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

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Abstract

International travel restrictions during the COVID-19 pandemic drastically reduced the number of tourists. This study explores the dynamic effects of tourism shocks in an open-economy Schumpeterian 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 production and innovation in the short run. However, a positive tourism shock also reallocates labor from production to service for tourists, which reduces production and innovation. 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, which is consistent with the stylized facts that we document using cross-country data. 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 had led to international travel restrictions, which drastically reduced the number of tourists. Some economies rely heavily on the tourism industry and were 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 local economy via two effects. On the one hand, a positive tourism shock raises the level of employment, and this *employment* effect increases the level of production and the rate of innovation in the short run.[1] 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,[2] which in turn determines the endogenous level of employment in the local economy. If leisure preference is weak (in which case tourism shocks have a small effect on employment), then the reallocation effect dominates, and the short-run effect of positive tourism shocks on innovation is negative. If leisure preference is strong (in which case tourism shocks have a large effect on employment), 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, which is consistent with the stylized facts that we document using cross-country panel data. Finally, permanent tourism shocks do not affect the steady-state innovation rate because tourism shocks affect employment, which in turn does not affect long-run growth due to the removal of the counterfactual scale effect in our scale-invariant Schumpeterian model with endogenous market structure.[3]

This study relates to the literature on tourism and economic growth. Growth-theoretic studies in this literature typically explore the effects of the tourism industry on economic growth using capital-based growth models, such as the neoclassical growth model and the AK growth model; see for example, Schubert and Brida (2011) and Liu and Wu (2019) for recent studies and Zhang (2022) for a survey.[4] Some studies, such as Copeland (1991) and Chao *et al.* (2006), focus on how the tourism industry can give rise to de-industrialization (i.e., the so-called Dutch Disease) in dynamic growth models.[5] Our study explores how a similar effect of the tourism industry that reallocates labor from the production sector to the service sector affects innovation using a modern version of the Schumpeterian growth model.

[1] See Faber and Gaubert (2019) for empirical evidence on a positive effect of tourism on employment and a positive spillover effect on manufacturing productivity.

[2] Here, leisure preference refers to that of the local population.

[3] See Jones (1999) and Laincz and Peretto (2006) for a discussion of the scale effect.

[4] We discuss related empirical studies in Section 2.

[5] See also Inchausti-Sintes (2015) for a recent study.

Therefore, this study also 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 seminal 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 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 featuring endogenous market structure that removes the counterfactual scale effect of labor on long-run growth.[6] Embedding our analysis into an early version of the R&D-based growth model, such as Romer (1990) or Aghion and Howitt (1992), would give rise to a long-run effect of tourism shocks on economic growth that is entirely driven by the scale effect of employment. The scale-invariant version of the Schumpeterian growth model 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 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 presents empirical motivation. Section 3 describes the Schumpeterian growth model. Section 4 explores the dynamic effects of tourism shocks on innovation. The final section concludes.

2 Stylized facts

In this section, we use cross-country panel data to document some stylized facts on the relationship between tourism and innovation. There is an established empirical literature that examines the relationship between tourism and economic growth; see for example, Balaguer and Cantavella-Jorda (2002), Brau *et al.* (2007), Sequeira and Nunes (2008), Figini and Vici (2010), Adamou and Clerides (2010), Deng *et al.* (2014), Ghalia and Fidrmuc (2018) and Zuo and Huang (2018).[7] Some of these studies, such as Adamou and Clerides (2010) and Zuo and Huang (2018), also identify a non-monotonic relationship between tourism and economic growth. We instead consider the relationship between tourism and innovation and document an inverted-U relationship between the two variables. To our knowledge, we provide a novel empirical analysis on how tourism affects R&D as a proxy for innovation. Our finding builds

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

[7] See Song and Wu (2022) for a recent survey.

on previous findings in the literature and sheds some new light on an important channel via innovation through which tourism affects economic growth.

We specify our main regression model as follows:

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

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.[8] Φ_{jt} is a vector of control variables (to be discussed below). 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

Our theory predicts an inverted-U relationship between innovation and tourism. Our above regression model captures such an inverted-U relationship with $\gamma_1 > 0$ and $\gamma_2 < 0$. We use cross-country panel data to provide some support for this theoretical 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 our main results without country fixed effects for the full sample. Then, we consider country fixed effects as a robustness check; however, the regression coefficients become insignificant for the full sample. In other words, our main results in the first two columns are driven by across-country variation, rather than within-country-across-time variation. Examining the data further, we 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 for the subsample even with country fixed effects; see column (5) and (6).

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.

[8] OECD Data defines the tourism share of GDP as "the part of GDP generated by all industries directly in contact with visitors."

[9] Data source: OECD Data. See https://data.oecd.org/. The variables are the R&D share and tourism share of GDP. The available countries for both variables are Australia, Austria, Czechia, Estonia, France, Iceland, Japan, Luxembourg, Mexico, Norway, Poland, Romania, Slovakia, Slovenia, South Africa, Spain and Sweden.

To mitigate omitted variable bias, we now add the following control variables: the employment rate, labor productivity, the size of labor force, taxation, and education.[10] 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%. Therefore, Table 3 also shows evidence for an inverted-U relationship between tourism expenditure and innovation.

Table 3: Robustness check

	R&D					
	(1)	(2)	(3)	(4)	(5)	(6)
τ_{jt}	0.534***	0.504***	0.860***	0.915***	0.485**	0.476**
	(0.086)	(0.091)	(0.118)	(0.133)	(0.203)	(0.205)
τ_{jt}^2	-0.037***	-0.034***	-0.048***	-0.051***	-0.025**	-0.034***
	(0.006)	(0.007)	(0.007)	(0.008)	(0.010)	(0.010)
control variables	yes	yes	yes	yes	yes	yes
year fixed effects	no	yes	no	yes	no	yes
country fixed effects	no	no	no	no	yes	yes
observations	120	120	89	89	89	89
no. of countries	17	17	13	13	13	13
R^2	0.7711	0.7836	0.8503	0.8620	0.9725	0.9790

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

3 A Schumpeterian model with a tourism sector

The Schumpeterian growth model with in-house R&D and endogenous market structure is from Peretto (2007, 2011). The model features both the invention of new products and the quality improvement of products. We develop an open-economy version and introduce a tourism sector to the model in order to explore the dynamic effects of tourism shocks.

3.1 Household

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

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

where $\rho > 0$ is the subjective discount rate. c_t denotes consumption of a domestically produced final good, which is the numeraire. I_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 $1 - l_t$.

[10]Data source: World Bank Dataset and OECD Data. The variable from World Bank Dataset is the employment rate. The variables from OECD Data are GDP per hour worked, log labor force, percentage of the 25-64 year-old population with upper secondary education, and tax revenue as a percentage of GDP.

The asset-accumulation equation is

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

where a_t is the value of assets owned by the household, and r_t is the real interest rate in the domestic economy.[11] 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.[12]

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

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

and the optimality condition for labor supply is

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

3.2 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.[13]

From profit maximization, we derive the conditional demand functions for $l_{y,t}$ and $X_t(i)$:

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

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

where $P_t(i)$ is the price of $X_t(i)$ for $i \in [0, N_t]$. 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.

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

[12] See Section 3.5 for a discussion.

[13] 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).

3.3 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 $i \in [0, N_t]$.[14] 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. ■

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

3.4 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 V_t (the value of a monopolistic firm) is

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

where $\Pi_t - R_t$ is monopolistic profit (net of R&D expenses) and $\dot{V}_t$ captures capital gain. Free entry implies that firm value equals the entry cost:

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

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

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

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

3.5 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.[16] Tourism expenditures have the following characteristics, and some of these characteristics are different from exports. First, tourists consume T_t units of domestic final good, which is like traditional export of domestic output.[17] Second, tourists require $l_{s,t}$ units of local labor for tourism service. This second characteristic makes tourism expenditures different from exports because tourists employ the (non-tradable) service of local labor. In other words, tourism expenditures differ from international trade because tourists also consume non-tradable service.

Both T_t and $l_{s,t}$ are supplied by perfectly competitive firms. Given that the domestic economy uses tourists' expenditures to pay for the imported good I_t, the balanced-trade condition is given by $p_t I_t = T_t + w_t l_{s,t}$. To ensure balanced growth in the long run, we assume that $T_t = \tau Y_t$ is proportional to domestic output, where $\tau \in [0, 1)$. For simplicity, we also assume that $l_{s,t} = \varrho l_t$ is proportional to the domestic labor force and normalize $\varrho = \tau$.[18] Therefore, the

[15] 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.

[16] If p_t is assumed to be exogenous instead, the parameter τ would need to become an endogenous variable.

[17] Y_t can also be exported abroad subject to an exogenous export demand χY_t; see Chu *et al.* (2023) for such an analysis without a tourism sector. 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.

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

balanced-trade condition becomes

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

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

3.6 Equilibrium

The equilibrium is a time path of allocations $\{a_t, I_t, c_t, Y_t, l_{y,t}, l_{s,t}, l_t, X_t(i), R_t(i), T_t\}$ 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;
- competitive firms supply T_t and $l_{s,t}$ to tourists taking 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 $p_t I_t = T_t + w_t l_{s,t}$;
- 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 $l_t = l_{y,t} + l_{s,t}$.

3.7 Aggregation

The resource constraint on domestic final good is

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

where c_t is the household's consumption, $N_t X_t$ is the production cost of intermediate goods, $N_t \phi Z_t$ is the operation cost of intermediate goods, $N_t R_t$ is the cost of quality-improving in-house R&D, and $\dot{N}_t \beta X_t$ is the entry cost of new products. Substituting (7) and $P_t(i) = 1/\theta$ into (5) and imposing symmetry yield the aggregate production function:

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

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.[19]

3.8 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 tourism demand τ and decreasing in the consumption-output ratio c_t/Y_t. Therefore, we first need to derive the dynamics of the consumption-output ratio. In the proof of Lemma 2, we show that the dynamics of c_t/Y_t is unstable, so that this jump variable c_t/Y_t must jump to its unique steady-state value. This convenient property of the Peretto model keeps the transition dynamics in the rest of the economy (which is determined by the dynamics of the state variable x_t) tractable.

Lemma 2 *The consumption-output ratio jumps to a unique 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 labor l_t also jumps to its steady-state equilibrium value l^*, which is increasing in tourism demand τ, and that consumption and output grow at the same rate at any time t:

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

where the last equality uses (2). Substituting (14) and (21) into (24) yields the innovation rate z_t as

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

which is increasing in firm size $x_t l_y^*$. Production labor l_y^* is given by

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

[19] 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.

which uses (22) and (23). In (25), the innovation rate 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 in order 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 the state variable x_t that evolves gradually.

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 $\rho < \min\{(1-\alpha)\phi, (1-\alpha)(1-\theta)/(\theta\beta)\}$, then the dynamics of the state variable 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[20]

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

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

4 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 tourism demand τ. Therefore, a positive tourism shock raises the contemporaneous level

[20] In the long run, the economy converges to a balanced growth path with steady-state growth.

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 $\delta < 1 - \theta$.

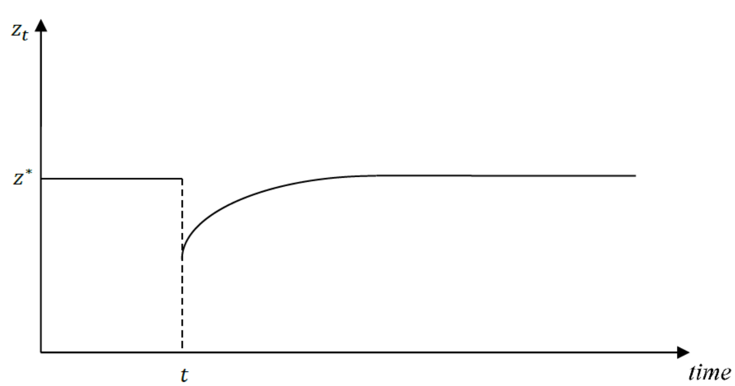

Figure 1: A positive tourism shock under $\delta < 1 - \theta$

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 tourism shock that is below $\overline{\tau}$ raises production l_y^* and the transitional innovation rate z_t, whereas a large tourism shock that rises above $\overline{\tau}$ reduces production l_y^* and the transitional innovation rate z_t. Furthermore, the threshold $\overline{\tau}$ is increasing in the degree δ of leisure preference, which implies that a high degree of leisure preference makes it more likely for a positive tourism shock (i.e., an increase in τ) to raise the transitional innovation rate z_t. As for the steady-state innovation rate z^*, it 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.

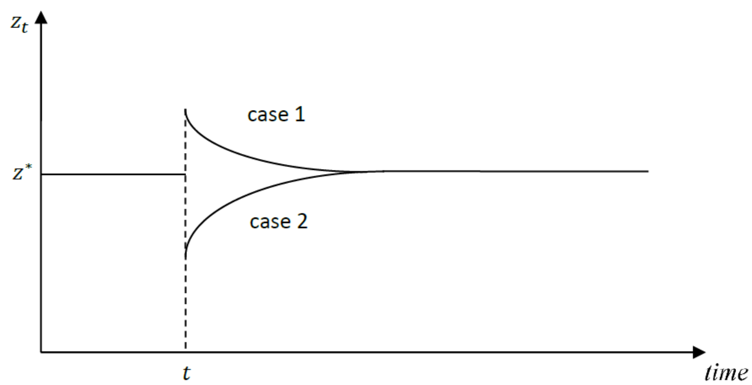

Figure 2: A positive tourism shock under $\delta > 1-\theta$

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 always 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 domestic 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.

4.1 Empirical range of values for leisure preference

Given the importance of leisure preference δ, we need to determine the empirically relevant range of values for δ in order to determine whether or not tourists' expenditure τ has 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. From (26), it can be shown that $l^* \leq 1/2$ is equivalent to

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

where the second inequality holds for $\tau \geq 0$ because $\rho\beta\theta < 1$ from Proposition 1. In the macroeconomic literature, a conventional estimate for the share of time devoted to work l^* is about 0.2 to 0.3 (and certainly below 0.5); see for example, Schmitt-Grohe and Uribe (2004) and Erauskin and Turnovsky (2019). Therefore, $\delta > 1 - \theta$ holds under empirically plausible values, and tourists' expenditure τ has an inverted-U effect on innovation as shown in the data in Section 2.

5 Conclusion

In this study, we have developed an open-economy Schumpeterian growth model with a tourism sector and applied it to explore the dynamic effects of tourism shocks on innovation and economic growth. 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 is inverted-U in our growth-theoretic framework. We also use cross-country panel data to document this inverted-U relationship in the data, which implies that negative tourism shocks may be a blessing in disguise because overreliance on tourism stifles innovation.

Before we conclude, we would like to discuss a caveat of our growth-theoretic framework. Our model features a stylized tourism sector that does not capture all characteristics of the tourism industry. An example would be a gambling industry that generates gambling revenues (i.e., a net transfer of wealth from tourists to casinos) for the local economy. Another example would be the utility that tourist amenities and the disutility that tourist overcrowding bring to local residents. We leave these interesting extensions to future research.

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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 $\theta Y_t = N_t X_t / \theta$.[21] 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), (A4) and $l_t = l_{y,t} + l_{s,t}$. 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, the dynamics of c_t/Y_t is unstable, so this jump variable jumps to the unique 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 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). ∎

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[21] 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

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

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.