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# Structural change versus turnpike optimality: A Polish perspective

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ABSTRACT

Using a modified dynamic IO model for Poland which allows taking into account actual trends observed in recently available statistical data we compare the rate of economic growth calculated for different growth paths resulting from the model. The goal of the research was to examine the distance between the actual structure of production and the structure on the turnpike and its impact on the economic growth of the economy under study. The results of the study indicate that the impact of structural change on output takes place in three general stages. The benefits of structural change do not outbalance the corresponding costs immediately, since it takes several periods until the growth rate of those paths which are closer to the von Neumann ray become larger than the corresponding growth rate of the benchmark growth path.



## 1. Introduction

Turnpike theory belongs to a research field of capital theory. Its aim is to investigate the property such that the efficient growth path would be in the neighbourhood of a balanced growth path (called a "turnpike") for most of the planning periods. The notions and terminology concerning "turnpike optimality" are based originally on contributions by Ramsey (1928) and von Neumann (1937). However, they weren't widely popularized until a book about linear programming by Dorfman et al. (1958) and in the work of Samuelson (1965) as well as many others. Turnpike theorems were proved among others by Morishima (1961), Radner (1961), Mckenzie (1963), Inada (1964), and Nikaidó (1964) for different economic models.

This terminology was created to reflect the behaviour of actual optimal paths in growth models. One can observe that optimal path starting from some initial point exhibits tendency to converge quickly to a distinguished optimal path (the turnpike). Actual growth path will remain in a close neighbourhood of that reference path for almost all time. It leaves that neighbourhood close to some (finite) final time in order to reach a prescribed final state, that is, assumed level of consumption or desired saturation with capital goods. The name of the theory refers to the idea that a turnpike is the fastest route between two points which are far apart, even if it is not the most direct route. In an extensive survey on the development of turnpike theory McKenzie (1976) gives a plausible explanation:

> *There is a fastest route between any two points; and if the origin and destination are close together and far from the turnpike, the best route may not touch the turnpike. But if the origin and destination are far enough apart, it will always pay to get on*

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*to the turnpike and cover distance at the best rate of travel, even if this means adding a little mileage at either end. The best intermediate capital configuration is one which will grow most rapidly, even if it is not the desired one, it is temporarily optimal.*

To summarize, growth on a turnpike path means that in most of the planning period an economy follows a balanced growth path, that is, both the rate of growth and the proportions of the growing sectors of an economy are stable over the time. In actual planning problems, an economic growth path does not have to approach the balanced growth path in a strict sense but just stay in the close neighbourhood of it for most of the planning period.

To the best of our knowledge there have been no empirical studies dealing with turnpike properties in a modified dynamic IO model constructed on the basis of SNA-based IO data in CEE transition economies. The modification of the traditional closed form of the dynamic IO model allows us to take into account the actual trends observed in recent statistical data, which – to the best of our knowledge – is a novel proposal in the literature. Next we try to compare the rate of economic growth calculated for different outcomes (growth paths) of the model. The goal of our paper is to fill a gap in the literature by examining the impact that the distance between the actual structure of production and the structure on the von Neumann output ray[1] has on economic growth. The latter, in turn, seems to have a range of potential policy implications.

The motivation to analyse the case of the Polish economy is twofold. First of all, Poland is not only the first CEE country where the transition process from a centrally planned economy to a market economy started, but this country is also the biggest CEE transition economy and - as one of the economic and political leaders in the region - it is often treated as a model transition country.[2] We expect that turnpike optimality may be easier to capture for actual data on transition economies and therefore the respective conclusions may be more interesting for these countries than for highly-developed market economies, where structural change is conducted gradually and in a strict manner. The latter arises from the nature of Leontief's dynamic input-output models which are thought of as growth models and thus are designed to capture dynamic processes. As Bulmer-Thomas (1982) points out, although dynamic IO models have the potential to become powerful analytical tools, an area where extensions and applications of these models have been modest is that of development planning in developing and transition economies. In other words, the analysis conducted in our study may provide some information on the probable structural change of the Polish economy during the upcoming stages of economic growth. In addition, most of well-known empirical applications of turnpike theorem were conducted for highly-developed market economies, for which the detailed data was fully available (or closely approximated) and where, in general, the initial structure of production was close to the structure given by the turnpike proportions. Thus, in those studies the solutions of dynamic IO models, that is, growth paths, very rapidly reached the close neighbourhood of the von Neumann ray and in consequence the corresponding structural change was hard to detect and to analyse (Tsukui, 1968). Moreover, to the best of our knowledge, the approach suggested in this paper has not been used in an empirical study to date, including for highly-developed economies. Thus, our paper seems to fill a gap in the literature by providing empirical results and some methodological suggestions which may prove important for both researchers and policymakers dealing with various applications of input-output models and planning, not only in transition or developing economies.

Due to the lack of reliable statistical data required for detailed IO modelling we were forced to apply several simplifications.[3] It is crucial to underline, however, that the simplifications used in the simulation procedures have a similar impact on all the scenarios analysed. Since we measure relative growth change, one may claim that the approximations do not bias significantly the final conclusions as they affect the results of all the assumed scenarios to the same degree.

The structure of the paper is as follows. The next section reviews selected contributions on empirical applications of the turnpike theorem to describe and simulate the evolution of the structure of an economy. The third section is concerned with a formulation of the main research hypotheses. Section 4 presents the fundamentals of the methodology applied. The empirical results and a discussion of them are presented in fifth section. Finally, in the last section we summarize the major conclusions and suggest directions for future research.

## 2. Literature overview

The literature on turnpike theorems is very extensive. Due to space limitations we refer the interested readers to the extensive survey of McKenzie (1976) and to the book of Carlson et al. (1991). The last contribution contains, in addition, an important classification of the corresponding growth models. The papers in this field can be divided roughly according to whether they deal with discrete models or continuous models and whether they consider a finite or an infinite time interval or horizon. The latter distinction may be extended to those dealing with models with or without discounting. For example, Radner (1961) discusses discrete time finite horizon models while Gale (1967) and Mckenzie (1963) deal with discrete time infinite horizon discounted models. Continuous time models are studied, among others, by Rockafellar (1976), Brock and Scheinkman (1976), Haurie (1976) and Feinstein and Oren (1985).

[1] The optimal structure is also referred to as the *Frobenius proportions*.

[2] This view is often expressed by both researchers (Lenain, 2000) and politicians. Recall US President Barack Obama hailing Poland as a model of transition during his visit in Warsaw in 2011 (http://www.huffingtonpost.com/2011/05/28/obama-poland-democracy_n_868434.html).

[3] For example we were forced to approximate the capital matrix quite roughly, since it is as yet absent in the Polish statistics.