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Pollution externalities, endogenous health and the speed of convergence in an endogenous growth model

Torben Klarl*

[a] University of Augsburg, Department of Economics, Universitätsstraße 16, D-86159 Augsburg, Germany
[b] Ulm University, Institute of Economics, Helmholtzstr. 18, D-89081 Ulm Augsburg, Germany
[c] Research Fellow at SPEA, Indiana University, Bloomington, 1315 E. Tenth Street, Bloomington, IN 47405-1701, United States

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ABSTRACT

Based on a dynamic general equilibrium model, we study the important link between pollution, health and growth during transition which has not received much attention in the existing theoretical literature on (semi-) endogenous growth. The focus of this paper is on the transitional dynamics behavior, with an emphasis both, on the asymptotic as well as on the average speed of convergence. We calibrate the model for a typical OECD country. On the basis of dynamic welfare calculations, which consider transitional dynamics effects, we show that welfare differences are most pronounced for an economy, which values health relatively highly and where the environmental tax change is more than just marginal. Hence, if an economy moves towards a more sustainable society, the policy maker should take into consideration transitional dynamic effects.

1. Introduction

Although there is a growing literature discussing the important link between environment, health and growth, the recently observed drastic and unbridled economic development particularly in countries such as China or those in the OECD show the necessity of designing and discussing efficient policies, not only in the long-run but also during transition towards a more sustainable economy[1]. Surprisingly however, this short-run focus with an emphasis on convergence is missing in the relevant (semi-) endogenous growth literature, although this seems to be particularly important for the behavior of the policy maker as will be further discussed below. This paper fills this gap.

Many studies embodying growth theories have introduced a pollution externality[2] and discuss the consequences of government interventions, such as abatement policies or Pigouvian tax schemes for long-run economic growth. In this context, some studies either find that governmental interventions, such as a rising income tax will deter the long-run growth rate

* Corresponding author. Fax: +49(0)821 598 4231, +49(0)731 50 23737, +(812) 855 7802.
E-mail addresses: torben.alexander.klarl@wiwi.uni-augsburg.de, torben.klarl@uni-ulm.de, tklarl@indiana.edu

[1] For instance, several studies for developing as well as for developed countries show that pollution as a source of negative externality affects the health status of people (see Remoundou and Koundouri (2009) for an review of the literature of environmental effects on public health).

[2] For instance, Lines (2005); Chu and Lai (2014) and Oueslati (2002); 2015) among others assume that a household derives negative utility from pollution.

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(Huang and Cai, 1994 and Ligthart and van der Ploeg, 1994) or conclude that a tax on emissions, where emissions affect learning abilities, stimulates growth (Smulders and Gradus, 1993; 1996; van Ewijk and van Wijnbergen, 1994; Pautrel, 2009; 2010).

Conversely, there are only a few studies which incorporate health into a theoretical, endogenous growth framework, although this point has been recognized in a voluminous number of empirical research[3]. A key premise of this literature is that human capital is positively related to a people's health status, and hence, contributes to growth. This argument is picked up by the theoretical contribution of van Zon and Muysken (2001), who introduce an additional health sector into the Lucas (1988) framework. van Zon and Muysken (2001) show that despite the welfare and productivity enhancing effect of health, the long-run growth decreases if people have preferences for health. Agénor (2008) introduces a health service sector into the Barro (1990) model, whereas the health service sector employs public spending on infrastructure and health, directly financed from income tax revenues.

To the best of our knowledge, only the contribution of Gupta and Barman (2010) explicitly deals with the interaction between health, environmental pollution and endogenous growth, and, thus is qualitatively closest to ours. The authors enrich the Agénor (2008) model with environmental pollution. However, our contribution differs from the Gupta and Barman (2010) framework and the before mentioned studies in several directions. First, we extend the simple (Jones and Manuelli, 1990) semi-endogenous growth model by a health production sector and a pollution externality. In contrast to Gupta and Barman (2010), health directly enters the household's utility function, in which health is explained endogenously. More specifically, we assume that a household's health status decreases with pollution but can be improved by health investments. Further, the level of pollution can be reduced by abatement endeavors, whereas abatement goods are exclusively purchased by the government from the abatement goods sector. The government levies a pollution tax on the final goods sector, which produces only with polluting capital. The governmental budget is equalized in any point of time and government revenues are only used for abatement purposes.

Hence, this contribution is also different to Greiner and Semmler (2005) besides others, where pollution does not directly affect a household utility function and, further, different to van Zon and Muysken (2001), where the health level is not endogenously affected by pollution. Based on this model, we derive the long-run growth rate of the economy, which is directly affected by several policy-relevant parameters, such as the household's weight for health in the utility function, the elasticity of pollution and the elasticity of health depreciation.

Second, our contribution is not only devoted to a steady state analysis of the growth model, but it is the first in the health/pollution/ growth context which provides a comprehensive convergence speed analysis which can be used to characterize the model's transition towards the steady state. In general two reasons make the speed of convergence analysis attractive in the growth context. First, the speed of convergence concept can be used to establish the stability of the long-run equilibrium and, second, it can be employed to check whether the model is able to replicate an empirically plausible speed of convergence (Ortigueira and Santos, 1997 and Eicher and Turnovsky, 2001).

We further believe that this kind of analysis is of particular importance for the policy maker, due to the following reason: Many growth models in the health/pollution context are directly employed to investigate the welfare effects of implemented policy schemes, such as the introduction of a Pigouvian tax or a health care subsidy. The important point is that such an analysis generally assumes that an economy is on its long-run growth path. However, as pointed out by Jones (1995), normative as well as positive implications might differ enormously depending whether an economy grows along the balanced growth path or converges to this. In general, the convergence speed in the growth context informs which weight should be placed on the adjustment phase relative to the steady state phase of an economy.

For instance, if the speed of convergence is high, policy design should particularly focus on the steady state behavior and associated comparative statics of the model by neglecting a possible importance of the transitional phase. If the speed of convergence is low, however, transitional dynamics elements should predominantly appear in the policy design. Otherwise, the design as well as a ranking of policy instruments may be biased (Trimborn et al., 2008) if it does not acknowledge the speed of convergence appropriately. Related to our study, we show that the model implies a speed of convergence which varies considerably between 1.6% and 11.5%, depending on the investigated pollution/health related parameter constellation. In particular, it turns out that for a household, who weights health relatively less compared to consumption, the model exhibits a considerable reduction of the speed of convergence compared to a household who puts an excessive and unrealistic large weight on health. Taken together, a policy aiming at a promotion of growth has to take transitional phases into account, given the society derives utility, both from health and consumption. This is the major point the paper makes, which is also supported by a dynamic welfare analysis.

To obtain a measure for the speed of convergence close to the steady state, usually, the model is linearized around the steady state (See Jones (1995), p. 774). However, we follow Atolia et al. (2010) and Atolia and Buffie (2009) and argue that the concept of the so-called asymptotic speed of convergence is somehow unsatisfactory for policy evaluation. The argument runs as follows: The asymptotic speed of convergence bears only importance off the steady state, but at the same time it is only a valid approximation close to the steady state. Instead, the entire transition path of the growth model should be

[3] For an overview refer to Muysken et al. (2003). Knowles and Owen (1997), by conducting a convergence study show that growth and health are strongly positively related. Mullins and Bharadwaj (2014) emphasize that high levels of air pollution negatively affect health.