Journal of Economic Dynamics & Control 32 (2008) 3895–3916

Contents lists available at ScienceDirect

Journal of Economic Dynamics & Control

journal homepage: www.elsevier.com/locate/jedc

R&D policies, endogenous growth and scale effects

Fuat Şener

Department of Economics, Union College, Schenectady, NY 12308, USA

ARTICLE INFO

Article history:
Received 14 February 2007
Accepted 12 March 2008
Available online 2 May 2008

JEL Classification:
O3
O4

Keywords:
Scale effects
Innovation
Rent protection
Technological change

ABSTRACT

This paper constructs a scale-free endogenous growth model and studies the determinants of optimal R&D policy. The model combines two of the main approaches to removal of scale effects: the rent protection approach and the diminishing technological opportunities approach. The steady-state rate of innovation is a function of all of the model's parameters including the R&D subsidy/tax rate. Thus, growth is fully endogenous. Numerical simulations imply that it is optimal to tax R&D when innovations are of very small and very large magnitudes, and to subsidize R&D when innovations are of medium size. Under a wide range of empirically relevant calibrations, the subsidy rate turns out to be positive and fluctuates between 5% and 25%.

1. Introduction

Endogenous growth theory came at a crossroads with the Jones critique in the mid 1990s. First generation endogenous growth models predicted that the long-run growth rate of an economy increases in the level of R&D inputs and thus larger economies should grow at higher rates.[1] In two influential papers Jones (1995a, b) refuted this scale effect prediction by examining the post-war time-series data from industrialized countries. In response, a second generation of endogenous growth models has emerged. This literature offers three main approaches to remove scale effects: (i) Diminishing Technological Opportunities (henceforth DTOs) put forward by Jones (1995b), Kortum (1997) and Segerstrom (1998); (ii) Rent Protection Activities (henceforth RPAs) proposed by Dinopoulos and Syropoulos (2007); (iii) Variety Expansion (henceforth VE) proposed by Aghion and

E-mail address: senerm@union.edu

[1] See Romer (1990), Segerstrom et al. (1990), Grossman and Helpman (1991) and Aghion and Howitt (1992).

0165-1889/$ - see front matter
doi:10.1016/j.jedc.2008.03.009

Howitt (1998, Chapter 12), Dinopoulos and Thompson (1998), Howitt (1999), Peretto (1998) and Young (1998).[2]

In all of the above papers, growth is endogenous in the sense that it is driven by the innovation efforts of profit-maximizing entrepreneurs. However, the determinants of the steady-state growth rates differ markedly across these approaches. Models based on the DTO approach imply that the steady-state growth rate is exclusively pinned down by the rate of population growth and the rate of exhaustion in technological opportunities, leaving no room for R&D policies to exert an influence. Therefore, these models are often referred to as *semi-endogenous* growth models. In contrast, models using the RPA or VE approach predict that the steady-state growth rate is a function of *all* of the model's parameters including the R&D subsidy/tax rate. Thus, these models are often referred to as *fully-endogenous* growth models.

These stark differences in terms of steady-state outcomes are important not only in their own right but also because of their welfare implications. In a typical endogenous growth model, the search for welfare-maximizing optimal R&D policy involves the comparison of positive and negative externalities associated with a marginal unit of innovation. In the DTO-based models, with only a small subset of parameters determining the rate of innovation, the majority of the parameters have no influence on the magnitudes of innovation externalities via their effect on the innovation rate. In contrast, in the RPA- or VE-based models, the entire set of the parameters do exert an influence through this particular channel. To see the implications for optimal R&D policy, compare for instance the results from the semi-endogenous growth model of Segerstrom (1998) and fully-endogenous growth model of Dinopoulos and Syropoulos (2007). Segerstrom (1998) finds that for small-sized innovations either R&D taxes or subsidies are optimal, whereas for sufficiently large-sized innovations R&D taxes are welfare maximizing. Quite the contrary, Dinopoulos and Syropoulos (2007) find that R&D taxes are optimal for small- and large-sized innovations, and R&D subsidies are optimal only for medium-sized innovations. It is easy to find more papers in this literature with major differences in R&D policy recommendations.[3]

Motivated by the above considerations I intend combine the DTO and RPA approaches under a unified setting and explore the implications for steady-state growth and R&D policy. I restrict the focus of the paper to these two approaches in order to facilitate the paper's comparison with the literature. The DTO approach captures the essence of the semi-endogenous growth theory, whereas the RPA approach captures the essence of the fully-endogenous growth theory. Incorporating the VE approach can of course be a fruitful avenue, which for now is left for further research.

Such a unified model can shed light on several important questions central to endogenous growth theory. When we combine the elements that give rise to fully-endogenous growth with those that give rise to semi-endogenous growth, will growth be fully endogenous or semi endogenous? Does the model point to taxes or subsidies as the optimal R&D policy? How do the externalities associated with marginal innovation respond to changes in parameters? When one calibrates the model what is the nature and extent of the optimal R&D policy?

The model is based on a standard quality-ladders growth setting in the tradition of Grossman and Helpman (1991, Chapter 4). The economy is characterized by a continuum of structurally-identical industries. Labor is the only factor of production, and there are two types of labor: general-purpose and specialized labor. General-purpose workers can be employed in either R&D or manufacturing, and specialized workers can only be employed in RPAs. In each industry, entrepreneurs participate in R&D races to innovate higher quality products. The winner of an R&D race establishes monopoly power as the sole manufacturer of the highest quality product in the industry. Further innovation in the industry implies the emergence of a new quality leader and hence the replacement of the incumbent firm. The replacement rate faced by the incumbent firms is equal to the rate of innovation ι, which is endogenously determined by the profit-maximizing decisions of entrepreneurs.

[2] See Dinopoulos and Şener (2007) for a recent analysis of scale-invariant growth theory. Jones (2005), Dinopoulos and Thompson (1999), and Jones (1999) also provide comprehensive overviews of the scale-invariant endogenous growth literature.

[3] See Segerstrom (2007) and Li (2001, 2003) for a comparative analysis of R&D policies implied by different endogenous growth models.