Innovation strategies and their implications for technological change and market outcomes

Valorization

This thesis study consists of essays on innovation strategies in the tradition of evolutionary economics. The chapters address the research topics: taxonomy of innovation strategies, sustainability of heterogeneity in innovation strategies, the effects of patent policy on market outcomes and research joint ventures. For the empirical part of the dissertation, latent class analysis is used to categorize firms into clusters with distinct innovation strategies using Community Innovation Survey 4 data. For the theoretical part, an evolutionary multi-agent based sector-level innovation model platform is created addressing supply and demand side of the market simultaneously with the coevolution of heterogeneous consumer preferences, heterogeneous firm knowledge bases and technology levels at the micro level.

Chapter 2 is a taxonomic exercise over innovation modes. It relies on firm-level survey data on innovation indicators from 16 countries participated CIS 4. An original contribution of this study is to show how a cluster of firms following a specific innovation strategy is linked to other groups within models of different number of clusters using latent class analysis. Then a 4-cluster model (science-based, market-based, external-based and low-profile innovators) is selected for an in-depth analysis of innovation strategies. It is concluded that policy makers should be well-informed about the extent of heterogeneity in innovation modes within and between sectors to conduct efficient innovation policies.

The aims of the third chapter are twofold. The first is to analyze the interaction between research and development (R&D) activities of firms and heterogeneous consumer preferences in structuring the evolution of an

industry. The second is to explore the heterogeneity in firms' innovation strategies: is heterogeneity sustainable in the long term and what happens to the market shares of firms having different innovation strategies when a structural market characteristic (market size) or a behavioural rule (R&D intensity) is changed. To answer these research questions, an evolutionary, multi-agent based, sector-level innovation model is designed. The model addresses supply and demand side of the market simultaneously with the coevolution of heterogeneous consumer preferences, heterogeneous firm knowledge bases and technology levels at the micro level. The simulation analysis concludes that coexistence of a variety firms with distinct innovation strategies is viable even in the long run and market sharing between these firm groups is determined by market size and R&D intensity. The pace of technological progress is affected by this very market sharing between different strategies throughout the simulation run.

Chapter 4 explores the effect of patent policy on market outcomes and opens with introducing the evolution of the main variables of interest to explore model dynamics and continues with the results of a series of simulation experiments designed to analyze how these variables of interest are conditioned by patent length and breadth. The effect of patent length manifests itself in a continuous manner whereas patent breadth should be broad enough to cover a whole new class of technologies to have its effect felt by the market participants. So, there is discontinuity in the way market outcomes are conditioned by patent breadth. The simulation analysis concludes that the optimum patent policy is granting broad patents for a limited time period.

Chapter 5 presents an alternative approach to R&D collaborations with an evolutionary, multi-agent based and sector-level R&D model. The model is firstly used to simulate the evolution of an R&D driven market composed of profit-driven firms and boundedly rational consumers. Next, frequently discussed research questions in the relevant empirical literature are explored. This modeling exercise extends beyond a basic confirmation/rejection of these research questions by showing that the way a firm is defined as an R&D collaborator has significant effects on research results. A clear inference based on these outcomes is that the research results of the empirical studies on

research joint ventures should be interpreted with some caution in regard to the chosen method of defining collaborator firms.

ABM requires a very explicit modelling of every module within the system (innovation mechanism, pricing heuristic, firm interaction, consumer purchase, etc.). In general, this specificity of the simulation exercise permitted an increased understanding of an industry-level innovation system through controlled computational experiments. The model demonstrated how firm level heterogeneity in innovation strategies evolved and persisted as a dynamic equilibrium with continuous technological change and firm entry and exit. It also functioned as a laboratory increasing our normative understanding for the discovery of good designs: the optimum patent length and breadth for the sake of fastest technological change and highest wealth creation. Last but not least, the distinctive capability of this modeling technique in tracking the status and behaviour of each and every individual agent in real time (e.g. being in an R&D collaboration or not at a specific point in time) enabled us to observe how micro-level interactions lead to macro outcomes.

We hope to have developed a reasonably realistic simulation model of innovation at sectoral level in a structured way giving due consideration to its multi-dimensionality. This simulation platform helped us to ask and answer several "what if" questions that would not be possible in an empirical study mostly due to data constraints.