. ι_t denotes consumption of an imported good, and $\sigma > 0$ is a preference parameter. l_t is the level of employment, and $\delta \geq 0$ is a preference parameter for leisure $1 - l_t$. The asset-accumulation equation is

$$\dot{a}_t = r_t a_t + w_t l_t - c_t - p_t \iota_t, \tag{1}$$

where a_t is the value of assets, and r_t is the real interest rate in the domestic economy.[3] The household supplies l_t units of labor to earn wage w_t. p_t is the price of the imported good relative to the domestic final good and is endogenously determined to ensure balanced trade. From dynamic optimization, the Euler equation is

$$\frac{\dot{c}_t}{c_t} = r_t - \rho. \tag{2}$$

The optimality condition for consumption is

$$p_t = \sigma c_t, \tag{3}$$

and the optimality condition for labor supply is

$$l_t = 1 - \frac{\delta c_t}{w_t}. \tag{4}$$

2.2 Domestic final good

Competitive domestic firms produce final good Y_t using the following production function:

$$Y_t = \int_0^{N_t} X_t^\theta(i) [Z_t^\alpha(i) Z_t^{1-\alpha} l_{y,t}/N_t]^{1-\theta} di, \tag{5}$$

where $\{\theta, \alpha\} \in (0, 1)$. $X_t(i)$ is the quantity of differentiated intermediate good $i \in [0, N_t]$, and N_t denotes their variety at time t. $Z_t(i)$ is the quality of $X_t(i)$, whereas $Z_t \equiv \frac{1}{N_t} \int_0^{N_t} Z_t(i) di$ is the average quality capturing technology spillovers for which the degree is $1 - \alpha$. Finally, $l_{y,t}/N_t$ captures a congestion effect of variety and removes the scale effect.[4]

From profit maximization, we derive the conditional demand functions:

$$l_{y,t} = (1 - \theta) Y_t / w_t, \tag{6}$$

$$X_t(i) = \left[\frac{\theta}{P_t(i)}\right]^{1/(1-\theta)} Z_t^\alpha(i) Z_t^{1-\alpha} l_{y,t}/N_t, \tag{7}$$

where $P_t(i)$ is the price of $X_t(i)$. Competitive firms pay $(1 - \theta) Y_t = w_t l_{y,t}$ for production labor and $\theta Y_t = \int_0^{N_t} P_t(i) X_t(i) di$ for intermediate goods.

[3] We assume the domestic financial market is not integrated to the global financial market.

[4] Our results are robust to parameterizing this effect as $l_{y,t}/N_t^{1-\xi}$ for $\xi \in (0, 1)$ as in Peretto (2015).

2.3 Intermediate goods and in-house R&D

To produce $X_t(i)$ units of intermediate good i, the monopolistic firm employs $X_t(i)$ units of domestic final good. It also incurs a fixed operating cost $\phi Z_t^\alpha(i) Z_t^{1-\alpha}$ in units of domestic final good. Furthermore, it invests $R_t(i)$ units of domestic final good to improve quality $Z_t(i)$. The in-house R&D process is

$$\dot{Z}_t(i) = R_t(i). \tag{8}$$

The profit flow (before R&D) of the firm at time t is

$$\Pi_t(i) = [P_t(i) - 1] X_t(i) - \phi Z_t^\alpha(i) Z_t^{1-\alpha}. \tag{9}$$

The value of the firm is

$$V_t(i) = \int_t^\infty \exp\left(-\int_t^s r_u du\right) [\Pi_s(i) - R_s(i)]\, ds. \tag{10}$$

The firm maximizes (10) subject to (7)-(9). The current-value Hamiltonian is

$$H_t(i) = \Pi_t(i) - R_t(i) + \eta_t(i) \dot{Z}_t(i), \tag{11}$$

where $\eta_t(i)$ is the co-state variable on (8). Solving this optimization problem in Appendix A, we derive the familiar profit-maximizing price $P_t(i) = 1/\theta > 1$.

We follow previous studies to consider a symmetric equilibrium in which $Z_t(i) = Z_t$ and $X_t(i) = X_t$ for $i \in [0, N_t]$.[5] From (7) and $P_t(i) = 1/\theta$, the quality-adjusted firm size is

$$\frac{X_t}{Z_t} = \theta^{2/(1-\theta)} \frac{l_{y,t}}{N_t}. \tag{12}$$

We will show the following transformed state variable capturing the model's dynamics:

$$x_t \equiv \frac{\theta^{2/(1-\theta)}}{N_t}. \tag{13}$$

Lemma 1 shows the return on quality-improving R&D being increasing in the quality-adjusted firm size $x_t l_{y,t}$.

Lemma 1 *The rate of return to in-house R&D is*

$$r_t^q = \alpha \frac{\Pi_t}{Z_t} = \alpha \left(\frac{1-\theta}{\theta} x_t l_{y,t} - \phi \right). \tag{14}$$

Proof. See Appendix A. ■

[5] Symmetry also implies $\Pi_t(i) = \Pi_t$, $R_t(i) = R_t$ and $V_t(i) = V_t$.

2.4 Entrants

Entrants have access to aggregate technology Z_t, which ensures the symmetric equilibrium at any time t. Entering the market with a new intermediate good requires βX_t units of domestic final good, where $\beta > 0$ is an entry-cost parameter. The asset-pricing equation that determines the rate of return on assets is

$$r_t = \frac{\Pi_t - R_t}{V_t} + \frac{\dot{V}_t}{V_t}. \tag{15}$$

Free entry implies that

$$V_t = \beta X_t. \tag{16}$$

We substitute (8), (9), (12), (13), (16) and $P_t(i) = 1/\theta$ into (15) to derive the return on entry as[6]

$$r_t^e = \frac{1}{\beta}\left(\frac{1-\theta}{\theta} - \frac{\phi + z_t}{x_t l_{y,t}}\right) + \frac{\dot{l}_{y,t}}{l_{y,t}} + \frac{\dot{x}_t}{x_t} + z_t, \tag{17}$$

where $z_t \equiv \dot{Z}_t / Z_t$ is the quality growth rate.

2.5 Tourism and international trade

We consider a small open economy in the sense that the inflow of tourists is exogenous to the domestic economy. Tourists consume $T_t = \tau Y_t$ units of domestic final good and require $l_{s,t} = \tau l_t$ units of local labor for service. The domestic economy uses the tourists' expenditures to pay for imported goods, and the balanced-trade condition is[7]

$$p_t \iota_t = T_t + w_t l_{s,t} = \tau(Y_t + w_t l_t). \tag{18}$$

Unanticipated changes in the parameter τ capture tourism shocks to the domestic economy.

2.6 Equilibrium

The equilibrium is defined in Appendix B.

2.7 Aggregation

The resource constraint on domestic final good is

$$Y_t - T_t = (1-\tau)Y_t = c_t + N_t(X_t + \phi Z_t + R_t) + \dot{N}_t \beta X_t. \tag{19}$$

Substituting (7) and $P_t(i) = 1/\theta$ into (5) and imposing symmetry yield

$$Y_t = (1-\tau)\theta^{2\theta/(1-\theta)} Z_t l_t, \tag{20}$$

[6] We treat entry and exit symmetrically (i.e., the scrap value of exiting an industry is also βX_t); therefore, $V_t = \beta X_t$ always holds and $r_t^e = r_t$ for all t.

[7] Y_t can also be exported abroad subject to an exogenous export demand χY_t. We assume $\chi = 0$ for simplicity, but our results are robust to $\chi > 0$; see Appendix C for the derivations.

which also uses $l_{y,t} = (1-\tau)l_t$. Therefore, the growth rate of domestic output is[8]

$$\frac{\dot{Y}_t}{Y_t} = z_t + \frac{\dot{l}_t}{l_t}, \tag{21}$$

where $z_t \equiv \dot{Z}_t / Z_t$ is the quality growth rate.

2.8 Dynamics

Substituting $l_{y,t} = (1-\tau)l_t$ and (6) into (4) yields the level of labor as

$$l_t = \left[1 + \frac{\delta(1-\tau)}{1-\theta}\frac{c_t}{Y_t}\right]^{-1}, \tag{22}$$

which is increasing in τ and decreasing in c_t/Y_t. Therefore, we first need to derive the dynamics of the consumption-output ratio.

Lemma 2 *The consumption-output ratio jumps to a unique and stable steady-state value:*

$$\frac{c_t}{Y_t} = \rho\beta\theta^2 + 1 - \theta - \tau > 0. \tag{23}$$

Proof. See Appendix A. ■

Lemma 2 implies that l_t jumps to its steady-state value l^* and that consumption and output grow at the same rate:

$$g_t \equiv \frac{\dot{Y}_t}{Y_t} = \frac{\dot{c}_t}{c_t} = r_t - \rho, \tag{24}$$

which uses (2). Substituting (14) and (21) into (24) yields

$$g_t = z_t = \alpha\left[\frac{1-\theta}{\theta}x_t l_y^* - \phi\right] - \rho, \tag{25}$$

where l_y^* is

$$l_y^* = (1-\tau)l^* = \left[\frac{1}{1-\tau} + \frac{\delta}{1-\theta}\left(\rho\beta\theta^2 + 1 - \theta - \tau\right)\right]^{-1}, \tag{26}$$

which uses (22) and (23). In (25), g_t is positive if and only if

$$x_t > \overline{x} \equiv \frac{\theta}{1-\theta}\left(\frac{\rho}{\alpha} + \phi\right)\frac{1}{l_y^*}$$

because firm size $x_t l_y^*$ needs to be sufficiently large for in-house R&D to be profitable. We assume $x_t > \overline{x}$, which implies $z_t > 0$ and $r_t^q = r_t$, for all t. Lemma 3 derives the dynamics of x_t.

[8] If we parameterize the congestion effect in (5) as $l_{y,t}/N_t^{1-\xi}$ as in Peretto (2015), then (20) would become $Y_t = (1-\tau)\theta^{2\theta/(1-\theta)} Z_t N_t^{\xi} l_t$. In this case, the growth rate of Y_t also depends on $\xi \dot{N}_t / N_t$, but $\dot{Y}_t / Y_t$ is still determined by r_t^q in (14) as (24) shows. See Peretto and Connolly (2007) for a discussion on why economic growth is ultimately driven by quality-improving innovation and Garcia-Macia *et al.* (2019) for evidence.

Lemma 3 *The dynamics of x_t is determined by an one-dimensional differential equation:*

$$\dot{x}_t = \frac{(1-\alpha)\phi - \rho}{\beta l_y^*} - \left[\frac{(1-\alpha)(1-\theta)}{\beta\theta} - \rho\right] x_t. \tag{27}$$

Proof. See Appendix A. ■

Proposition 1 *If $\rho < \min\{(1-\alpha)\phi, (1-\alpha)(1-\theta)/(\theta\beta)\}$, the dynamics of x_t is stable and x_t gradually converges to a unique steady-state value:*

$$x^* = \frac{(1-\alpha)\phi - \rho}{(1-\alpha)(1-\theta)/\theta - \beta\rho} \frac{1}{l_y^*} > \overline{x}. \tag{28}$$

Proof. See Appendix A. ■

Proposition 1 implies that given an initial value, x_t gradually converges to its steady state. Then, (25) shows that when x_t converges to x^*, the growth rate g_t also converges to

$$g^* = \alpha \left[\frac{1-\theta}{\theta} \frac{(1-\alpha)\phi - \rho}{(1-\alpha)(1-\theta)/\theta - \beta\rho} - \phi\right] - \rho > 0, \tag{29}$$

which is independent of tourists' demand τ due to the scale-invariant property of the model.

3 Dynamic effects of tourism shocks

In this section, we explore the dynamic effects of tourism shocks. Equation (25) shows that the growth rate of domestic output Y_t at any time t is

$$g_t = \alpha \left[\frac{1-\theta}{\theta} x_t l_y^* - \phi\right] - \rho,$$

which is increasing in firm size $x_t l_y^*$. Suppose the economy is in a steady state at time t. Then, $x_t l_y^* = x^* l_y^*$, which is independent of τ as shown in (28). Now a positive tourism shock occurs (i.e., an increase in τ). In this case, production labor l_y^* jumps to its new steady-state value while the state variable x_t initially remains in the previous steady state. Therefore, the instantaneous effect of a positive tourism shock on the growth rate of domestic output depends on whether l_y^* in (26) increases or decreases in response; i.e.,

$$sgn\left(\frac{\partial g_t}{\partial \tau}\right) = sgn\left(\frac{\partial l_y^*}{\partial \tau}\right) = sgn\left(\frac{\delta}{1-\theta} - \frac{1}{(1-\tau)^2}\right), \tag{30}$$

which is negative if $\delta < 1-\theta$. In this case, a positive tourism shock reduces production labor l_y^* and the growth rate g_t of domestic output. If $\delta > 1-\theta$, then a positive tourism shock has an inverted-U effect on production labor l_y^* and the growth rate g_t of domestic output.

The intuition can be explained as follows. A tourism shock affects the economy via two effects. First, a positive tourism shock reallocates labor from production to service for tourists. We refer to this effect as the *reallocation* effect. Second, a positive tourism shock increases total employment l^*. We refer to this effect as the *employment* effect. Under perfectly inelastic labor supply (i.e., $\delta = 0$), the employment effect is absent because total employment is fixed (i.e., $l^* = 1$). In this case, a positive tourism shock reduces production l_y^* and the instantaneous growth rate g_t due to the reallocation effect, which dominates the employment effect so long as $\delta < 1 - \theta$. Then, (27) shows that the state variable $x_t = \theta^{2/(1-\theta)}/N_t$ gradually rises (due to the exit of firms). Eventually, the average firm size $x_t l_y^*$, which determines the incentives for quality-improving innovation, returns to its initial steady-state level $x^* l_y^*$, which is independent of τ. Figure 1 illustrates the negative effect of a positive tourism shock on the transitional growth rate of domestic output under $\delta < 1 - \theta$.

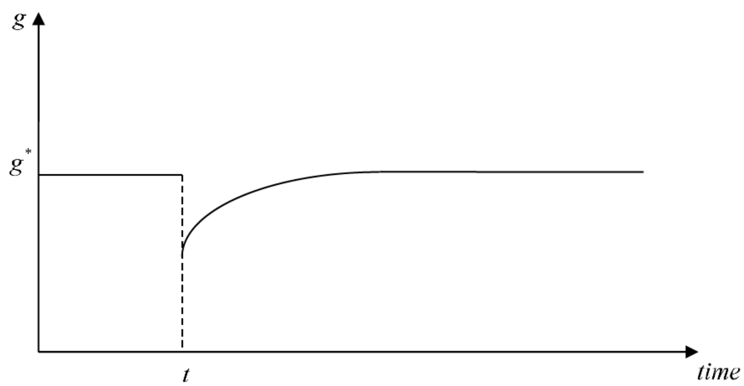

Figure 1: A positive tourism shock under $\delta < 1 - \theta$

When $\delta > 1 - \theta$, the employment effect dominates the reallocation effect for a small value of τ. However, as τ increases, the employment effect becomes weaker and the reallocation effect becomes stronger. When τ rises above $\overline{\tau} \equiv 1 - \sqrt{(1-\theta)/\delta}$, the employment effect becomes dominated by the reallocation effect. Therefore, the instantaneous effect of τ on the growth rate of domestic output is inverted-U. In other words, a small (large) tourism shock raises (reduces) production l_y^* and the transitional growth rate g_t. The steady-state growth rate g^* is once again independent of τ due to the scale-invariant Schumpeterian model with endogenous market structure (i.e., an endogenous N_t). Figure 2 illustrates these ambiguous effects of a positive tourism shock on the transitional growth rate of domestic output under $\delta > 1 - \theta$, where case 1 (case 2) refers to a small (large) tourism shock. Proposition 2 summarizes all the above results.

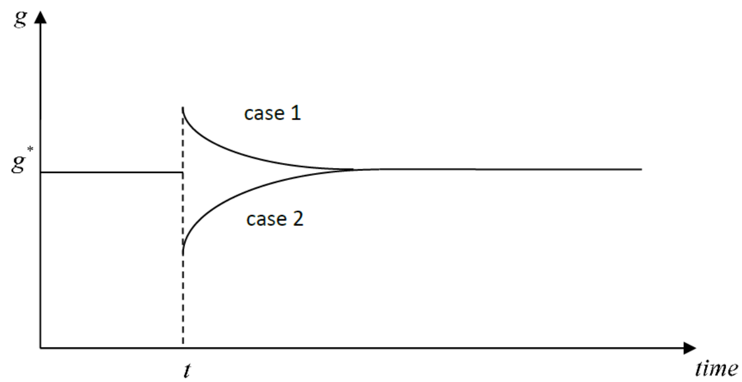

Figure 2: A positive tourism shock under $\delta > 1 - \theta$

Proposition 2 *If leisure preference is weak (i.e., $\delta < 1 - \theta$), a positive tourism shock has a negative effect on the transitional growth rate. If leisure preference is strong (i.e., $\delta > 1 - \theta$), a positive tourism shock has an inverted-U effect on the transitional growth rate. The steady-state growth rate is independent of tourism shocks.*

Proof. Use (30) and (29) to determine the effects of τ on g_t and g^*, respectively. ■

4 Evidence

Tourists' expenditure τ may have an inverted-U effect on innovation. Specifically, if $\delta > 1 - \theta$, then the innovation rate $g_t = z_t$ in (25) is an inverted-U function in τ. An empirical value of $l^* \leq 1/2$ requires

$$\delta \geq \frac{1 - \theta}{(1 - \tau)\left[1 - \tau - \theta\left(1 - \rho\beta\theta\right)\right]} > 1 - \theta,$$

where $\rho\beta\theta < 1$ from Proposition 1; therefore, $\delta > 1 - \theta$ holds under empirically plausible values.

Here we use cross-country data to provide some evidence for the inverted-U relationship. We specify our main regression model as

$$y_{jt} = \gamma_0 + \gamma_1 \tau_{jt} + \gamma_2 \tau_{jt}^2 + \varepsilon_{jt}, \tag{31}$$

where y_{jt} is the R&D share of GDP and τ_{jt} is the tourism share of GDP of country j in year t. We use all available data from 2008 to 2019.[9] Table 1 provides the summary statistics.

Table 1: Summary statistics

variables	obs	mean	median	std dev
R&D	148	1.749	1.703	0.958
tourism	148	4.678	3.538	2.743

[9]Data source: OECD Data.

Our theory predicts $\gamma_1 > 0$ and $\gamma_2 < 0$. We test this prediction. Table 2 summarizes the results and shows some evidence that there is an inverted-U relationship between tourism expenditure and innovation in the data. Column (1) and (2) report the results without country fixed effects for the full sample; however, the regression coefficients become insignificant with country fixed effects. We examine the data and find that the patterns for Estonia, Iceland, Poland and Slovakia are different from other countries. Therefore, we drop these four countries and rerun the regressions in column (3) to (6). In this case, we find that the regression coefficients remain statistically significant even with country fixed effects.[10]

Table 2: Regression results

	R&D					
	(1)	(2)	(3)	(4)	(5)	(6)
τ_{jt}	0.491***	0.480***	0.394***	0.376***	0.249**	0.236*
	(0.114)	(0.117)	(0.131)	(0.137)	(0.118)	(0.126)
τ_{jt}^2	-0.041***	-0.041***	-0.036***	-0.035***	-0.014**	-0.015**
	(0.009)	(0.010)	(0.011)	(0.011)	(0.006)	(0.007)
year fixed effects	no	yes	no	yes	no	yes
country fixed effects	no	no	no	no	yes	yes
observations	148	148	117	117	117	117
R^2	0.1172	0.1174	0.1030	0.1034	0.0452	0.0536

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Standard errors in parentheses.

5 Conclusion

In this study, we have explored the dynamic effects of tourism shocks in an open-economy Schumpeterian model with endogenous market structure. In summary, a positive tourism shock causes a negative reallocation effect and a positive employment effect on the transitional growth rate. Which effect dominates depends on the degree of leisure preference. Under empirically plausible degrees of leisure preference, the effect of tourism shocks on innovation is inverted-U. We use cross-country data to confirm this inverted-U relationship, which implies that negative tourism shocks may be a blessing in disguise because overreliance on tourism stifles innovation.

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Appendix A: Proofs

Proof of Lemma 1. The current-value Hamiltonian for monopolistic firm i is given by (11). Substituting (7)-(9) into (11), we can derive

$$\frac{\partial H_t(i)}{\partial P_t(i)} = 0 \Rightarrow \frac{\partial \Pi_t(i)}{\partial P_t(i)} = 0, \tag{A1}$$

$$\frac{\partial H_t(i)}{\partial R_t(i)} = 0 \Rightarrow \eta_t(i) = 1, \tag{A2}$$

$$\frac{\partial H_t(i)}{\partial Z_t(i)} = \alpha \left\{ [P_t(i) - 1] \left[\frac{\theta}{P_t(i)}\right]^{1/(1-\theta)} \frac{l_{y,t}}{N_t} - \phi \right\} Z_t^{\alpha-1}(i)\, Z_t^{1-\alpha} = r_t \eta_t(i) - \dot{\eta}_t(i). \tag{A3}$$

(A1) yields $P_t(i) = 1/\theta$. Substituting (A2), (13) and $P_t(i) = 1/\theta$ into (A3) and imposing symmetry yield (14). ■

Proof of Lemma 2. Substituting (16) into the total asset value $a_t = N_t V_t$ yields

$$a_t = N_t \beta X_t = \theta^2 \beta Y_t, \tag{A4}$$

where the second equality uses $\theta Y_t = N_t X_t / \theta$.[11] Differentiating (A4) with respect to t yields

$$\frac{\dot{Y}_t}{Y_t} = \frac{\dot{a}_t}{a_t} = r_t + \frac{1-\theta-\tau}{\theta^2 \beta} - \frac{c_t}{\theta^2 \beta Y_t}, \tag{A5}$$

where the second equality uses (1), (6), (18) and (A4). Using (2) for r_t, we can rearrange (A5) to obtain

$$\frac{\dot{c}_t}{c_t} - \frac{\dot{Y}_t}{Y_t} = \frac{1}{\beta\theta^2}\left[\frac{c_t}{Y_t} - \left(\rho\beta\theta^2 + 1 - \theta - \tau\right)\right], \tag{A6}$$

which is increasing in c_t/Y_t with a strictly negative vertical intercept. Therefore, c_t/Y_t must jump to the steady-state value in (23). ■

Proof of Lemma 3. Substituting $z_t = g_t = r_t - \rho = r_t^e - \rho$ into (17) yields

$$\frac{\dot{x}_t}{x_t} = \rho - \frac{1}{\beta}\left(\frac{1-\theta}{\theta} - \frac{\phi + z_t}{x_t l_{y,t}}\right), \tag{A7}$$

which also uses $\dot{l}_{y,t} = \dot{l}_t = 0$ from (22) and (23). Then, we use the expression of z_t in (25) to derive (27). ■

Proof of Proposition 1. One can rewrite (27) simply as $\dot{x}_t = d_1 - d_2 x_t$. This dynamic system for x_t has a unique (non-zero) steady state that is stable if

$$d_1 \equiv \frac{(1-\alpha)\phi - \rho}{\beta l_y^*} > 0, \tag{A8a}$$

$$d_2 \equiv \frac{(1-\alpha)(1-\theta)}{\beta\theta} - \rho > 0, \tag{A8b}$$

from which we obtain $\rho < \min\{(1-\alpha)\phi, (1-\alpha)(1-\theta)/(\theta\beta)\}$. Then, $\dot{x}_t = 0$ yields the steady-state value $x^* = d_1/d_2$, which gives (28). ■

[11] We derive this by using $P_t(i) = 1/\theta$ and $X_t(i) = X_t$ for $\theta Y_t = \int_0^{N_t} P_t(i) X_t(i) di$.

Appendix B: Equilibrium

The equilibrium is a time path of allocations $\{a_t, \iota_t, c_t, Y_t, l_{y,t}, l_{s,t}, l_t, X_t(i), R_t(i), T_t\}$ and a time path of prices $\{r_t, w_t, p_t, P_t(i), V_t\,(i)\}$ such that the following conditions are satisfied:

- the household maximizes utility taking $\{r_t, w_t, p_t\}$ as given;
- competitive firms produce Y_t and maximize profits taking $\{P_t(i), w_t\}$ as given;
- a monopolistic firm produces $X_t(i)$ and chooses $\{P_t(i), R_t(i)\}$ to maximize $V_t(i)$ taking r_t as given;
- entrants make entry decisions taking V_t as given;
- the value of monopolistic firms is equal to the value of the household's assets such that $N_t V_t = a_t$;
- the balanced-trade condition holds such that $p_t \iota_t = T_t + w_t l_{s,t}$;
- the final-good market clears such that $Y_t = c_t + N_t(X_t + \phi Z_t + R_t) + \dot{N}_t \beta X_t + T_t$; and
- the labor market clears such that $l_t = l_{y,t} + l_{s,t}$.

Appendix C: Export demand

In this appendix, we consider the case in which the domestic final good Y_t is also exported abroad subject to an exogenous export demand χY_t, where $\chi > 0$. In this case, the balanced-trade condition in (18) becomes

$$p_t \iota_t = \chi Y_t + T_t + w_t l_{s,t} = \chi Y_t + \tau(Y_t + w_t l_t). \tag{C1}$$

Then, the resource constraint on the domestic final good in (19) becomes

$$Y_t - \chi Y_t - T_t = (1 - \chi - \tau) Y_t = c_t + N_t(X_t + \phi Z_t + R_t) + \dot{N}_t \beta X_t. \tag{C2}$$

One can follow the same derivations as in the proof of Lemma 2 to show that the consumption-output ratio jumps to the following unique and stable steady-state value:

$$\frac{c_t}{Y_t} = \rho\beta\theta^2 + 1 - \theta - \chi - \tau > 0, \tag{C3}$$

which in turn changes the level of production labor in (26) as follows:

$$l_y^* = (1 - \tau) l^* = \left[\frac{1}{1 - \tau} + \frac{\delta}{1 - \theta} \left(\rho\beta\theta^2 + 1 - \theta - \chi - \tau \right) \right]^{-1}. \tag{C4}$$

The rest of the model is the same as before.

Equation (C4) shows that the effects of tourism demand τ remain the same as before. If $\delta < 1 - \theta$, then a positive tourism shock reduces production labor l_y^* in (C4) and the transitional growth rate g_t in (25). If $\delta > 1 - \theta$, then a positive tourism shock has an inverted-U effect on production labor l_y^* and the transitional growth rate g_t. Interestingly, the effect of a positive export demand shock (i.e., an increase in χ) is different: it only causes a positive effect on employment l^*, production labor l_y^* and the transitional growth rate g_t because it does not give rise to the reallocation effect from production to local service. Finally, the steady-state growth rate g^* in (29) is independent of tourism demand τ and export demand χ.