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Overall assessment

The thesis consist of three essays analyzing various aspect of vertical differentiation, in particular, a multi-market setting with complementary goods. This setting is interesting, since it occurs rather frequently in reality, think about a system consisting from several components that can be of different qualities (e.g., car and tires). The performance of the system and the consumers' utility depends on the qualities of both components. Nevertheless, such a market structure has been (with few exceptions) mostly omitted in the literature. The thesis provides some new results for this setup.

Chapter 1. Exogenous Expenses in Industries with Vertical Product Differentiation and Quality Constraints

The paper analyzes an extension of the model by Shaked and Sutton (1982) with an additional lump-sum tax. It is shown that the market structure, and in particular the coveredness of the market, change with the lump-sum tax. First, for small tax, the structure resembles Shaked and Sutton (1982) with maximal differentiation in equilibrium. Second, for intermediate tax, the market is not covered and minimal differentiation occurs in equilibrium. Third, for large tax, the market is monopolized by the high-quality firm.

From reading the Abstract and the Introduction it is, however, not clear what is the main goal/purpose of the paper. Is it the characterization of the market structure or are there some particular aspects that should be highlighted? As the author claims "The aim is to show that in the new setting the structure and the coveredness of the market also depend on the amount of the exogenous expense defined in terms of the equilibrium qualities." (p. 2). It is not surprising that the market structure depends on the size of the tax. However, as particularly interesting. I find the result that there is a "switch" from maximal to minimal differentiation when the size of the tax increases. I think the author could stress this result more.

More technically, the author should be clear about which range of the tax T is covered by the analysis in the paper and which range is not (maybe indicating them in a picture). For the range that is not covered, I would expect at least a verbal discussion of the equilibrium market structure.

Minor Comments

1.1. (p. 2) The reference to the results of Shaked and Sutton (1982) is imprecise. Given the uniform distribution of income, it is necessary and sufficient for consumer income having support with right bound which is more than twice and less than four times bigger than its left bound.

1.2. (pp. 3-4) The discussion of the relevant literature should focus more on the case of expense that are constant in the quality, which is relevant for current paper.

1.3. (p. 20) There is a typo in the expression for $R_2^{(C\_2)}$ in (30). It seems that the denominator should be $9u_2^{C\_2}$.

1.4. It seems that some references to earlier formulas are incorrect. For instance,

- (p. 15) the sentence "The if-condition in (18) can be also imposed on T." refers to formula (18) that has not been introduced yet. I suppose (15) is meant.
- (p. 21) the last sentence refers to "inequality in (18)", where (18) is an expression for the demand D_1. There are more such errors and they should be fixed!
- (pp. 21-22) There are two limits considered, for $\varepsilon \to 0$ and also $T \to 0$. What is the order of those limits?

Chapter 2. Why Middle-qualities May Not Survive in Market Equilibrium? The Case of Vertical Product Differentiation.

The second chapter studies markets for complementary goods where the final good consists of two complements and each complement is produced by several firms. Each component is vertically differentiated. The author derives conditions so that there are two firms in each market and the market is covered. In addition, it is shown that then only the extreme combinations of complements have positive market shares in equilibrium, resembling the principle of maximal differentiation.

I am not sure how one should interpret the result. Since all firms still make positive profits, it is maybe not appropriate talking about foreclosure. In addition, it would be good to understand what drives the result. Is it the fact that the intensity of preferences for both components is (for a consumer) the same and it also has the same distribution? As a potential alternative one could imagine that the consumers' valuation for the good is given by $\chi_{ij} = \{\frac{1}{2}[\theta_A f(A_i)]^r + \frac{1}{2}[\theta_B f(B_j)]^r\}^{1/r}$. Here I do not require any additional results, just an extended discussion.

Related to the previous comment, the introduction does a good job in relating the model to some examples and discussing the relevant literature. However, it does not provide intuition for the results. In addition it would be good to revisit some of the examples from the Introduction in the Conclusion in order to illustrate the results.

Minor Comments

2.1. (p. 44) The Cobb-Douglas and the Leontief functions as special cases of the CES function cannot be be obtained as limit cases of formula (3). For the specified form. For the specified form $\chi_{ij} \to 2$ when $r \to 0$, and $\chi_{ij} \to 0$ when $t \to -\infty$. Instead, one needs to use CES in the form $\chi_{ij} = \{\frac{1}{2}[f(A_i)]^r + \frac{1}{2}[f(B_j)]^r\}^{1/r}$

2.2. Some of the results use the general form of the CES function, whereas some results use just the three forms specified on p. 44. The author should make it transparent which result are general and which assume the three forms from p. 44.

2.3. P. 53 contains no text, just a footnote.

Chapter 3. Vertical Product Differentiation in a Market for Sys- tems: How the Leverage Effect of Tying Depends on Consumer Taste Variability and Differences in Qualities?

Similarly as Chapter 2, this chapter analyses markets where the final good is composed of two complements. Each of them is produced by several firms and is vertically differentiated, one of them being a multi-product firm who is active on both markets. As the novel feature the consumers are allowed to buy more than one from each component. This might be useful if, for instance, when a high-quality component is bundled together with a low-quality complement. Instead of using the low-quality component, the consumer can buy a high-quality substitute.

Within this framework, the author analyses 3 settings. In the first setting, it is assumed that one of the markets is monopolized. It is then shown that the multi-product firm cannot effectively deter entry of high-quality rival in the other market. In the second setting, the multi-product firm faces potential entrants in both markets. Here the author provides a rationale for zero price that does not involve predatory behavior. The third setting is similar to the second one, but with consumers being less diversified. It is shown that entry deterrence can occur in equilibrium. The author also provides a welfare analysis.

In general, as also mentioned above, it is not clear what is/are the main results. Related to this, the organization of the introduction does not make the contribution of the paper transparent. The author jumps immediately to the literature review and only on page 4 of the Introduction (p. 91 of the thesis) starts with the present paper.

Minor Comments

3.1. (p. 95) The justification using the non-profit fund is not clear. Why is this needed if the costs are sunk?

3.2. It is a little bit confusing to first introduce 2 cases (p. 95) and then analyze 3 settings (p. 101).

3.3. (p. 105) The author should clarify why the price needs to be non-negative. In particular, in the case of complements, it might make sense to sell one of them at a negative price (or price below the costs) and the other at a positive and sufficiently high price.

Conclusion

In general, the thesis is quite well written. With few exceptions exceptions mentioned above, the arguments can be mostly followed. However, the main text is mostly formal and I would appreciate, if the author could expand on the intuition (for instance, for the results formulated in propositions). Also, it would be good to include a more general introduction to the topic, in particular since all three chapters are closely related. The current Abstract for the thesis essentially consists of the three abstracts of the chapters.

Overall, the thesis satisfies formal and content requirements for a PhD thesis in economics and I recommend the dissertation for a defense.