Research in Economics 71 (2017) 798–802

Contents lists available at ScienceDirect

Research in Economics

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

Monopolistic competition, the Dixit–Stiglitz model, and economic analysis☆

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ARTICLE INFO

Article history:
Available online 26 October 2017

1. Introduction

I welcome this opportunity to provide a comment for this Special Issue of *Research in Economics* honoring forty years since the publication of the Dixit-Stiglitz 1977 paper. I have been pleased both by the way that our simple parameterization has provided a tool that others in a variety of sub-disciplines—growth theory, macro-economics, and international trade—have found so useful. In many ways, I am not surprised—indeed, I was aware of some of these possible applications at the time that we wrote the paper. As I noted in the essay I wrote on the occasion of the 25th anniversary of our paper (Stiglitz, 2004), the standard competitive model—where every firm faces demand curves of infinite elasticity—leads to numerous conundrums. For instance, small open economy could quickly restore itself to full employment by a slight adjustment of the exchange rate—it would easily remedy any deficiency of aggregate demand. In almost all sectors of the economy, firms face downward sloping demand curves, and competition is "imperfect."

Of course, there are many different forms of imperfect competition. Some forty years before our work, Chamberlin (1933) had posited a simple model where there were enough firms that no firm believed it had any effect on the behavior of others but the products they produced were sufficiently differentiated that each faced a downward sloping demand curve. Moreover, there was free entry, ensuring that the (marginal) firm earned zero profits. His graphical analysis assumed U shaped average cost curves; there were important fixed costs. But fixed costs were explicitly excluded from the standard Arrow-Debreu paradigm: it presented intractable problems both in the proof of the existence of competitive equilibrium and its optimality. Strikingly, until our work and that of Spence (1976), there had been almost no theoretical development, and the common wisdom was motivated by the observation that in monopolistic competition, firms operated at output levels that were smaller than that generating the minimum average costs; average costs could accordingly be decreased if there were fewer firms, each producing more. Hence, it was argued that with monopolistic competition there were too many firms, each producing too little. But this analysis simply ignored the reason for downward sloping demand curves; there was a social value to product variety.

Our work was in part motivated to answer the normative question of the efficiency of markets with monopolistic competition, in a formal model, recognizing that the reason that there are multiple firms is that society values variety—different individuals value different things and/or individuals value a range of products. Our benchmark model, which has proved so useful, established the constrained efficiency of the market. Yet, in many respects, it was the rest of the paper that was the most important. Any benchmark model is just that—a point of departure. The Arrow-Debreu model is a benchmark

☆ Parts of this essay are adapted from Stiglitz (forthcoming).

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https://doi.org/10.1016/j.rie.2017.10.010

model through which we understand the stringent conditions required for markets to be efficient, i.e. we glean insights into market failures. As we noted, the efficiency of the benchmark model depended crucially on assumptions of symmetry and constancy of the elasticity of demand. That's why some of the extensions and generalizations of our basic model over the last forty years, including the contributions to the 2017 Special Issue of *Research in Economics*, are so important.

The formalisms, though, sometimes hide the simple intuitions that we tried to provide graphically towards the end of the paper. A profit-maximizing market does not maximize societal well-being; it does not care about consumer surplus, and there is no fixed relationship between profits and consumer surplus. We explored an asymmetric case, where the entry of good with a high own-elasticity of demand (a mass produced good) with low consumer surplus "knocks" out a good with a low own elasticity of demand, with much higher consumer surplus. More generally, and more intuitively, the marginal entrant "steals" customers from other firms. If it has a high elasticity (and a low consumer surplus) and the firms from which it steals have a low elasticity (and a high consumer surplus), then its entry may be profitable yet societal welfare decreased.

There is an important warning here: one has to be very careful about making welfare statements in trade, macroeconomic, and growth models using the Dixit–Stiglitz framework. If one obtains a result that the market is inefficient, the analysis can be useful, in isolating another market failure. If one obtains a result that the market is in some sense constrained Pareto efficient, take it with a grain of salt.

2. Monopolistic competition with differences in location

That is why it is also important to explore other parameterizations of monopolistic competition. Firms may face downward sloping demand curves because search is costly, or because of differences in product characteristics, including location. Each of these naturally give rise to other specifications, which may not be easily mapped into even a generalization of the Dixit Stiglitz model; more importantly, results may be quite different. Consider, for instance, the product characteristic/location model, explored by Salop (1979), Perloff and Salop (1985) and Stern (1972). In the 1929 Hotelling model, with a single dimension (firms located along a line) so long as transport costs increase with distance, which is equivalent to saying individuals increasingly dislike moving further away from their ideal choice, there are too many firms, each charging too high a price. But there is something unnatural about this formulation for studying monopolistic competition—each firm has only two neighbors, so it is plausible that there will be strategic interactions.

But we can correct for this easily by moving into higher dimensions. In the case of three dimensions, in the symmetric case, each firm has six near neighbors, and sells to a "cube" surrounding his product (store). In higher dimensions, there are far more competitors. Moreover, the relationship between profits and surplus (travel costs) changes dramatically as we increase dimensionality. In the case of three dimensions, the elasticity is related to the ratio of the surface area of the cube to the volume of the cube. As the dimensionality increases, the corresponding ratio increases—in effect, the elasticity of demand increases, as there are more competitors. When the elasticity is low, prices are high, entry is induced until profits are driven to zero, and there will be, as a result, too many products (stores). But when the elasticity increases, prices and profits fall, and so the number of firms decreases.

In Stiglitz (1986), we were able to establish a result of remarkable simplicity. If the transport cost function is linear, and occurs along a rectangular grid (what is called the taxi-cab metric), then there will be too few firms if the dimensionality of the product space is greater than 4. If the transportation cost function is quadratic, then there will be too few firms if the dimensionality of the product space is greater than 6.[1] The most relevant interpretation of this higher dimension model is to product characteristics; different individuals have different preferences over characteristics. For each individual, there is an "ideal" set of characteristics—a dish that is not to hot and not to cold, just the right temperature, saltiness, sweetness, texture, etc. The utility an individual receives from a product that is not his ideal diminishes with the distance (measured somehow) from the ideal. Thus, the locational model just described can be thought of as a particular specification of how utility diminishes as one moves away from the ideal. Since in fact the dimensionality of the product space (taking into account color, durability, etc.) is almost surely fairly high, there is some presumption that there is too little product diversity.[2]

3. Discontinuities and existence

One of the reasons that Arrow and Debreu ruled out fixed costs, as we noted, is the challenge it presents for the existence of equilibrium. In the Dixit–Stiglitz benchmark model, the relevant demand and supply curves are continuous (ignoring the discontinuities associated with the discreteness of the number of firms, which can easily be handled.) But as we noted, in the asymmetric case, there was the possibility of no equilibrium. Similarly, a disquieting aspect of the Hotelling spatial equilibrium model is that, if transport costs are linear (as is often assumed), demand curves are discontinuous, so that equilibrium may not exist. Consider three firms, A to the left of B to the left of C.

A_____B_____C

Initially, assume they charge the same price, so individuals closer to A than to B go to A; and those closer to C than to B go to C. As, say, A lowers its price, it steals customers away from B, but this has no effect on how B and C divide their customers. But as soon as a firm lowers its price enough—so that it undercuts its neighbor, i.e. a customer located at B's store

[1] If the elasticity of the transport cost function is α, then there will be too few firms if $n > 2(1+\alpha)$.

[2] An important work synthesizing the different strands of monopolistic competition is Omori (1989).

would find it preferable to buy from A, because the transport cost plus the price is still lower than the price at B—it discontinuously gets all of his customers. (That is, if A charges p_A, the total cost of a good bought at any location is $p_A + at$, where t is the distance from A and a is the cost per unit distance. If t^* is the distance between A and B, if $p_A + at^* < p_B$, then B buys at A. But then for any point between B and C, $p_A + a(t^* + \tau) < p_B + \tau$, where τ is the distance from B to the point. Thus, when A lowers its price below $p_B + t^*$, A not only gets customers between A and B, but all the customers that are between B and C and that previously had gone to B, e.g. if $p_B = p_C$, A gets all the customers up to the mid-point between B and C.) But this result is a result of the linear transport costs. If marginal transport costs increase with distance, then even if someone at B prefers to buy at A, someone between B and C might still prefer to buy at B—the incremental cost of going from B to A is just too much (Of course, even with say quadratic transport cost functions, if p_A is low enough relative to p_B and p_C, an individual between B and C could choose to go to A. But a slight lowering of his price leads to a slight increase in his sales).

4. Limit theorems and other mathematical niceties

A standard part of the analysis of economies with monopolistic competition is to ask what happens as sunk costs go to zero. When they are zero, we get the perfectly competitive outcome. But one of the insights of the Dixit–Stiglitz model is that lowering the level of sunk costs may not lower price. Price may remain markedly above marginal cost. What happens is that the number of commodities (producers) increases. Of course, if there were a finite number of commodities, then as the number of producers increased, they would get "nearer" to each other, in some sense, and then presumably the elasticity of demand would increase, price would fall, and the economy would converge to the competitive equilibrium. But there are in fact an infinite number of possible commodities, and having more commodities doesn't then necessarily make them "nearer" to each other. That is the underlying presumption of the Dixit–Stiglitz model. In the Stiglitz generalized location/characteristic model, whether firms get closer together or not is endogenous, and even if in the limit the economy converged to the competitive equilibrium, price may not converge smoothly to marginal cost.

The important message of Dixit–Stiglitz is that just because in the limit there might be perfect competition, this says nothing about markets as they are—with a finite number of firms, a large enough number that they might ignore strategic interactions, a small enough number that they still face downward sloping demand curves. This is the situation that describes many markets—indeed, as I noted earlier, it is a rarity that firms really believe that they face a horizontal demand curve.

5. Monopolistic competition and the capital market

Capital markets provide another quite distinct context for thinking about monopolistic competition, with a quite different parameterization. If the returns to shares of firms are not perfectly correlated, then each is an imperfect substitute for the other. Individuals will want to hold all shares in their portfolio—just as in the Dixit–Stiglitz model, individuals want to buy all commodities that are produced. (In this way, these models are markedly different from the "spatial" models, where individuals go to only one store—the one that is closest—and closer to Dixit–Stiglitz, but with a quite different structure.) In Stiglitz (1989b) I use a variant of the standard mean-variance model of finance to ask again whether there are too many or too few firms in equilibrium; in this model, as in the Dixit–Stiglitz model, as more firms enter the market, they do not necessarily become "closer" to each other.

Each firm then faces a downward-sloping demand curve for its securities. The recognition of this will lead firms to cut back their scale—as in the standard monopolistic competition model. But with a fixed supply of investment, that implies that there will be more firms—more diversification, and that itself would enhance welfare. By setting the question within a general equilibrium context, we are able to ask another question (analogous to the Dixit–Stiglitz analysis of asymmetric markets): If there are two sectors, one safe and one risky, the former will be competitive, the latter monopolistically competitive. Looking at investment in the risky sector as a whole, does the market allocate too few resources to the risky (monopolistically competitive) sector? In the special case where all firms have identical but independently distributed returns, we show that the market is efficient in the decisions it makes about the number vs. scale of risky firms, *given the level of investment* in the monopolistically competitive sector (the risky industry). But there is not overall efficiency: the optimal allocation entails more risky firms. But the market equilibrium is *constrained* Pareto efficient, under the assumption that subsidies to the risky industry are not feasible. However, when returns are not independent (for instance, they are correlated because they are partially driven by a market factor) the market is not even constrained Pareto efficient. The pattern of distortions is complex—with biases depending, for instance, on the size of own variance relative to co-variances with respect to the risk of the market (the market appears to be biased toward firms with low own variances).

6. Imperfect information and search

There is one other set of well-developed monopolistic competition models in which firms face downward sloping demand curves because of imperfect information and the costs of search.[3]

[3] See, e.g. Salop (1976) Salop and Stiglitz (1977), (1982), (1987), Stiglitz (1979), (1985), (1987), (1989a).

If the only information that individuals did not have was that of price, then the development of the internet would have resulted in making markets perfectly competitive. But firms differ in many ways that are evaluated differently by different individuals. In terms of our earlier discussion, the "product space" (the relevant space of job attributes) has many dimensions, and a worker seeks to find the job that is nearest to his preferences. With high search costs, raising wages (lowering price) may attract relatively few workers (new customers); the workers (customers) that are attracted are a subset of those that would, with perfect information, have preferred the job (product), the subset that knows about the firm, its wage, and its non-pecuniary characteristics.[4]

In a paper with Steve Salop (Salop and Stiglitz, 1987), in the context of a search model, we again ask the question posed by Dixit–Stiglitz, whether additional firms (increasing product diversity)[5] enhance welfare. There are two countervailing effects. On the one hand, an additional firm means that it is likely that there is a firm that better meets one's preferences. On the other hand, it may be more difficult to find a firm that is close to one's liking, and if search is more difficult, competition is adversely affected. We show that if there are costs associated with search (obtaining information), increased product diversity may lower welfare, as a result of the increased search costs it induces. Thus, in this formulation, the old conventional wisdom is restored.[6]

7. Discriminatory pricing

The nature of the distortions associated with monopolistic competition depend critically on the ability of the firm to use non-linear pricing and to price-discriminate. As Spence (1976) and Stiglitz (1977) emphasized, it is the inability to price discriminate which gives rise to distortions, and as my 1977 paper noted, that is related to imperfections of information. In the past forty years, though, the use of these instruments has expanded enormously, enhanced by new tools for extracting information about individuals. The theory of the second best warns us that enhancing the ability to price discriminate may well lower societal welfare. This, it seems to me, is an important issue that future research should address.

8. Limited entry

Perhaps the most limiting assumption of the Dixit–Stiglitz was the assumption that all firms have the same cost functions, so that profits are zero, not only at the margin, but on average. Similar results would obtain if we depart from our assumption of symmetric preferences. Some firms (with a particular set of product characteristics) may be attractive to a larger mass of consumers than others.

9. Concluding comments

The reason I have emphasized the alternative parameterizations and the important limitations of Dixit–Stiglitz is that it is important for users of any "benchmark" model to understand the limitations. Models are designed to give us insights into the economy. Only by understanding the limitations of the model can we fully understand the extent to which they do so.

As I reflect on the contributions of our paper, the most important was to provide a tractable model that allowed the economics profession to break out of the mold of the perfect competition model in which had so long dominated analytic work. It is rewarding that monopolistic competition model has now proved useful, not just in trade, growth, and macroeconomics, but in a variety of other areas, including banking, finance, and the economics of natural resources.[7]

I am pleased that over the past forty years it has inspired so much fruitful research.

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[4] As we also explain in these papers costly search may give rise to kinked demand curves. In some limiting cases, the price may even rise to the monopoly level (Diamond 1971). In other cases, the only equilibrium may be characterized by a price distribution. It is also possible that there is no equilibrium.

[5] In the model (as in most of the literature), an increase in product diversity is linked with an increase in the number of firms. Obviously, a single firm can produce multiple products. However, in deciding to produce an additional product, the multi-product firm takes into account the adverse effect of the introduction of the new product on the demands for his other products (what is sometimes described as 'cannibalization' effects). There can, as a result, be an efficiency gain from having a single firm, offset by a loss of competition.

[6] By the same token, we show that the effect of improved information (lowering the costs of information) is, seemingly paradoxically, ambiguous. It *may* lower welfare as a result of a change in market power: changes in the market area drawn to any store *may* lower the elasticity of demand. Still, "normally" a lowering of the cost of information has a direct positive welfare effect (lower costs, better matches) and a lowering of prices from more effective competition.

[7] See, e.g. Hoff and Stiglitz (1997) and Dasgupta and Stiglitz (1982)

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