Chapter 9
The Dynamics of Technical Progress in Some Developing and Developed Countries

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ABSTRACT

We calibrate a semi-endogenous growth model to study the transitional dynamic and the properties of balanced growth paths of technological progress. In the model, long-run growth arises from global discoveries of new ideas, which depend on population growth. The transitional dynamic consists of the growth rates of capital intensity, labor, educational attainment (human capital), and research and ideas in excess of world population growth. Most of the growth in technical progress in a large number of developed and developing countries is accounted for by transitional dynamics.

INTRODUCTION

Technological progress, also known as Total Factor Productivity (TFP) is essentially Solow's (1956, 1957) "exogenous" residuals. However, Kuznets (1966) attributed growth in TFP to *useable knowledge*. In endogenous growth models, knowledge and research ideas, which produce new goods and services, drive growth because they drive technological progress. In the growth models of Jones (1995, 2002), discoveries of new ideas throughout the world drive long-run economic growth, which is consistent with many other endogenous growth models such as Romer (1990a), Grossman and Helpman (1991), Aghion and Howitt (1992), Howitt (1992, 1998, 1999), and Lucas (1988, 2009). These papers were built on earlier contributions from Nelson and Phelps

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(1966), among others, who hypothesized that "educated people make good innovators, so that education speeds the process of technological diffusion".

Obstfeld and Rogoff (1996, p. 492) argue that a corollary of the Romer model is that as a country's population grows, the rate of growth of income per capita increases. More people mean more inventions and a bigger market for inventions, and a greater rate at which inventions will be discovered. Kremer (1993) argues that the *world population size* predicts economic growth, with the assumption that technology advances diffuse across countries over time.

The basic premise of Romer (1990a), Grossman and Helpman (1991), and Aghion and Howitt (1992, 1998, 1999) is that the rate of technological progress and the growth rate of output per person increase because the population growth rate increases. A larger population induces an increase in the supply of Research & Development (R&D) workers and the demand for their services; increased demand occurs because successful innovators take advantage of the increase in the market size. The combined effects of these two factors are referred to as "scale effect."

These models have been challenged by, for example, Young (1998). He presented an endogenous growth model without the scale effect. In his model, any increase in the reward for innovation, which results from a large population, dissipates in the long run. Larger economies must allocate a large number of workers to the innovation process in order to maintain a constant rate of productivity growth because those workers have to improve more products than in smaller economies. Growth models with no scale effect can also be found in Smulders and van de Klundert (1995), Seagerstrom (1998) and Peretto (1998).

Howitt (1999) presented an endogenous growth model that incorporated the idea of "no scale effect" without changing any of the growth implications of previous endogenous growth models. His modified model resulted in steady-state equilibrium with constant growth in output per person even though both the population and R&D inputs grew steadily over time. The long-term growth is determined by exactly the same factors as in the original endogenous growth models with scale effect, which are increased by subsidy to R&D. He argues that these modified endogenous growth models without scale effect are broadly consistent with Jones (1995).

In the model of Jones (2002), without trade in goods and services, ideas of research are traded across countries. Growth in the world's stock of useable knowledge is tied to the growth of the world's research effort. He explains the US growth data from 1950 to 1993. As in Kremer (1993), although long-run growth is ultimately tied to *world population growth*, some 80 percent of the US growth in GDP per worker over that sample is explained by "transitional dynamics".

Jones (2002) decomposes that transitional dynamics into four factors: capital intensity, labor reallocation, educational attainment, and excess ideas. The increasing level of educational attainment (i.e., investments in education) accounts for more than one-third of growth, and increased research intensity, which drives the discovery of new ideas in the G-5 countries, accounts for about 50 percent of growth.

Our objective is to calibrate the Jones (2002) model and examine the robustness of the model to a sample of 23 developed and developing countries, including the USA, and to a different sample span covering the period 1980 to 2007. We follow Laabas and Razzak (2011) and adjust the data for the quality of human capital because it varies across countries (e.g., a year of education in the USA is not the same as a year of education in Egypt). The sample includes the G-7, a few OECD and Asian countries and a number of the Middle East and North Africa countries (MENA).

We can compare the growth paths of different countries including Canada, France, Germany, Italy, Japan, the United Kingdom, and the USA plus Australia and New Zealand, Austria, Denmark, the