INDUSTRIAL ORGANIZATION II (ECO 2901)

University of Toronto. Department of Economics. Spring 2011

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FINAL EXAM

Monday, April 18, 2011. From 9:00-12:00 (3 hours)

INSTRUCTIONS: The exam consists of 5 Questions (with sub-questions). You have to answer all the questions. No study aids, including calculators, are allowed.
TOTAL MARKS = 100

Consider the retail industry of coffee shops in a region. This industry is characterized by the leadership of three retail chains that we denote as SB, SC, and TH. You may think in *Starbucks*, *Second Cup* and *Tim Hortons*, though this problem deals with an hypothetical industry. Suppose that the retail chains SC and TH have announced a merger. You have been hired by the *Competition Commission* to evaluate the effects of this merger (in the hypothetical case that it is approved) on prices, market shares, profits, and consumer welfare.

You have been provided with a panel dataset with information from this industry that covers $T = 30$ quarters and $M = 500$ local markets (census blocks). We index time by t, markets by m, and firms by i. The information in the dataset includes: prices, p_{imt}; quantities, q_{imt}; a measure of market size, h_{mt}; average household income, y_{mt}; rental prices, r_{mt}; and average wage in the retail sector, w_{mt}. Of course, the dataset includes only 'pre-merger' information.

To evaluate the effects of the merger, you propose and estimate a structural model of competition in this industry. Firms compete in local markets, and competition is independent across local markets. The model of competition in a single market has the following features. Every quarter t, firms decide simultaneously whether to have or not a store in the market. This decision is static (i.e., there are not sunk costs of entry). Then, the active firms in the local market compete in prices ala Nash-Bertrand, and this competition determines firms' profits. The profit of firm i in market m is:

$$\Pi_{imt} = a_{imt} \ \left[(p_{imt} - MC_{imt}) \ q_{imt} - FC_{imt} \right]$$

$a_{imt} \equiv 1\{q_{imt} > 0\}$ is the binary indicator of the event "firm i has a store in market m at quarter t". And MC_{imt} and FC_{imt} are the marginal cost and the fixed cost of firm i in market m, respectively. Firms' products are differentiated. We model consumer demand using a logit model where product 'quality' can interact with consumer income at the market level. The market share of firm i in market m is:

$$s_{imt} \equiv \frac{q_{imt}}{h_{mt}} = \frac{a_{imt} \ \exp\{\delta_{imt}\}}{1 + \sum_j a_{jmt} \ \exp\{\delta_{jmt}\}}$$

with

$$\delta_{imt} = \alpha_i^{(1)} + \alpha_i^{(2)} y_{mt} - \alpha_i^{(3)} p_{imt} - \alpha_i^{(4)} y_{mt} \ p_{imt} + \xi_m^{(1)} + \xi_t^{(2)} + \xi_{imt}^{(3)}$$

where $\{\alpha_i^{(1)}, \alpha_i^{(2)}, \alpha_i^{(3)}, \alpha_i^{(4)} : i = SB, SC, TH\}$ are demand parameters, and $\xi's$ represent error terms that are observable to firms but unobservable to you as a researcher. The specification of marginal costs is:

$$MC_{imt} = \beta_i^{(1)} + \beta_i^{(2)} w_{mt} + v_m^{(1)} + v_t^{(2)} + v_{imt}^{(3)}$$

where $\{\beta_i^{(1)},\ \beta_i^{(2)}\ :\ i = SB,\ SC,\ TH\}$ are parameters, and $v's$ represent error terms that are observable to firms but unobservable to you as a researcher. Finally, the specification of fixed operating costs is:

$$FC_{imt} = \gamma_i^{(1)} + \gamma_i^{(2)} r_{mt} + \varepsilon_m^{(1)} + \varepsilon_t^{(2)} + \varepsilon_{imt}^{(3)}$$

where $\{\gamma_i^{(1)},\ \gamma_i^{(2)}\ :\ i = SB,\ SC,\ TH\}$ are parameters, and $\varepsilon's$ represent error terms that are observable to firms but unobservable to you as a researcher.

As for the unobservable variables of the structural model, we make the following assumptions. The variables $\xi_m^{(1)}$, $v_m^{(1)}$, and $\varepsilon_m^{(1)}$ are treated as market fixed effects and controlled for by including market dummies. The variables $\xi_t^{(2)}$, $v_t^{(2)}$, and $\varepsilon_t^{(2)}$ are treated as time 'fixed effects' and controlled for by including time dummies. And the variables $\xi_{imt}^{(3)}$, $v_{imt}^{(3)}$, and $\varepsilon_{imt}^{(3)}$ are assumed independently distributed of (exogenous) observed market characteristics, h_{mt}, y_{mt}, w_{mt}, and r_{mt}.

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Question 1.1. (20 points). Estimation of Demand. The demand model can be described by the equations:

$$\ln(s_{imt}/s_{0mt}) = \delta_{imt} \qquad \text{if} \;\; a_{imt} = 1$$

where s_{0mt} is the share of the outside good, $s_{0mt} = 1 - s_{SBmt} - s_{SCmt} - s_{THmt}$.

(a) Discuss the endogeneity problems (both endogenous prices and endogenous entry) in the estimation of demand parameters in this model.
(b) Propose a method for the estimation of the demand parameters that deals with these endogeneity problems. Explain your method in detail.
(c) Suppose that we assume that the error terms $\xi_{imt}^{(3)}$ are unknown to firms when they decide to be active or not in the market. Explain how this assumption simplifies the estimation of demand parameters.

Question 1.2. (20 points). Estimation of Marginal Costs. Suppose that you have consistent estimates of demand parameters, including market and time fixed effects. Nash-Betrand competition implies the following best response functions for prices:

$$p_{imt} = MC_{imt} + \frac{1}{(\alpha_i^{(3)} + \alpha_i^{(4)} y_{mt})\ (1 - s_{imt})} \qquad \text{if} \;\; a_{imt} = 1$$

(a) In the estimtation of marginal cost parameters, discuss the selection or endogeneity problem due to endogenous firm entry.
(b) Propose a method for the estimation of marginal cost parameters that deals with this endogeneity problem. Explain your method in detail.
(c) Suppose that we assume that the error terms $v_{imt}^{(3)}$ are unknown to firms when they decide to be active or not in the market. Explain how this assumption simplifies the estimation of demand parameters.

Question 1.3. (20 points). Construction of Variable Profits. Suppose that you have consistent estimates of demand and marginal cost parameters. Let $VP_{imt}(a_{SB},\ a_{SC},\ a_{TH})$ be the variable of firm i in market m at period t under the hypothetical market structure $(a_{SB},\ a_{SC},\ a_{TH})$.

(a) Explain in detail how to calculate estimated values of variable profit function $VP_{imt}(a_{SB},\ a_{SC},\ a_{TH})$ for every market-quarter in the sample and for every hypothetical market structure $(a_{SB},\ a_{SC},\ a_{TH}) \in \{0,1\} \times \{0,1\} \times \{0,1\}$. Assume that $\xi_{imt}^{(3)} = v_{imt}^{(3)} = 0$ for every (i, m, t).
(b) Explain why the assumption $\xi_{imt}^{(3)} = v_{imt}^{(3)} = 0$ for every (i, m, t) helps in the calculation of $VP_{imt}(a_{SB},\ a_{SC},\ a_{TH})$.
(c) Suppose that $\xi_{imt}^{(3)}$ and $v_{imt}^{(3)}$ are not zero but we still assume that they are unknown to firms when they make their entry decision. Suppose that $\xi_{imt}^{(3)}$ and $v_{imt}^{(3)}$ are iid over (i, m, t). Now, $VP_{imt}(a_{SB},\ a_{SC},\ a_{TH})$ represents expected variable profit, where the expectation is taken over the distribution of $\xi_{imt}^{(3)}$ and $v_{imt}^{(3)}$. Explain how to estimate this expected variable profit.

Question 1.4. (20 points). Estimation of Fixed Costs. Suppose that you have consistent estimates of the variable profit function $VP_{imt}(a_{SB},\ a_{SC},\ a_{TH})$ for every firm i, market, and time period, and for every possible market structure $(a_{SB},\ a_{SC},\ a_{TH})$. The next step is the estimation of parameters in fixed costs. Suppose that the variables $\varepsilon_{imt}^{(3)}$ are firms' private information shocks that are independent across firms and over time and $\varepsilon_{imt}^{(3)}$ is iid extreme value type 1 with dispersion parameter σ_i. Given beliefs about the entry strategies of the other firms, firm i's best response is:

$$a_{imt} = 1\{\ E\left(VP_{imt}(1, a_{-imt}) \mid x_{mt}\right) - FC_{imt} \geq 0\}$$

x_{mt} is the vector of exogenous market characteristics of market m at period t, including h_{mt}, y_{mt}, w_{mt}, r_{mt}, and the estimated fixed effects $\xi_m^{(1)}$, $\xi_t^{(2)}$, $v_m^{(1)}$, and $v_t^{(2)}$. $E\left(VP_{imt}(1, a_{-imt}) \mid x_{mt}\right)$ is the expected variable profit of firm i if the firm is active in the market and integrated over the unknown private information of the other firms.

(a) Let $P_i(x_{mt})$ be the Conditional Choice Probability (CCP) that represents $\Pr(a_{imt} = 1|x_{mt})$. Show how to represent a Bayesian Nash Equilibrium (BNE) of the entry game as system of 3 equations with the 3 unknowns $P_{SB}(x_{mt})$, $P_{SC}(x_{mt})$, and $P_{TH}(x_{mt})$. Write the functional form of this system of equations.
(b) Explain how to compute a BNE in a market m at period t.
(c) Explain in detail a method to estimate the fixed cost parameters in this model of entry.
(d) Are the parameters $\gamma_i^{(1)}$, $\gamma_i^{(2)}$, and σ_i separately identified? Why/Why not?
(e) Explain why the assumption that $\varepsilon_{imt}^{(3)}$ are independent private information shocks facilitate the identification and estimation of the model.

Question 1.5. (20 points). Counterfactual experiment: Merger. Suppose that you have consistent estimates of all the parameters of the model.

> (a) Explain how to compute firms' profits and consumer surplus for every market-quarter observation in the data.

Suppose that retail chains SC and TH merge to become a single corporation but with two different brands: brand SC and brand TH. Suppose that the brand-specific parameters in demand and costs remain the same after the merger. The only differences between pre-merger and post-merger competition are: (1) the new firm chooses prices of SC and TH to maximize the total variable profits of the company; and (2) the new firm chooses market entry decisions, a_{SC} and a_{TH}, to maximize the total profits of the company.

> (b) Explain in detail the different steps to calculate firms' profits and consumer surplus under this counterfactual post-merger scenario for every market-quarter observation in the data.