Imitation and price competition in a differentiated market☆

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ABSTRACT

We study the stable market outcome that evolves in a spatially differentiated market when price-competing firms choose actions by imitation of the most profitable firm. We compare and contrast the stable outcomes under two imitation procedures: one, where each firm immediately imitates the most profitable firm, and the other when a firm imitates another firm only if it is more profitable while being "sufficiently similar" (in context of the market segment it operates in) or "sufficiently close". In either case, the symmetric pure strategy Nash equilibrium is always a stable outcome. However, when imitation of the most profitable firm is immediate and market differentiation is 'moderate', states with prices lower than the Nash equilibrium are also stable. In contrast, when imitation of the most profitable firm is more gradual and market differentiation is below a threshold, states with prices above the Nash equilibrium are also stable. Thus, while competitive evolutionary pressure in this imitation based model does result in the Nash equilibrium always being stable, other outcomes may be stable as well. Interestingly, the states that are stable under gradual imitation give the firms a higher profit than the stable states under immediate imitation.

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1. Introduction

In this paper, we explore the stable outcomes of an evolutionary model of firm behaviour, where firms, primarily motivated by relative performance or relative profit rather than their absolute profit, imitate the most profitable firm. This primacy accorded to relative performance could be because firms may not be able to 'profit-maximise' or 'best-respond' due to lack of precise knowledge of the market structure (such as consumer preferences or the extent of market differentiation). In fact, these considerations led (Alchian, 1950) to argue that market behaviour evolves through a dynamic process of imitation and occasional experimentation, rather than conscious profit-maximisation on the part of firms.[1] On the other hand, (Friedman, 1953) posits an 'as-if' justification for more rational profit-maximising models of firm behaviour: even if firms do not consciously and objectively maximise profits, the market outcomes obtained because of competitive pressures would

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[1] Adoption of industry best practices serve as an example of imitative behaviour. In the academic literature, (Huck et al., 1999; Offerman et al., 2002) and (Apesteguia et al., 2007), amongst others, find experimental evidence of imitative firm behaviour on provision of feedback on strategies and profits. Further, the first two papers report that while experimental subjects do follow a best-response process when they are provided the relevant information to do so, provision of additional information such as the profit of the competitors – which should not have an effect on optimising behaviour – actually pushes the observed outcome in the direction of the theoretical prediction under an imitation paradigm.

be *as if* firms rationally engaged in profit-maximising behaviour. One contribution of this paper is to formally construct an Alchian type of model to 'test' Friedman's as-if justification. We find partial support for this view (as we elaborate on below) and emphasise a subtler consideration: the "speed/rate" at which imitation occurs may have important consequences for stable market outcomes. For example, the stable market outcomes that arise when all firms immediately imitate the strategy of the most profitable firm may be different from when imitation is more gradual, in that in the latter, only some firms may imitate the most profitable firm at first, and thereafter, imitation proceeds if and only if the imitated strategy continues to be the most profitable strategy. Thus, the main question we focus on is the differential effect of immediate imitation versus more gradual imitation on stable market outcomes.

We examine this question in the framework of a symmetric spatially differentiated oligopoly à la Salop (1979). A finite number of price-setting firms, located equidistantly on a unit circle, compete for consumers who are uniformly distributed over the circumference of the circle.[2] Firms set prices and the profit obtained depends on the profile of prices chosen, following which they adjust/adapt by imitating the price of the most profitable firm. This imitative behaviour leads to a symmetric/monomorphic strategy profile or state (i.e. all firms choose the same price), and we use the notion of stochastic stability to determine the symmetric strategy profiles that describe stable market outcomes. Stability of a particular market outcome is determined by the 'ease' of reaching it from other states on the one hand, and the 'difficulty' of reaching other states from it on the other hand. In a market state with a symmetric/monomorphic strategy profile, all firms receive the same profit, and so, only experimentation by firms with some other strategy may cause a transition to another market state. This happens when, for example, experimentation makes the experimenting firm(s) the most profitable, as a result of which it is imitated by other firms. Intuitively, a market state is stable if it is 'relatively easy' to reach it from other market states and it is 'relatively difficult' to reach any other market state from it by means of experimentation.

Before presenting our results, we first clarify the meaning of immediate and gradual imitation. In contrast to immediate imitation wherein all other firms instantly imitate the price of the most profitable firm, gradual imitation is more involved. Given the spatial nature of the market (described by the Salop circle), we assume that firms sufficiently close to the most profitable firm imitate it first; thereafter, imitation of the price spreads to other firms that are located farther away only if a firm sufficiently close to them is more profitable while using that particular price. This is similar in spirit to a diffusion process where a new innovation spreads from the innovating unit to other units which are closer to it, and then gradually to other units farther away. A possible explanation for gradual imitation is either that a firm is able to *observe* and hence imitate, or is inclined to imitate, only those firms that are located sufficiently close to it, i.e. the firms with whom it competes more intensely.[3] Thus, immediate imitation is similar to imitation under complete observability (all other firms are observed) while gradual imitation is similar to imitation under incomplete observability (only the firms in a 'neighbourhood' can be observed and imitated). Hence, a critical feature in gradual imitation, which does not arise in immediate imitation, is that after a particular price has been imitated by some firms in the first wave of imitation, that price has to be profitable enough for the firms using it for it to be imitated by the other firms.

We now contrast the stable market outcomes that obtain when imitation of the most profitable firm by other firms is immediate versus when it is gradual, and compare it to the symmetric pure Nash equilibrium market outcome (of the static game) in order to relate it to the arguments of Alchian and Friedman. In either case, the symmetric pure strategy Nash equilibrium is always a stable outcome. However, when imitation of the most profitable firm is immediate and market differentiation is 'moderate', a particular set of states with prices lower than the Nash equilibrium are also stable. In contrast, when imitation of the most profitable firm is more gradual and market differentiation is not sufficiently high, a particular set of states with prices higher than the Nash equilibrium are also stable. Thus, in the spatial differentiation model we consider, gradual imitation is actually profit-improving for the firms, and market outcomes that may appear to be collusive, in that prices maybe higher than the Nash equilibrium, may be actually generated by this type of imitation. Furthermore, we see a partial justication for Friedman's as-if hypothesis. When imitation is immediate, Friedman's conjecture holds for levels of market differentiation that endows firms with 'local monopoly power' and for markets that are close to being competitive; when imitation is gradual, this conjecture holds for markets that are not too competitive. For other levels of differentiation, in either model of imitation, the Nash equilibrium prediction is among the stable outcomes.

In order to firstly understand the intuition behind the stability of the Nash equilibrium state, we recall that stability of a market state is determined by the ease of reaching it from other market states on the one hand, and the difficulty of reaching other market states from it on the other hand. The Nash equilibrium state is stable (with both immediate and gradual imitation) because we find that: (i) from any other symmetric price strategy profile, if a firm experiments with the Nash equilibrium price, it always (weakly) improves its own profit – this makes reaching the Nash equilibrium relatively easy, and (ii) the Nash equilibrium is strict, meaning that from the Nash equilibrium state, if a firm experiments with any other price, its profit is strictly lower, and this makes reaching other market states from it via experimentations relatively difficult.

In case of immediate imitation, the reason for the stability of other market states (with prices lower than the Nash equilibrium state) is as follows. In any symmetric strategy profile, all firms obtain the same profit. When the price in an

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