Growth, Conventional Production and Tourism Specialisation: Technological Catching-up Versus Terms-of-Trade Effects

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Keywords: Endogenous growth, Two-country models, Technology diffusion, Trade specialization

JEL Classification: F12, F43, O33

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Abstract. This paper extends the 'expanding-varieties' growth model in a two-countries-two-goods setup, and describes the dynamics of growth rates and terms of trade when the industry-based economy is the innovation leader, while the tourism-based economy is the follower (i.e. increases the number of intermediate inputs by readapting innovations developed abroad). Two types of transitional dynamics may exist: technological catching-up and technological falling-behind. Contrary to the standard result, technological catching-up by the follower is associated with lower growth rates with respect to the leader, whereas terms-of-trade effects guarantee positive growth differentials for the tourism-based economy when the technological gap with the leader increases over time. The underlying principle of 'increased relative demand' might explain the good economic performance observed in tourism-dependent economies.

1. Introduction

The fast economic growth of countries specialised in tourism poses a number of questions for economic analysis at both the theoretical and the empirical level. International data show that tourism-dependent economies exhibit higher growth rates with respect to most industrialised countries over the last two decades, suggesting a systematic link between tourism development, product specialisation and international trade with manufacturing-based economies. A possible explanation of the economic performance of countries specialised in tourism is that of a favourable trend in terms of trade with conventional consumption goods produced by industrialised countries. However, as tourism-based economies *keep* growing faster even beyond the very short run, this explanation calls for a more detailed analysis of the conditions under which the favourable trend in terms of trade is structurally linked to technological differences between trading countries. This paper tackles the issue in the context of endogenous growth theory and shows that: (i) in a two-countries-two-goods setup with full specialisation, terms-of-trade effects always dominate the effects of growth in physical output; (ii) tourism specialisation is growth improving when convergence towards the long run equilibrium implies a dynamic increase in the foreign relative demand for tourism services, which drives terms of trade in the favourable direction.

The view that tourism specialisation is growth improving due to terms-of-trade effects is consistent with many stylised facts: typical features of tourism-based economies are small relative size, extensive use of environmental resources, lower labour skills with respect to most industrialised countries. Our

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formal analysis hinges on the assumption that tourism-based economies exhibit lower ability to generate high-tech innovations: the existence of a technological gap between industrialised and tourism-dependent countries is the source of growth differentials along the transition to the long run equilibrium. Following a standard approach in international economics (Frenkel and Razin, 1985; Gardner and Kimbrough, 1990; Turnovsky, 1997, Chap. 7), we assume a world consisting of two countries, each of which is fully specialised in producing one final good - either tourism services or conventional manufactured goods - that is exchanged at the international level. Trade allows all consumers to enjoy both goods, so that terms-of-trade dynamics are determined by the demand functions for the two goods. In the literature on tourism and growth, Lanza and Pigliaru (1998) implement this approach in a learning-by-doing model *à la* Lucas (1988), and show that the sign of growth differentials is determined by the elasticity of substitution between the two goods in consumers preferences. The preference elasticity still plays a role in our model, although the present analysis studies transitional dynamics of terms of trade and emphasises technological sources of growth differentials.

The supply side of the economies is modelled following the 'expanding-varieties' approach (Spence, 1976; Dixit and Stiglitz, 1977; Romer, 1987), extending a recent version developed by Barro and Sala-i-Martin (1997) to include full specialisation in non-homogeneous traded goods. Final output is produced by means of labour and a number of intermediate input goods supplied by quasi-monopolists. The source of growth is represented by increases in the number of intermediates, which can be obtained in two ways: (a) developing a new type of intermediate goods through innovations and paying the associated R&D cost, or (b) readapting intermediates developed abroad and paying the associated 'readaptation cost'. The industrialised country exhibits a higher ability to produce innovations, so that the tourism-based economy faces a *technological gap*. In this environment, the industrialised economy is the 'innovation leader', whereas the tourism-based country acts as a 'follower'. In the long run, both economies converge to a balanced-growth path, so that no differentials arise in equilibrium. However, two different types of convergence may exist during the transition. In the first case, which we label 'convergence from below', the tourism-based economy reduces the technological gap over time and experiences higher growth rates in *physical* output with respect to the innovation leader; however, terms-of-trade effects induced by the increase in the relative demand for manufactured goods are stronger, and the growth rate differential is in favour of the industrialised country. Conversely, when the tourism-based economy 'converges from above', the technological gap increases over time, and growth rates in physical output are below those experienced by the innovation leader; also in this case, terms-of-trade effects induced by the increase in the foreign relative demand for tourism dominate, and the overall growth rate differential is positive for the tourism-based country. Hence, *technological catching-up* is associated with lower growth, whereas *technological falling-behind* corresponds to higher growth rates for the tourism-based economy. In contrast to the standard result that technological falling-behind is bad for growth (Barro and Sala-i-Martin, 1997), our analysis emphasises the role of terms of trade in determining the development path of tourism-based countries, suggesting that the observed performance might be explained by dynamic increases in the relative foreign demand for tourism services.

2. The model

The world consist of two countries indexed by $i = M, T$: country M is specialised in manufactured goods, country T is specialised in tourism. International trade allows all consumers to enjoy both goods, population is constant and equal to total labour force H_i. In particular, we assume that labour is more abundant in country M with respect to the tourism-based economy:

$$H_M > H_T. \tag{1}$$

Since international lending is ruled out, trade is balanced in every instant.

Demand side. Individual wealth is represented by assets of firms operating in the home country. Each individual supplies one unit of labour, earning the real wage rate w^h. Denoting by a_i per-capita wealth, expressed in terms of the home-produced good, the individual wealth constraint in country i reads

$$\dot{a}_i = \mu_i a_i + w_i^h H_i - c_i, \tag{2}$$

where μ_i is the interest rate. Consumers preferences are identical between the two countries, and instantaneous utility is represented by

$$u\left(c_i^m, c_i^t\right) = \frac{\sigma}{\sigma - 1} \log\left[\beta\left(c_i^m\right)^{\frac{\sigma-1}{\sigma}} + (1-\beta)\left(c_i^t\right)^{\frac{\sigma-1}{\sigma}}\right], \tag{3}$$

where c_i^m and c_i^t are individually consumed quantities of manufactured and tourism goods, respectively, $\beta \in (0, 1)$ is a weighting parameter and $\sigma > 0$ is the elasticity of substitution between the two types of goods. Denoting by p_i the relative price of Y_i, individual spending for consumption goods in country i can be expressed in terms of the home-produced good as

$$c_i = \frac{1}{p_i}\left(p_M \cdot c_i^m + p_T \cdot c_i^t\right). \tag{4}$$

The consumer problem is solved in two steps. In the first step, each agent maximises $u\left(c_i^M, c_i^T\right)$ choosing how to allocate consumption between c_i^M and c_i^T, taking total expenditure c_i as given. Defining the terms-of-trade index as $p = p_T/p_M$, first-step optimality conditions imply

$$\frac{c_M^m}{c_M^t} = \frac{c_T^m}{c_T^t} = \left(p\frac{\beta}{1-\beta}\right)^{\sigma}, \tag{5}$$

which can be substituted back in (3) to obtain the indirect utility functions

$$U(c_M, p) = \log c_M + \frac{\sigma}{\sigma - 1} \log (\Phi_M(p)), \tag{6}$$

$$U(c_T, p) = \log c_T + \frac{\sigma}{\sigma - 1} \log (\Phi_T(p)), \tag{7}$$

where Φ_M and Φ_T are functions of p. In the second step, each agent maximises the objective function

$$\int_0^\infty U(c_i(\tau), p(\tau)) e^{-\delta\tau} d\tau \tag{8}$$

where τ is the time-index, and $\delta > 0$ is the time-preference rate. Maximising (8) subject to (2) yields the standard Keynes-Ramsey rule

$$\frac{\dot{c}_i}{c_i} = \mu_i - \delta. \tag{9}$$

Supply side. The supply side of the two economies is modelled as in Barro and Sala-i-Martin (1997), with the difference that each country is fully specialised, so that final goods are not homogeneous. Final output Y is obtained by means of labour H and a number of intermediate inputs x_k (where the type of intermediate good is indexed by $k = 1, ..., N$) according to the homogeneous production function

$$Y_i = H_i^{1-\alpha} \sum_{k=1}^{N_i} x_{ki}^{\alpha}, \qquad i = M, T, \tag{10}$$

where $\alpha \in (0, 1)$.[1] Constant returns to scale allow to model the whole final sector as a single competitive firm. Denoting the real wage rate by w^h and the marginal cost of the k-th variety of intermediate good by w_k^x, profit maximisation in the final sector implies

$$w_i^h H_i = (1 - \alpha) Y_i, \tag{11}$$

$$w_{ki}^x x_{ki} = \alpha Y_i, \qquad k = 1, ..., N_i. \tag{12}$$

The intermediate good is produced by technology monopolists that face a constant marginal cost, normalised to unity. Instantaneous profits for the k-th type of intermediate thus equal $\pi_{ki} = x_{ki}(w_{ki}^x - 1)$. Maximisation of π_{ki} subject to the demand schedule (12) gives the standard solution of *constant mark-up* over marginal costs, i.e.

$$w_{ki}^x = w_i^x = 1/\alpha > 1 \qquad \forall k. \tag{13}$$

[1] Assuming that factor shares α and $(1 - \alpha)$ are equal between the two countries simplifies the algebra without affecting the main results: setting $\alpha_T \neq \alpha_M$ would not alter qualitative dynamics, and hence our characterization of growth differentials (see section 4).

From (13), the optimal quantity of each type of intermediate is

$$x_{ki} = \bar{x}_i = H_i \alpha^{\frac{2}{1-\alpha}}, \tag{14}$$

and instantaneous profits are accordingly equalised across varieties:

$$\pi_{ki} = \bar{\pi}_i = \left(\frac{1-\alpha}{\alpha}\right) \alpha^{\frac{2}{1-\alpha}} H_i. \tag{15}$$

Equation (14) implies that

$$\sum_{k=1}^{N_i} x_{ki}^{\alpha} = N_i \bar{x}_i^{\alpha} = N_i H_i^{\alpha} \alpha^{\frac{2\alpha}{1-\alpha}}, \tag{16}$$

which can be substituted in (10) to obtain

$$Y_i = H_i N_i \alpha^{\frac{2\alpha}{1-\alpha}}. \tag{17}$$

From (17), output per worker is proportional to the number of intermediates, N_i. In line with the basic idea of the 'expanding-varieties' model pioneered by Spence (1976) and Dixit and Stiglitz (1977), the source of endogenous growth is represented by increases in N_i obtained through innovations. In the present context, an 'innovation' is the development of a new variety of intermediates, and the innovator becomes its sole supplier by virtue of a patent which is perfectly enforced within the country.

However, as in Barro and Sala-i-Martin (1997), we assume that countries are able to expand N_i not only by 'original' innovation, but also 'by imitation': new types of intermediates developed *e.g.* in country M can be re-adapted as intermediates for producing tourism goods in country T, thereby raising N_T.[2] Hence, countries may in principle obtain new varieties by means of two alternative strategies. On the one hand, country i may act as the *innovation leader* by inventing new intermediates: the associated marginal cost (which will be called 'R&D cost') is assumed constant and denoted $\lambda_i > 0$. On the other hand, if innovators in country $i' \neq i$ are actually developing new blueprints on their own, country i may choose to be a *follower*: technology monopolists readapt intermediates invented abroad, and readapt it for the specialised good produced in country i. This second strategy implies a marginal 'readaptation cost' denoted by $f_i > 0$.

Obviously, innovators would find profitable to invest resources in discovering new types 'by themselves' as long as $\lambda_i < f_i$, and if this inequality holds in

[2] For the readaptation process to be possible in the present context, it is not strictly necessary to assume that laws for copyright protection are ineffective at the international level: countries are producing different goods, and the readaptation process may generate intermediates $x_{\bar{k}T}$ featuring specific differences (and hence not violating international laws) with respect to their 'original versions' $x_{\bar{k}M}$ developed in country M. The lack of effective copyright protection at the international level is instead an implicit assumption in Barro and Sala-i-Martin (1997), as they assume that countries produce exactly the same final good.

both countries none of the two will act as a follower. In the present context, it is plausible to assume that country M exhibits a higher ability to generate innovations with respect to country T: a positive *technological gap* in favour of industrialised countries with respect to tourism-based economies is indeed typically observed, especially in terms of the number of high-tech innovations. Formally, we make three assumptions in this regard: (i) at time $\tau = 0$ the set of intermediates existing in the tourism-based economy is a subset of that employed in country M, with $N_M(0) > N_T(0)$; (ii) inventing new intermediates is relatively more expensive in the tourism-based economy, $\lambda_M < \lambda_T$; (iii) readaptation costs are specified according to the 'cost of imitation' function in Barro and Sala-i-Martin (1997),

$$f_T = \lambda_T \left(\frac{N_T}{N_M} \right)^{\nu}. \tag{18}$$

The cost function (18) exhibits two important properties. First, $N_M > N_T$ implies $f_T < \lambda_T$, which means that if there is a 'technological gap' in favour of country M readapting is more convenient than innovating for the tourism-based economy: this property implies that it is profitable for country T to act as a follower at time zero, because $N_T(0) < N_M(0)$ yields $f_T(0) < \lambda_T$. Second, since $\partial f_T / \partial \left(\frac{N_T}{N_M} \right) > 0$, the wider is the technological gap (i.e. the lower is N_T/N_M) the lower is the cost of readaptation: followers imitate foreign intermediates beginning with the variety which is the easiest to readapt, so that marginal costs rise with the number of varieties already readapted.[3]

Given the above assumptions, free-entry conditions for firms in R&D sectors can be derived as follows: the present value of profits from inventing a new type of intermediates at instant τ equals

$$V_i(\tau) = \int_{\tau}^{\infty} \pi_{ki}(s)\, e^{-\int_{\tau}^{s} \mu_i(b) db} ds. \tag{19}$$

If there is free-entry in innovation in country M, and free-entry in 'readaptation' in country T as well, we have

$$V_M = \lambda_M, \qquad V_T = f_T, \tag{20}$$

because an equilibrium with positive amounts of resources devoted to obtain new intermediates requires R&D costs be equal to the market value of R&D firms, represented by V_M and V_T. Notice that (20) implies that V_M is constant over time, whereas V_T is generally time-varying since readaptation costs depend, through (18), on the technological gap between the two countries. This has important consequences for economic dynamics and growth differentials between the two countries, as shown below.

[3] An alternative interpretation is that readaptation proceeds chronologically: countries bearing a relatively wide technological gap first readapt intermediates that are relatively 'old' with respect to those being pioneered by the leader in that moment; if the technological gap is reduced thereafter, imitating becomes more expensive because intermediates available for readaptation are 'technologically closer' to the frontier currently determined by the leader.

3. Equilibrium and dynamic analysis

Since international lending is not allowed, trade is balanced in each instant and the aggregate resource constraints of the two economies can be expressed as

$$Y_i = C_i + D_i, \qquad i = M, T, \tag{21}$$

where $C_i = H_i c_i$, and D_i equals total spending - in terms of the home-produced good - devoted to expand the set of intermediates. Setting $A_i = a_i H_i$, the aggregate wealth constraint is derived by (2) as $\dot{A}_i - \mu_i A_i = w_i^h H_i - C_i$. As shown in the Appendix, world intertemporal equilibrium is characterised by

$$\frac{\dot{N}_i}{N_i} = \mu_i + (1-\alpha)\frac{Y_i}{V_i N_i} - \frac{C_i}{V_i N_i} - \frac{\dot{V}_i}{V_i}, \tag{22}$$

$$\frac{\dot{C}_i}{C_i} = \mu_i - \delta, \tag{23}$$

$$\frac{\dot{p}}{p} = \frac{1}{\sigma}\left(\frac{\dot{C}_M}{C_M} - \frac{\dot{C}_T}{C_T}\right), \tag{24}$$

and equilibrium interest rates in the two economies equal

$$\mu_M = \frac{\bar{\pi}_M}{\lambda_M}, \tag{25}$$

$$\mu_T = \frac{\bar{\pi}_T}{f_T} + \frac{\dot{f}_T}{f_T}. \tag{26}$$

Equation (22) represents the growth rate of the number of intermediate varieties in country i; equation (23) is the Keynes-Ramsey rule in terms of aggregate consumption; equation (24) describes the dynamic behaviour of terms of trade: the growth rate of the relative price index $p = p_T/p_M$ equals the algebraic difference between growth rates of consumption indices, times the inverse of the preference-elasticity of substitution between the two goods (σ).

Equations (25)-(26) result from equilibrium between the value of total households assets and the market value of R&D firms. In this regard, two points should be emphasised. First, equilibrium interest rates μ_M and μ_T are endogenously determined within the respective countries, and variations in terms of trade occur as a consequence of interest rate differentials: from (23) and (24),

$$\dot{p}/p = \sigma^{-1}(\mu_M - \mu_T). \tag{27}$$

Second, the equilibrium interest rate in the leader country is constant over time along the entire path, whereas μ_T is generally time-varying: in (25), marginal costs of innovation λ_M and instantaneous profits $\bar{\pi}_M$ are constant, whereas readaptation costs imply non trivial dynamics in (26), because f_T depends on the technological gap observed in each point in time. That is, assumption (18) implies that the tourism-based economy will experience non-constant growth rates in C_T whenever $\dot{N}_T/N_T \neq \dot{N}_M/N_M$. The asymmetric behaviour of output growth and interest rates between the two economies generates the following result.

PROPOSITION 1. *Country M immediately achieves balanced growth at time zero and exhibits a constant growth rate $\dot{C}_M/C_M = \dot{Y}_M/Y_M = g_M$ in each instant $t \in [0, \infty)$. Country T displays transitional dynamics, and real growth rates converge to g_M in the long run.*

A rigorous proof of Proposition 1 is obtained in exactly the same way as in Barro and Sala-i-Martin (1997), and a brief explanation will be given here. With respect to the dynamics of country M, from (23) and (25), a constant interest rate in country M implies a constant growth rate of C_M in each point in time. By (17), output and the number of intermediates grow at each point in time at the same rate $g_M = \dot{Y}_M/Y_M = \dot{N}_M/N_M$, which is constant (see Barro and Sala-i-Martin, 1997). Since any equilibrium where C and Y grow at constant but different rates would violate either the aggregate resource constraint (21) or the constraint $C \geq 0$ in finite time, the only possible equilibrium path is the one along which

$$\dot{C}_M/C_M = \dot{Y}_M/Y_M = \dot{N}_M/N_M = g_M \text{ for each } t \in [0, \infty) \,. \tag{28}$$

In the tourism-based country, a non-constant interest rate implies $\dot{C}_T/C_T$ be time-varying. Defining control-like and state-like variables $\chi_T = C_T/N_T$ and $N_\star = N_T/N_M$, the following dynamic equations can be derived (see Appendix):

$$\frac{\dot{N}_\star}{N_\star} = \frac{1}{\lambda_T N_\star^\nu}\left[\left(\frac{1+\alpha}{\alpha}\right)\bar{\pi}_T - \chi_T\right] - g_M, \tag{29}$$

$$\frac{\dot{\chi}_T}{\chi_T} = \frac{1}{\lambda_T N_\star^\nu}\left[(1-\nu)\,\chi_T - \bar{\pi}_T\frac{(1-\nu)\,(1+\alpha)-\alpha}{\alpha}\right] - \nu g_M - \delta. \tag{30}$$

Equations (29)-(30) describe economic dynamics in country T for each $t \in [0, \infty)$ provided the tourism-based economy is always acting as a follower.[4] Little algebra shows that equation (29) is dynamically stable regardless of different combinations of parameters: $N_\star$ approaches a steady state value as time goes to infinity, and the numbers of intermediate varieties in the two countries, N_T and N_M, will consequently grow at the same rate in the long run. Since Y_i is proportional to N_i from (17), it follows that

$$\lim_{t\to\infty}\frac{\dot{N}_T}{N_T} = \lim_{t\to\infty}\frac{\dot{Y}_T}{Y_T} = \lim_{t\to\infty}\frac{\dot{C}_T}{C_T} = g_M. \tag{31}$$

Convergence of the growth rate $\dot{C}_T/C_T$ towards g_M is ensured by saddle-point stability, as shown in the phase diagram depicted in Figure 1.

[4] For the moment, we take for granted that parameters are such that this strategy is convenient for each $t \in [0, \infty)$ in country T: this allows us to ascertain whether the economy converges to a steady growth path in this case; we will subsequently show (Lemma 2-3) that our assumptions guarantee that country T is in fact a follower from time zero onward.

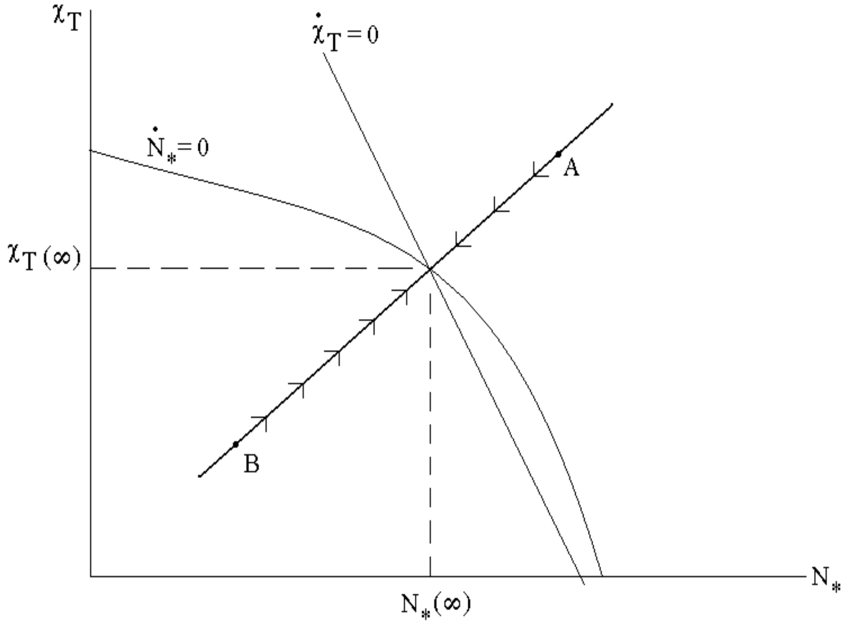


Figure 1. Phase diagram of system (29)-(30). If country T starts from point A the technological gap with the leader increases over time. Conversely, starting from point B, the tourism-based economy reduces the technological gap with the leader.

As usual in standard growth models, only one stable arm exists, and all diverging paths would violate either optimality conditions or the aggregate resource constraint in the long run.[5] The economy jumps at time zero along the stable arm of the saddle, which brings χ_T and $N_\star$ towards equilibrium values $\chi_T(\infty)$ and $N_\star(\infty)$. Since $\dot{\chi}_T = 0$ in the long run, C_T and N_T (and hence, also Y_T) grow asymptotically at the same rate, implying balanced growth in country T. From (31), convergence in growth rates of C_T and C_M requires interest rates be equalised in the long run, by virtue of the Keynes-Ramsey rule (23). This in turn implies that terms of trade are asymptotically time-invariant: from (24),

$$\lim_{t\to\infty} \mu_T = \mu_M \Rightarrow \lim_{t\to\infty} \dot{p} = 0. \tag{32}$$

[5] Note that the conclusion that also the growth rate $\dot{C}_T/C_T$ converges to g_M can be reached heuristically by applying (as $t \to \infty$ in country T) the same reasoning used to rule out non-balanced growth paths in country M (at each t).

3.1. Growth rates differentials

Asymptotic balanced growth in the two countries implies that no type of specialisation - tourism or manufacturing - may be labelled as growth improving in the long run. More precisely, define the *growth rates differential* Δ between country T and country M as

$$\Delta = \Delta^y + \frac{\dot{p}}{p} = \Delta^y - \frac{\Delta^c}{\sigma}, \tag{33}$$

where

$$\Delta^y = \left(\dot{Y}_T/Y_T\right) - \left(\dot{Y}_M/Y_M\right) \text{ and } \Delta^c = \left(\dot{C}_T/C_T\right) - \left(\dot{C}_M/C_M\right).$$

The term Δ^y represents the *output effect*, whereas $-\Delta^c/\sigma$, which equals by (24) the growth rate of the price index, is the *terms-of-trade effect*. The economic meaning of (33) is as follows. The sign of the growth rates differential between countries T and M is determined by the relative strength of two forces: on the one hand, Δ is *higher* the higher is the gap between the growth rates of physical output in country T and in country M. On the other hand, Δ is *lower* the higher is the gap between the growth rates of C_T and C_M, because a positive gap means a decrease in the relative foreign demand for the tourism good, which causes the terms-of-trade index p_T/p_M to fall ($\dot{p} < 0$).

In our model, Δ approaches zero in the long run because, by (31), convergence implies $\Delta^y(\infty) = \Delta^c(\infty) = 0$. However, output and terms-of-trade effects need not compensate along the *transitional path*, since growth rates of Y_T and C_T clearly differ before the balanced-growth equilibrium is achieved. This key feature of the model yields the main insights on growth differentials between tourism-based and manufacturing-based economies, as the time needed for substantial convergence is long, being of the order of generations if compared to the human life cycle.

4. Transitional dynamics

The characterization of economic dynamics in the two countries developed above, and Proposition 1 in particular, postulates that readaptation costs always remain below innovation costs in country T. That is, we have been supposing that acting as a follower is profitable in each instant $t \in [0, \infty)$ for the tourism-based country. This is actually true due to the assumptions made about readaptation costs and initial conditions, as shown in Lemma 2 and Lemma 3 below.

LEMMA 2. *The relative scarcity of labour in country T ensures that readapting is cheaper than innovating for the tourism-based economy when $\dot{\chi}_T = \dot{N}_\star = 0$.*

To prove Lemma 2 recall that the cost function (18) is such that $f_T < \lambda_T$ as long as $N_\star < 1$. In the long run equilibrium we have

$$f_T(\infty) = \lambda_M \left(\frac{\bar{\pi}_T}{\bar{\pi}_M}\right) \equiv \lambda_M \left(\frac{H_T}{H_M}\right), \tag{34}$$

where the first equality derives from setting $\mu_T = \mu_M$ in equations (25)-(26), and the last term is obtained by substituting (15) for each country. Having assumed $H_T < H_M$, i.e. that labour is relatively scarce in country T, and that innovation costs are lower in the industrialised country ($\lambda_M < \lambda_T$), it follows from (34) that $f_T < \lambda_T$ in the steady state equilibrium of system (29)-(30). The steady state equilibrium is therefore associated with $N_\star(\infty) < 1$ in Figure 1.

Combining this result with assumption $N_T(0) < N_M(0)$, i.e. that the technological gap is in favour of country M at time zero, we obtain that the tourism-based country is always a follower:

LEMMA 3. *If initial conditions are such that* $N_\star(0) < 1$*, readapting is cheaper than innovating in every instant* $t \in [0, \infty)$ *for the tourism-based economy.*

Lemma 3 is immediately proved by means of Figure 1. Since $N_\star(\infty) < 1$, there are two possible cases, which we label as *convergence from below* and *convergence from above*. This classification reflects the positive slope of the stable arm in the phase plane.[6]

If $N_\star(0) < N_\star(\infty) < 1$, the economy converges from below, starting *e.g.* in point B of Figure 1. If $N_\star(\infty) < N_\star(0) < 1$, the economy converges from above, starting *e.g.* in point A. In both cases, $N_\star$ converges monotonically to $N_\star(\infty)$ so as to remain, during the whole transition, on the left of the vertical line $N_\star = 1$. Since $N_\star < 1$ guarantees $f_T < \lambda_T$, we have $f_T < \lambda_T$ along the entire transitional path: for country T, readapting intermediates developed abroad is always more profitable than developing new varieties.

Hence, if $N_\star(0) < 1$, the tourism-based economy is always a follower, regardless of whether the economy approaches the long run equilibrium from above or from below. However, the direction of convergence is of fundamental importance for our analysis, as it ultimately determines the sign of Δ, the growth rate differential, during the transition. The following propositions characterise the two cases:

PROPOSITION 4. *Convergence from below:* $N_\star(0) < N_\star(\infty)$*. If the economy converges from below, the technological gap is reduced over time*

$$\frac{d(N_T/N_M)}{d\tau} > 0, \tag{35}$$

[6] Our use of the terms 'above' and 'below' relates to the phase diagram in Figure 1, and does *not* refer to initial output levels as often done in the growth literature. The analysis will clarify that 'above' and 'below' are then associated with the growth rate differential between the follower and the leader, but this is peculiar to the present model since the opposite result holds in the original Barro and Sala-i-Martin (1997) model (see below).

and

$$\frac{\dot{C}_T}{C_T} > \frac{\dot{Y}_T}{Y_T} > \frac{\dot{Y}_M}{Y_M} = \frac{\dot{C}_M}{C_M} \tag{36}$$

along the transitional path.

PROPOSITION 5. *Convergence from above: $N_\star(0) > N_\star(\infty)$. If the economy converges from above, the technological gap increases over time,*

$$\frac{d\left(N_T/N_M\right)}{d\tau} < 0, \tag{37}$$

and

$$\frac{\dot{C}_T}{C_T} < \frac{\dot{Y}_T}{Y_T} < \frac{\dot{Y}_M}{Y_M} = \frac{\dot{C}_M}{C_M} \tag{38}$$

along the transitional path.

Both propositions hinge on the fact that the stable path towards the steady state equilibrium is upward sloping in the phase plane $(\chi_T, N_\star)$, as shown in Figure 1. Firstly consider Proposition 4, which corresponds to a situation where the economy starts from point B. As the economy converges from below we have $\dot{\chi}_T > 0$ during the transition, implying $\dot{C}_T/C_T > \dot{N}_T/N_T = \dot{Y}_T/Y_T$ which proves the first inequality in (36). On the other hand, starting from point B implies $\dot{N}_\star > 0$ during the transition, so that $\dot{N}_T/N_T > \dot{N}_M/N_M$. Since $\dot{N}_i/N_i = \dot{Y}_i/Y_i$, also the second inequality in (36) is proved.

Next consider Proposition 5, which corresponds to a situation where the economy starts from point A in Figure 1. As the economy converges from above we have $\dot{\chi}_T < 0$ during the transition, so that $\dot{C}_T/C_T < \dot{N}_T/N_T = \dot{Y}_T/Y_T$, which proves the first inequality in (38); starting from point A also implies $\dot{N}_\star < 0$ during the transition: since $\dot{N}_T/N_T < \dot{N}_M/N_M$ corresponds to $\dot{Y}_T/Y_T < \dot{Y}_M/Y_M$, also the second inequality in (38) is proved. The last equality $\dot{Y}_M/Y_M = \dot{C}_M/C_M$ in both (36) and (38) just follow from balanced growth in country M, which completes the proof.

Propositions 4 and 5 provide all the information needed to determine the sign of growth differentials along the transitional path. For the sake of clarity, we begin by discussing the case in which tourism and manufactured goods are neither substitutes nor complements ($\sigma = 1$).

4.1. Growth differentials with $\sigma = 1$

When the elasticity of substitution between the two types of goods is $\sigma = 1$, the growth rate differential (33) reduces to

$$\Delta' = \Delta^y - \Delta^c, \tag{39}$$

that is, the *terms of trade effect* coincides with (-) the difference between growth rates of C_T and C_M. In this case, it follows from (36) and (38) that

PROPOSITION 6. *If country T converges from below, tourism specialisation implies lower growth rates during the transition. If country T converges from above, tourism specialisation implies higher growth rates during the transition.*

The statement is proved as follows: when country T converges from below, the growth rate differential is negative because expression (36) implies

$$\Delta^c > \Delta^y > 0 \quad \Rightarrow \quad \Delta' < 0. \tag{40}$$

The economic reason for this result is that when country T converges from below, the technological gap is being reduced, implying that physical output and the internal consumption index (Y_T and C_T) are both growing at higher rates than in country M. However, the consumption index gap between the two countries, Δ^c, exceeds the physical output gap Δ^y, so that the terms-of-trade effect dominates and the resulting growth rate differential is negative.

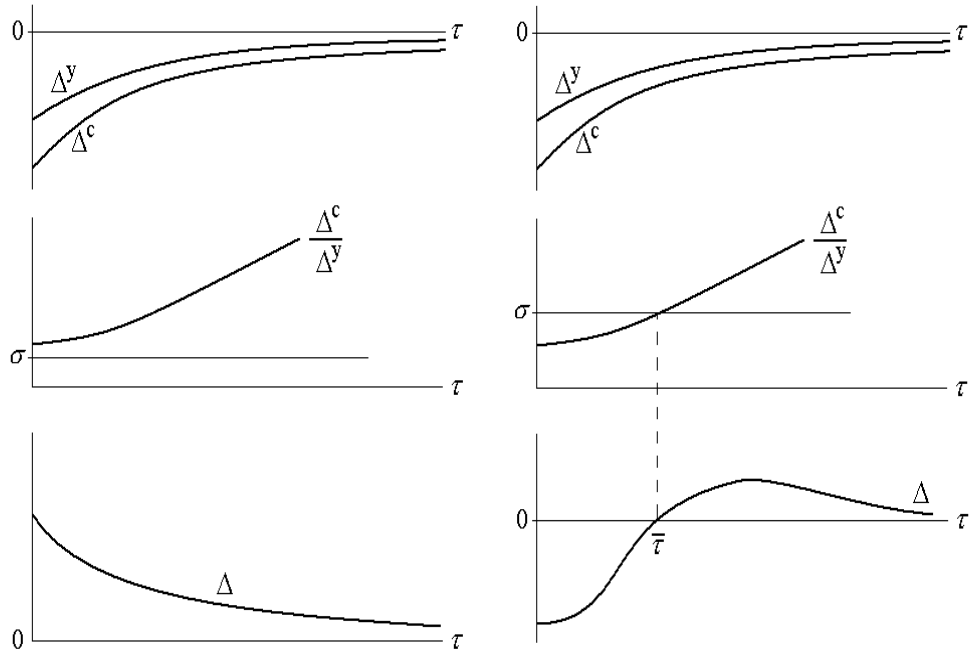
Conversely, when country T converges from above, the growth rate differential is negative because expression (38) implies

$$\Delta^c < \Delta^y < 0 \quad \Rightarrow \quad \Delta' > 0. \tag{41}$$

In economic terms, when country T converges from above, the technological gap increases during the transition, implying physical output and the internal consumption index be both growing at lower rates than in country M. But the consumption index gap dominates in absolute value the physical output gap, and the terms-of-trade effect is favourable to tourism specialisation in this case, yielding a positive overall differential $\Delta' > 0$.

The conclusion is that, since terms-of-trade effects always dominate output effects, tourism specialisation guarantees higher growth when tourism-based countries *fall behind* the innovation leader: as the technological gap increases over time (the economy starts in point A), the relative price of tourism rises due to the increase in the relative foreign demand, and country T obtains higher growth rates by virtue of the terms-of-trade effect. Conversely, *technological catching-up* is bad for growth: if the tourism-based economy reduces the technological gap with the industrialised country (starting from point B), the resulting growth differential is negative because the relative demand for manufactured goods by consumers in country T is increased, implying a transitional reduction in the relative price of the tourism good.

It should however be stressed that the above results do hold provided $\sigma = 1$, i.e. tourism and manufactured goods are neither complements nor substitutes: in this case, the individual demand for one good is not affected by variations in the price of the second, all other things being equal. Conclusions are slightly modified when the elasticity of substitution differs from unity, as shown below.



Graph (a) *Graph (b)*

Figure 2. Growth differentials and preference-elasticity. Graph (a) shows that when $\sigma < \Delta^c/\Delta^y$ at time zero, tourism specialisation ensures higher growth rates during the entire transitional path. Graph (b) shows that when $\sigma > \Delta^c/\Delta^y$ at time zero and the adjustment speed of Δ^c is strictly below that of Δ^y, tourism specialisation is growth reducing in the short run, and growth improving in the medium run, before balanced-growth is achieved.

4.2. Growth differentials with $\sigma \neq 1$

When tourism and manufactured goods are either complements ($\sigma < 1$) or substitutes ($\sigma > 1$), the relative strength of the terms-of-trade effect changes: as intuitive, whether these *substitution effects* are sufficient to overturn previous conclusions is a matter of parameters. The issue is interesting, as the peculiar role of σ was already discussed in previous literature. Elaborating on Lucas (1988), Lanza and Pigliaru (1998) analysed growth paths of a small economy specialised in tourism, using a standard learning-by-doing model of endogenous growth. Assuming that labour productivity in tourism-based countries grows at lower rates, Lanza and Pigliaru (1998) show that specialisation in tourism guarantees higher growth rates if the preference-elasticity of substitution is strictly less than unity. We will refer to this result as to the *LP-condition*, and ascertain whether it is modified in the present model.

The LP-condition builds on the assumption that real productivity in the tourism-based economy grows at a lower rate with respect to the manufacturing-based economy. In our model, this situation corresponds to the case 'convergence from above', where the growth rate of physical output is lower in country T during the transition. From (33), the growth rate differential is now redefined as $\Delta = \Delta^y - \sigma^{-1}\Delta^c$. Following the same steps as in Proposition 5, it can be easily shown that

PROPOSITION 7. *If country T converges from above, tourism specialisation implies higher growth rates along the transition as long as*

$$\sigma < \frac{\Delta^c}{\Delta^y}, \tag{42}$$

where $\Delta^c/\Delta^y > 1$ along the transition.

Proposition 7 implies that a modified LP-condition holds in the present model, though inequality (42) must be re-interpreted in a dynamic context. More precisely, the growth rate differential exhibits different dynamics depending on whether (42) is satisfied at time zero. In particular, Δ is time-varying during transition, and its sign is crucially determined by adjustment speeds of Δ^c and Δ^y. Since $\Delta^c/\Delta^y > 1$ along the entire transitional path, the speed at which Δ^c approaches zero will not exceed the adjustment speed of Δ^y around the steady state, implying that Δ^c/Δ^y is non-declining over time and bounded below by unity. As a consequence, if inequality (42) holds at time zero, it will also be satisfied along the entire transitional path: as shown in Figure 2.a, when $\sigma < \Delta^c/\Delta^y$ at $\tau = 0$ the tourism-based economy (converging from above) exhibits higher growth during the whole transition to the long run equilibrium.

When $\sigma > \Delta^c/\Delta^y > 1$ at $\tau = 0$, instead, the growth rate differential Δ may approach zero following a non-monotonic transitional path: in Figure 2.b, the adjustment speed of Δ^c is strictly less than that of Δ^y, which implies that although (42) is initially violated, the ratio Δ^c/Δ^y will grow over time so as to achieve $\Delta^c/\Delta^y = \sigma$ at some instant $\tau = \bar{\tau}$, with inequality (42) be satisfied from that time onward. The associated path of Δ is therefore non-monotonic, with negative values over the interval $\tau \epsilon [0, \bar{\tau}]$, positive values for $\bar{\tau} < \tau < \infty$, and approaching zero in the long run. That is, tourism specialisation in this case is growth reducing in the short run, and growth improving in the medium run: at the beginning, the increase in the relative demand for tourism is more than offset by the negative impact of increasing the technological gap with leader; subsequently, terms-of-trade effects dominate implying higher growth in the tourism-based economy, before achieving balanced growth. Clearly, the non-monotonic case in Figure 2.b does not occur when the preference-elasticity is below unity: $\sigma < 1$ implies $\sigma < \Delta^c/\Delta^y$ at any point in time. This is indeed the link between Proposition 7 and the LP-condition: in the present model, $\sigma < 1$ is not strictly necessary to have positive growth differentials between tourism-based and manufacturing-based economies; but $\sigma < 1$ is sufficient to ensure that tourism specialisation is growth improving along the *entire* transitional path.

Due to an exactly symmetric reasoning, when country T converges from below tourism specialisation is growth *reducing* as long as $\sigma < \Delta^c/\Delta^y$: when $\sigma < \Delta^c/\Delta^y$ at time zero, country T exhibits lower growth rates along the entire transitional path; if σ initially exceeds $\Delta^c/\Delta^y > 1$ and adjustment speeds differ between Δ^c and Δ^y, also the non-monotonic case is reversed, and tourism specialisation is growth improving in the short run but growth reducing in the medium run.

4.3. Comment

In the model presented, tourism-based economies exhibit higher growth when the technological gap with industrialised countries increases over time. It should however be stressed that technological falling-behind need not be thought of as *the* requirement for obtaining higher growth, as the above results may be interpreted more generally as follows. In a two country-two good setup, the growth effects of increasing physical output are more than offset by price movements. Consequently, tourism specialisation is growth improving when the increase in the foreign relative demand is sufficient to drive terms of trade in the favourable direction. With standard specifications for preferences and technology, this process occurs when growth rates of physical output are lower than those experienced by trading partners: in general, any specialisation is growth improving as long as the *relative scarcity* of the home-produced good is increased over time.

From this broad perspective, it is clear that other sources of 'relative scarcity' may play the same role as the technological gap in our model. Considering tourism-dependent economies, a standard index of 'physical output' is likely to be subject to finite upper bounds, by virtue e.g. of land availability, accommodation capacity, depletable environmental resources, *et cetera*; in this case, good economic performance is necessarily driven by either quality improvements or increasing relative prices for tourism. Similarly, product-differentiation strategies pursued by tourism-dependent economies may be interpreted as way of implementing an equivalent 'scarcity principle' when facing industrialised countries, where the levels of conventional production steadily increase. Whether and to what extent relative scarcity and differentiation strategies actually explain the observed economic performance of tourism-based economies, is an empirical question. On the other hand, further theoretical work is needed to provide a full characterization of the problem at hand, with particular respect to the long run consequences of trading tourism versus conventional goods at the international level. The model presented focuses on technological sources of growth differentials, and extending the analysis to include country-specific features - such as differences in the relative size, the nature of factors employed in production, the use of exhaustible natural resources - appears an interesting topic for future research.

Finally, it is worth noting the sharp contrast with the original expanding-varieties model. In this regard, we have extended the one-good version developed by Barro and Sala-i-Martin (1997) to include full specialisation in non-homogeneous final goods, and terms-of-trade effects. This apparently slight modification brought about a major difference: when both countries produce the same final good, relative prices disappear and the growth rate of physical output is all that matters. As a consequence, conclusions about growth differentials are radically overturned: in a one-good setup, technological catching up (i.e. converging from point B) guarantees higher growth rates along the transition for the follower; conversely, converging from point A, the technological gap increases over time and transitional growth rates are lower with respect to the innovation leader.

5. Conclusions

This paper analysed the dynamics of growth differentials between countries specialised in manufactured goods and tourism-based economies. Elaborating on Barro and Sala-i-Martin (1997), we have extended the 'expanding-varieties' growth model to include heterogenous final goods in a two-countries setup. The analysis focused on the time paths of growth rates and terms of trade when the industrialised country is the 'innovation leader' and the tourism-based country is the 'follower'. In the long run, both countries converge to balanced growth, and no differentials arise in the steady state equilibrium. However, two different types of transitional dynamics may arise: in the case of 'convergence from below', the tourism-based economy reduces the technological gap over time and experiences higher growth rates in *physical* output with respect to the innovation leader, but terms-of-trade effects imply the growth rate differential be in favour of the industrialised country. In the case of 'convergence from above', the technological gap increases over time and terms-of-trade effects induced by the increase in the foreign relative demand imply that the overall growth rate differential is positive for the tourism-based country. This contradicts some results of the standard one-good model, where technological falling-behind is bad for growth: in the two-goods version, terms-of-trade effects always dominate growth in physical output. The analysis suggests that the process of 'increased relative foreign demand' plays an important role in the development of specialised countries, and might explain the good economic performance of tourism-based economies.

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Appendix

Derivation of (22)-(23)-(24). Since $A_i = N_i V_i$, the aggregate wealth constraint can be rewritten as

$$\dot{N}_i V_i + N_i \dot{V}_i = \mu_i N_i V_i + w_i^h H_i - C_i. \tag{43}$$

and, substituting final-sector f.o.c. $w_i^h H_i = (1-\alpha) Y_i$ together with (17) yields

$$\dot{N}_i V_i + N_i \dot{V}_i = \mu_i N_i V_i + (1-\alpha) H_i N_i \alpha^{\frac{2\alpha}{1-\alpha}} - C_i. \tag{44}$$

Dividing by $V_i N_i$ yields equation (22) in the text. Equation (23) is simply the Keynes-Ramsey rule expressed (9) in terms of aggregate consumption. Equation (24) is derived as follows: optimality conditions for the individual consumer's problem imply

$$c_M = \left[\frac{p + p^\sigma \left(\frac{\beta}{1-\beta}\right)^\sigma}{p^\sigma \left(\frac{\beta}{1-\beta}\right)^\sigma} \right] c_M^m, \quad c_T = \left[1 + p^{\sigma-1} \left(\frac{\beta}{1-\beta} \right)^\sigma \right] c_T^t. \tag{45}$$

Taking the ratio and time-differentiating yields

$$\frac{\dot{c}_M}{c_M} - \frac{\dot{c}_T}{c_T} = \frac{\dot{c}_M^m}{c_M^m} - \frac{\dot{c}_T^t}{c_T^t} + (1-\sigma)\frac{\dot{p}}{p}. \tag{46}$$

From (5) we can substitute $\frac{\dot{c}_M^m}{c_M^m} = \frac{\dot{c}_M^t}{c_M^t} + \sigma\frac{\dot{p}}{p}$ and $\frac{\dot{c}_T^t}{c_T^t} = \frac{\dot{c}_T^m}{c_T^m} - \sigma\frac{\dot{p}}{p}$ to obtain

$$\frac{\dot{c}_M}{c_M} - \frac{\dot{c}_T}{c_T} = \frac{\dot{c}_M^t}{c_M^t} - \frac{\dot{c}_T^m}{c_T^m} + (1+\sigma)\frac{\dot{p}}{p}. \tag{47}$$

Trade balance requires $c_T^m = pc_M^t$: differentiating and substituting the resulting expression in (47) gives the terms-of-trade equation (24).

Derivation of equations (25)-(26). Differentiating $V_i(\tau)$ with respect to time yields the traditional dynamic programming equation

$$\dot{V}_i = \mu_i V_i - \bar{\pi}_i, \tag{48}$$

where we have used (15), i.e. the fact that monopoly profits are equalised across varieties. Substituting equilibrium free-entry conditions (20) in (48), we obtain (25)-(26).

Derivation of equations (29)-(30). Equation (29) is derived as follows. Equations (14) and (17) imply $Y_T = \alpha^{-2}\bar{x}_T N_T$, which can be substituted in (15) to obtain

$$(1-\alpha)\frac{Y_T}{N_T} = \frac{\bar{\pi}_T}{\alpha}. \tag{49}$$

Now rewrite (22) as

$$\frac{\dot{N}_T}{N_T} = \mu_T + \frac{1}{V_T}\left[(1-\alpha)\frac{Y_T}{N_T} - \chi_T - \dot{V}_T\right], \tag{50}$$

where $\chi_T = C_T/N_T$ as defined in the text. Substituting (20), (26) and (49) in (50) gives

$$\frac{\dot{N}_T}{N_T} = \frac{1}{f_T}\left[\left(\frac{1+\alpha}{\alpha}\right)\bar{\pi}_T - \chi_T\right]. \tag{51}$$

Setting $N_\star = N_T/N_M$ we obtain, from (28) and (51),

$$\frac{\dot{N}_\star}{N_\star} = \frac{1}{f_T}\left[\left(\frac{1+\alpha}{\alpha}\right)\bar{\pi}_T - \chi_T\right] - g_M.$$

Substituting as $f_T = \lambda_T N_\star^\nu$ from (18) in the above expression yields equation (29) in the text.

Equation (30) is derived as follows. Substituting (26) in (23) gives

$$\frac{\dot{C}_T}{C_T} = \nu\frac{\dot{N}_\star}{N_\star} + \frac{1}{\lambda_T N_\star^\nu}(\bar{\pi}_T - \delta), \tag{52}$$

where we have used $f_T = \lambda_T N_\star^\nu$ and $\dot{f}_T / f_T = \nu \dot{N}_\star / N_\star$. Using (51) and (52), the growth rate of χ_T is obtained as

$$\frac{\dot{\chi}_T}{\chi_T} = \nu \frac{\dot{N}_\star}{N_\star} + \frac{1}{\lambda_T N_\star^\nu} \left(\bar{\pi}_T - \delta \right) - \frac{1}{\lambda_T N_\star^\nu} \left[\left(\frac{1+\alpha}{\alpha} \right) \bar{\pi}_T - \chi_T \right]. \tag{53}$$

Substituting (25) for $\dot{N}_\star / N_\star$ and rearranging terms gives equation (30) in the text.

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(lxv) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications” organised by Fondazione Eni Enrico Mattei and sponsored by the EU, Milan, September 25-27, 2003

(lxvi) This paper has been presented at the 4th BioEcon Workshop on “Economic Analysis of Policies for Biodiversity Conservation” organised on behalf of the BIOECON Network by Fondazione Eni Enrico Mattei, Venice International University (VIU) and University College London (UCL) , Venice, August 28-29, 2003

(lxvii) This paper has been presented at the international conference on “Tourism and Sustainable Economic Development – Macro and Micro Economic Issues” jointly organised by CRENoS (Università di Cagliari e Sassari, Italy) and Fondazione Eni Enrico Mattei, and supported by the World Bank, Sardinia, September 19-20, 2003

(lxviii) This paper was presented at the ENGIME Workshop on “Governance and Policies in Multicultural Cities”, Rome, June 5-6, 2003

(lxix) This paper was presented at the Fourth EEP Plenary Workshop and EEP Conference “The Future of Climate Policy”, Cagliari, Italy, 27-28 March 2003

(lxx) This paper was presented at the 9th Coalition Theory Workshop on "Collective Decisions and Institutional Design" organised by the Universitat Autònoma de Barcelona and held in Barcelona, Spain, January 30-31, 2004

(lxxi) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications”, organised by Fondazione Eni Enrico Mattei and Consip and sponsored by the EU, Rome, September 23-25, 2004

(lxxii) This paper was presented at the 10th Coalition Theory Network Workshop held in Paris, France on 28-29 January 2005 and organised by EUREQua.

(lxxiii) This paper was presented at the 2nd Workshop on "Inclusive Wealth and Accounting Prices" held in Trieste, Italy on 13-15 April 2005 and organised by the Ecological and Environmental Economics - EEE Programme, a joint three-year programme of ICTP - The Abdus Salam International Centre for Theoretical Physics, FEEM - Fondazione Eni Enrico Mattei, and The Beijer International Institute of Ecological Economics

(lxxiv) This paper was presented at the ENGIME Workshop on “Trust and social capital in multicultural cities” Athens, January 19-20, 2004

(lxxv) This paper was presented at the ENGIME Workshop on “Diversity as a source of growth” Rome November 18-19, 2004

(lxxvi) This paper was presented at the 3rd Workshop on Spatial-Dynamic Models of Economics and Ecosystems held in Trieste on 11-13 April 2005 and organised by the Ecological and Environmental Economics - EEE Programme, a joint three-year programme of ICTP - The Abdus Salam International Centre for Theoretical Physics, FEEM - Fondazione Eni Enrico Mattei, and The Beijer International Institute of Ecological Economics

(lxxvii) This paper was presented at the Workshop on Infectious Diseases: Ecological and Economic Approaches held in Trieste on 13-15 April 2005 and organised by the Ecological and Environmental Economics - EEE Programme, a joint three-year programme of ICTP - The Abdus Salam International Centre for Theoretical Physics, FEEM - Fondazione Eni Enrico Mattei, and The Beijer International Institute of Ecological Economics.

(lxxviii) This paper was presented at the Second International Conference on "Tourism and Sustainable Economic Development - Macro and Micro Economic Issues" jointly organised by CRENoS (Università di Cagliari and Sassari, Italy) and Fondazione Eni Enrico Mattei, Italy, and supported by the World Bank, Chia, Italy, 16-17 September 2005.

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