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Transitional dynamics of output, wages and profits in innovation-led growth: a general equilibrium analysis☆

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Abstract

This paper focuses on the transition between steady states of innovation-led growth, in the context of a general-equilibrium model in which the exogenous appearance of a new technological paradigm triggers a wave of endogenous, stochastic, incremental innovations through which it is implemented. The analysis demonstrates existence of a unique Markov-perfect equilibrium, and shows that its transition dynamics conform in expected values to commonly observed empirical patterns. These include an initial productivity decline followed by a greater increase in productivity; and 'creative destruction' that reduces the market value of traditional, incumbent firms while creating new value in innovative entrants.

JEL classification: O41; O33

Keywords: Growth; Technology; Innovation; Transitional dynamics; General equilibrium

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1. Introduction

Transitional dynamics play a key role in innovation-led growth. When technological change is ubiquitous, long-run steady states may be few and far between though short-run equilibria prevail in individual markets (Nelson and Winter, 1982). Detailed studies of major innovations describe the singular impact of specific 'paradigm shifts' setting off Schumpeterian waves of technological diffusion that last for decades before approaching a steady state (Freeman et al., 1982; Dosi, 1982).[1] Such waves have been associated with the introduction of electric power (Freeman, 1982; David, 1991), crop hybridization (Griliches, 1957; 'the invention of a method of inventing'), synthetic fibers (Hollander, 1965) and semiconductors (Braun and MacDonald, 1982), each of which set off an extended diffusion process. More recently, Greenwood and Yorukoglu (1997) have argued from a macroeconomic perspective that the productivity slowdown in the 1970s was a transitional phenomenon that marked the beginning of a new industrial revolution based on radical innovation in information technologies.[2] Models of innovation-led growth that focus on steady-state outcomes are poorly suited to describing such trajectories of technological progress, which are driven by the singular introduction of new technological paradigms.

The present paper focuses instead on the transitional dynamics of innovation-led growth to describe such trajectories, while placing their development in a general-equilibrium context. It models growth as triggered by the appearance of a radical innovation that challenges the ruling technological paradigm, followed by subsequent incremental innovations through which the economic impact of the new paradigm is realized and diffused.[3] While the appearance of a paradigm shift is treated as an exogenous, random occurrence that is not explained by the model, the incremental innovations that follow it are viewed as the stochastic result of endogenous investment in research and development by profit-maximizing firms.[4] Analysis of the model shows that under reasonable assumptions such trajectories can be described as random realizations of a unique, Markov-perfect Nash equilibrium in contingent consumption, production and innovation strategies; and that the trajectory of expected values of this unique stochastic equilibrium has certain properties commonly observed in actual paradigm shifts.

[1] Various terms have been used to describe these radical innovations. 'Paradigm shift' is an implicit reference to Kuhn's work on scientific revolutions. Bresnahan and Trajtenberg (1995), Helpman and Trajtenberg (1994, 1996) refer more explicitly to 'General Purpose Technologies'. Other terms commonly used to describe new technological regimes are trajectories (Dosi, 1982) or filieres. Mokyr (1990) borrowed the term 'punctuated equilibria' from evolutionary biology to describe the dynamics of technological development.

[2] In related work, Greenwood et al. (1997) point to a sharp increase in the relative importance of investment-specific technological change after the mid 1970s; and Galor and Tsiddon (1997) similarly attribute the subsequent increase in the wage gap between skilled and unskilled workers to an acceleration of technological change.

[3] This distinction is grounded in Schumpeter (1934) view of innovation and diffusion as the fundamental dual phases of economic growth.

[4] Treating paradigm shifts as exogenous events is supported by Solomou (1988) careful statistical investigation of long-run 'phases of growth', which showed that historically such 'episodic disturbances' have occurred randomly rather than at regular intervals.