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 rate of innovation in the short run. However, a positive tourism shock also reallocates labor from production to service for tourists, which reduces production and innovation. 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 on innovation is monotonically negative. If leisure preference is strong, the employment effect dominates initially, and the short-run effect of tourism shocks on innovation becomes inverted-U. We use cross-country panel data to provide evidence for this inverted-U relationship. Finally, permanent tourism shocks do not affect the steady-state innovation rate 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 rely heavily on the tourism industry and are affected severely by this negative tourism shock; for example, the economies of Macau and Maldives contracted by 56.3% and 29.3%, respectively, in 2020. Given the growing importance of tourism economics, this study develops an open-economy Schumpeterian growth model with endogenous market structure and a tourism sector to explore the dynamic effects of tourism shocks on economic growth and innovation. 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 rate of innovation 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 innovation. Although a positive tourism shock unambiguously raises the contemporaneous level of wage income, its effect on innovation and the growth rate of wage income is ambiguous, depending on the relative magnitude of the above two effects.

Whether the reallocation effect 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 on innovation is negative. If leisure preference is strong, then the employment effect dominates initially. In this case, a small tourism shock raises production and innovation, whereas a large tourism shock reduces production and innovation. So, the effect of tourism shocks on innovation becomes inverted-U, and we use cross-country panel data to provide evidence for this inverted-U relationship. Finally, permanent tourism shocks do not affect the steady-state innovation rate 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.[1] This study contributes to this interesting branch of the literature by introducing a tourism sector to a recent vintage of the Schumpeterian model that has the advantages of featuring both dimensions of innovation (i.e., variety-expanding innovation and quality-improving innovation) and featuring analytically tractable transitional dynamics. This so-called second-generation Schumpeterian growth model originates from Smulders and van de Klundert (1995), Peretto (1998, 1999) and Howitt (1999) and also has the advantage of endogenous market structure that removes 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

[1] There is a related literature on tourism and economic growth based on AK growth models; see for example, Schubert and Brida (2011) and Liu and Wu (2019) for recent studies and Zhang (2022) for a recent survey.

[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.

growth as in previous studies. This recent vintage of the Schumpeterian growth model with the addition of a tourism sector can serve as a workhorse model for the literature on tourism and innovation-driven growth.

The rest of this study is organized as follows. Section 2 describes the Schumpeterian model. Section 3 explores the dynamic effects of tourism shocks on innovation. Section 4 presents empirical evidence. The final section concludes.

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.

2.1 Household

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

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

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 for which $\sigma > 0$ is its preference parameter and $\epsilon \in [0, 1)$ is the inverse of its intertemporal elasticity of substitution. 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 for domestic consumption is

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

The optimality condition for relative consumption is

$$p_t = \frac{\sigma c_t}{\iota_t^\epsilon}, \tag{3}$$

and the optimality condition for labor supply is

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

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

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, $l_{y,t}$ is production labor, and the specification $l_{y,t}/N_t$ 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.

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 $P_t(i) = 1/\theta > 1$.

[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).

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 that the following transformed state variable captures the model's dynamics:

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

Lemma 1 shows that the rate of return on quality-improving R&D is 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. ■

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 rate of 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.

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

[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.

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, instead of the relative price p_t being exogenous, because we want to explore the effects of exogenous changes in tourism demand.[7] Tourism expenditures have the following characteristics. First, tourists consume $T_t = \tau Y_t$ units of domestic final good. Second, tourists require $l_{s,t} = \tau l_t$ units of local labor for tourism services.[8] This second characteristic makes tourism expenditures different from exports.[9] The domestic economy uses the tourists' expenditures to pay for the imported good ι_t, and the balanced-trade condition is

$$p_t \iota_t = T_t + w_t l_{s,t} = \tau(Y_t + w_t l_t) \Rightarrow \sigma \iota_t^{1-\epsilon} = \tau \frac{Y_t + w_t l_t}{c_t}, \tag{18}$$

where $\epsilon \in [0, 1)$ and the second equation uses (3). Unanticipated changes in the parameter τ capture tourism shocks to the domestic economy.

2.6 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 $l_t = l_{y,t} + l_{s,t}$.

[7] If p_t is assumed to be exogenous instead, then τ_t would need to be an endogenous variable.

[8] We can also introduce another parameter in $l_{s,t} = \varrho \tau l_t$, where $\varrho > 0$. We normalize this parmeter to unity for simplicity, without changing our results.

[9] Y_t can also be exported abroad subject to an exogenous export demand χY_t. We assume $\chi = 0$ for simplicity, but the effects of tourism shocks are robust to $\chi > 0$. Interestingly, export shocks only affect the economy via the employment effect but not the reallocation effect; see Appendix B for the derivations.

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

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

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

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

where the quality growth rate $z_t \equiv \dot{Z}_t/Z_t$ will be referred to as the innovation rate.[10]

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^*, which is increasing in τ, 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 the innovation rate z_t as

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

[10] 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 overall innovation rate is $z_t + \xi \dot{N}_t/N_t$, which 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.

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), z_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 innovation 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.

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 innovation rate z_t also converges to

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

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 effects of tourism shocks. Given the importance of the tourism industry for local workers, we first examine how a positive tourism shock affects wage income $w_t l_t$. From (6) and (20), it is given by

$$w_t l_t = (1-\theta)\theta^{2\theta/(1-\theta)} Z_t l^*,$$

where the steady-state equilibrium level of labor l^* is determined by (22)-(23) and increasing in τ. Therefore, a positive tourism shock raises the contemporaneous level of wage income $w_t l_t$ via an increase in employment l^*. However, this is a one-time level effect (unless τ keeps rising), rather than a growth effect. As for the growth rate of wage income, it is determined by the innovation rate $z_t = \dot{Z}_t/Z_t$, which we examine next.

Equation (25) shows that the innovation rate z_t at any time t is

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

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 innovation rate depends on whether l_y^* in (26) increases or decreases in response; i.e.,

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

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

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 innovation rate z_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 innovation rate z_t under $\delta < 1-\theta$.

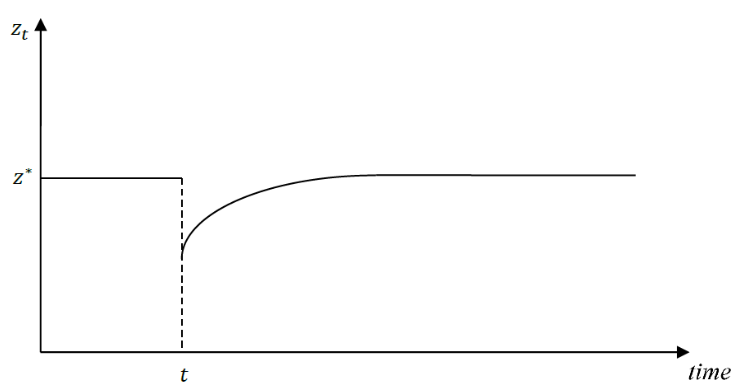

Figure 1: A positive tourism shock under $\delta < 1-\theta$

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 innovation rate z_t is inverted-U. In other words, a small (large) tourism shock that is below $\overline{\tau}$ (rises above $\overline{\tau}$) raises (reduces) production l_y^* and the transitional innovation rate z_t. The steady-state innovation rate z^* 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 innovation rate z_t under $\delta > 1-\theta$, where case 1 (case 2) refers to a small (large) tourism shock. Proposition 2 summarizes all the above results.

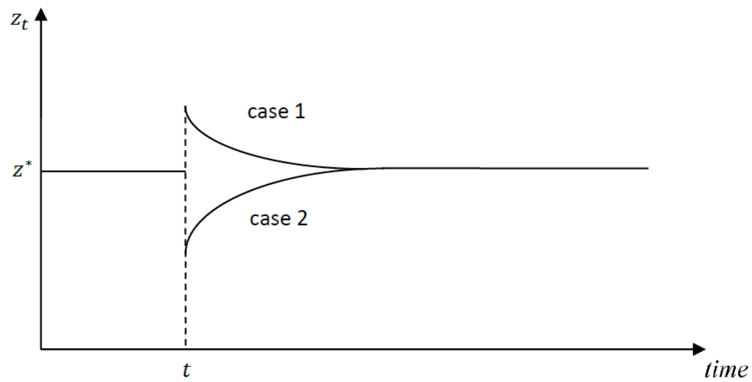

Figure 2: A positive tourism shock under $\delta > 1 - \theta$

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

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

The reason why the leisure preference parameter is key to our results can be explained as follows. The innovation rate is determined by firm size, which is proportional to production labor. Production labor is total labor supply minus tourism service labor. Therefore, a rise in tourism demand has two opposite effects on production labor as shown in (26). First, it lowers production labor share directly by reallocating labor from production to tourism. Second, it increases labor supply because the increase in tourism demand crowds out domestic consumption as shown in (23). This decrease in consumption in turn decreases leisure and increases labor supply. The magnitude of this positive effect is increasing in the degree of leisure preference. Therefore, when leisure preference is weak, the positive effect is dominated by the negative effect. When leisure preference is strong, the positive effect dominates the negative effect, at least for a small tourism shock.

4 Empirical evidence

Our theoretical model shows that tourists' expenditure τ may have an inverted-U effect on innovation. Specifically, if $\delta > 1 - \theta$, then the innovation rate 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 panel data to provide some evidence for the inverted-U relationship. There is an established empirical literature that examines the relationship between tourism and economic growth; see Balaguer and Cantavella-Jorda (2002), Brau *et al.* (2007), Sequeira and Nunes (2008) and Figini and Vici (2010) for early studies and Song and Wu (2022) for a recent survey. Our empirical analysis contributes to this literature by examining instead the relationship between tourism and innovation and identifying a novel inverted-U relationship between the two variables.

We specify our main regression model as

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

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. $\Phi_{j,t}$ is a vector of control variables (to be discussed below). We use all available data from 2008 to 2019.[11] 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

Our theory predicts $\gamma_1 > 0$ and $\gamma_2 < 0$. We test this prediction. Table 2 summarizes the results and shows 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. Therefore, the results in the first two columns are driven by across-country variation, rather than within-country-across-time variation. 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.

[11] Data source: OECD Data. See https://data.oecd.org/. The variables are tourism GDP and gross domestic spending on R&D. The countries are Australia, Austria, Czechia, Estonia, France, Iceland, Japan, Luxembourg, Mexico, Norway, Poland, Romania, Slovakia, Slovenia, South Africa, Spain and Sweden.

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
no. of countries	17	17	13	13	13	13
R^2	0.1172	0.1468	0.1030	0.1289	0.9798	0.9819

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

To mitigate omitted variable bias, we now add the following control variables: labor productivity, income level, size of labor force, taxation, and education.[12] Table 3 reports the regression results. As before, we continue to find that $\gamma_1 > 0$ and $\gamma_2 < 0$. Also, most of the regression coefficients are statistically significant at 1%, except for the coefficient of τ_{jt} in column (4).

Table 3: Robustness check

	R&D			
	(1)	(2)	(3)	(4)
τ_{jt}	1.164***	1.166***	0.542***	0.452**
	(0.127)	(0.135)	(0.204)	(0.209)
τ_{jt}^2	-0.069***	-0.068***	-0.029***	-0.033***
	(0.007)	(0.008)	(0.010)	(0.011)
control variables	yes	yes	yes	yes
year fixed effects	no	yes	no	yes
country fixed effects	no	no	yes	yes
observations	89	89	89	89
no. of countries	13	13	13	13
R^2	0.8378	0.8487	0.9730	0.9791

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 innovation 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

[12] Data source: OECD Data. See https://data.oecd.org/. The variables are GDP per hour worked, log GDP per capita, log labor force, tax revenue as a percentage of GDP, and percentage of the 25-64 year-old population with upper secondary education.

is inverted-U. We use cross-country panel 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 $\theta Y_t = N_t X_t / \theta$.[13] 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). ■

[13] 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: 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

$$p_t \iota_t = \chi Y_t + T_t + w_t l_{s,t} = \chi Y_t + \tau(Y_t + w_t l_t). \tag{B1}$$

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

$$Y_t - \chi Y_t - T_t = (1 - \chi - \tau) Y_t = c_t + N_t(X_t + \phi Z_t + R_t) + \dot{N}_t \beta X_t. \tag{B2}$$

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:

$$\frac{c_t}{Y_t} = \rho\beta\theta^2 + 1 - \theta - \chi - \tau > 0, \tag{B3}$$

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

$$l_y^* = (1-\tau) l^* = \left[\frac{1}{1-\tau} + \frac{\delta}{1-\theta} \left(\rho\beta\theta^2 + 1 - \theta - \chi - \tau \right) \right]^{-1}. \tag{B4}$$

The rest of the model is the same as before.

Equation (B4) 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 (B4) and the transitional innovation rate z_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 innovation rate z_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 innovation rate z_t because it does not give rise to the reallocation effect from production to local service. Finally, the steady-state innovation rate z^* in (29) is independent of tourism demand τ and export demand χ.