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Notes, Comments, and Letters to the Editor

The refoundation of the symmetric equilibrium in Schumpeterian growth models

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Abstract

We provide a refoundation of the symmetric growth equilibrium characterizing the research sector of vertical R&D-driven growth models. We argue that the usual assumptions made in this class of models leave the agents indifferent as to where targeting research: hence, the problem of the allocation of R&D investment across sectors is indeterminate. By introducing an "ε-contamination of confidence" in the expected distribution of R&D investment, we prove that the symmetric structure of R&D investment is the unique rational expectations equilibrium compatible with ambiguity-averse agents adopting a maxmin strategy.

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1. Introduction

Most vertical R&D-driven growth models (such as [9,12,1]) focus on the symmetric equilibrium in the research sector, that is, on that path characterized by an equal size of R&D investment in each industry. In these models the engine of growth is technological progress, which stems from R&D investment decisions taken by profit-maximizing agents. By means of research, each product line can be improved an infinite number of times, and the firms manufacturing the most updated version of a product monopolize the relative market and thus earn positive profits. These

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profits have a temporary nature since any monopolistic producer is doomed to be displaced by successive improvements in its product line. The level of expected profits together with their expected duration, as compared to the cost of research, determines the profitability of undertaking R&D in each line.

The *plausibility* of the symmetric equilibrium requires that each R&D industry be equally profitable, so that the agents happen to be indifferent as to where targeting their investment [9, p. 47]. The profit-equality requirement implies two different conditions. First, the profit flows deriving from any innovation need to be the same for each industry: this is guaranteed by assuming that all the monopolistic industries share the same cost and demand conditions. Second, the monopolistic position acquired by innovating needs to be expected to last equally long across sectors: this requires that the agents expect the future amount of research to be equally distributed among the different sectors. As is well known to the reader familiar with the neo-Schumpeterian models of growth, future is allowed to affect current (investment) decisions via the forward-looking nature of the Schumpeterian "creative destruction" effect.

Expecting equal future profitability across sectors, however, does not constitute a sufficient condition for each agent to choose a symmetric allocation of R&D efforts: indeed, equal future profitability makes the investor indifferent as to where targeting research. As a result, when symmetric expectations are assumed the allocation problem of investment across product lines is *indeterminate*. First, notice that this indeterminacy in the intersectoral allocation of R&D may have powerful effects on the equilibrium growth rate in this class of models, as recently pointed out by Cozzi [3,4]. Second, indeterminacy does not depend on the focus on the symmetric equilibrium. In a recent paper [1] Giordani and Zamparelli develop an extension of the standard quality-ladder model to an economy with asymmetric fundamentals where the equilibrium allocation of R&D investment turns out to be asymmetric. However, the multiplicity of equilibria still exists, because the source of indeterminacy is *not* the symmetric structure of the economy but the fact that, in equilibrium, the returns from R&D are equalized, which still characterizes the asymmetric extension and which, once again, makes the agents indifferent in the allocation of R&D efforts.

In this paper we provide a way to eliminate indeterminacy in this class of models. Our reasoning goes as follows: the agents' indifference—arising from the equalization of R&D returns across industries—gives them in principle the possibility of adopting a whatever (even randomly chosen) investment strategy. This makes these agents *highly uncertain* about the configuration of future R&D investment, since that configuration is the result of a decision problem analogous to the one they are currently facing. To represent uncertainty (or *ambiguity*) and the agents' attitude towards it, we follow the maxmin expected utility (MEU) theory axiomatized by Gilboa and Schmeidler [8]. In representing subjective beliefs this approach suggests to replace the standard single (additive) prior with a closed and convex set of (additive) priors. The choice among alternative acts is determined via a maxmin strategy, where the minimization is carried out over the set of priors and is meant to represent the individuals' aversion towards ambiguous scenarios. The plausibility of individuals' *aversion* to ambiguity (or preference for "pure risk") has been first shown by Ellsberg [6] via a thought experiment (then known as the Ellsberg paradox). [2] In particular, we follow the "ε-contamination of confidence" argument, recently axiomatized by Nishimura and Ozaki [11]. As we will see, a however small "contamination of confidence" in the expectations of

[1] Giordani and Zamparelli (2006). The importance of industrial policy in the quality ladder growth models, Mimeo.

[2] Abundant experimental evidence supports the idea of the decision-makers' ambiguity aversion. See among the others Heath and Tversky [10], Fox and Tversky [7]. See also Camerer and Weber [2] for a survey.