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Supplementary Materials for "Non-Exclusive Dealing with Retailer Differentiation and Market Penetration"

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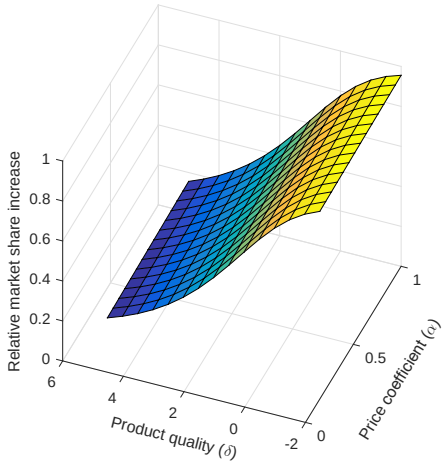
OA Assumptions in the Example with Logit Demand

In this section, we verify that the assumptions on the demand functions in section 3 hold in the logit demand example.

Assumption 1 requires that the market penetration effect exists for both products. Figure OA.1 shows the difference in the demand for product a between the two types of contracts for different values of (α, δ).[27] For each (α, δ), we first compute the exclusive equilibrium, then we use the exclusive equilibrium wholesale prices to compute the corresponding retail prices and demand in the non-exclusive case. The vertical axis shows the ratio $\frac{Q_a^{nn}(w_a^{ee*}, w_b^{ee*}) - Q_a^{ee}(w_a^{ee*}, w_b^{ee*})}{Q_a^{ee}(w_a^{ee*}, w_b^{ee*})}$, which represents the strength of the penetration effect. This ratio is always positive in all the parameter values we consider, which means that Assumption 1 holds. As product quality goes up, this ratio decreases because the market penetration effect weakens. Intuitively, when the quality of both products is high, the outside option share is small, so the non-exclusive contracts do not significantly increase the demand for either product.

Figure OA.1: Differences in Demand between Non-Exclusive and Exclusive Contracts



Assumption 2 requires that the wholesale price demand elasticities are greater under the non-exclusive contracts than under the exclusive contracts at the exclusive equilibrium wholesale prices. For the purpose of demonstration, we fix the price coefficient and product costs.[28] For

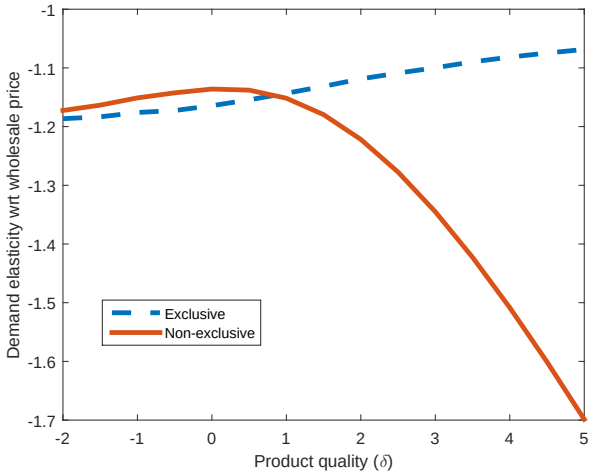
[27] In principle, product cost parameter plays a similar (but opposite) role as product quality. In this exercise, we fix the unit cost of the two products to be $c_a = c_b = 0.4$. The results are robust to the value of the cost parameter.

[28] The price coefficient is $\alpha = 0.45$. The unit cost of the two products is $c_a = c_b = 0.4$.

each δ, we compute the exclusive equilibrium wholesale prices and calculate the demand elasticities at these prices in both types of contracts. Figure OA.2 shows the elasticities in the two types of contracts. The dashed curve shows the elasticities in the exclusive case, and the solid curve shows these in the non-exclusive case. The demand is less elastic under the non-exclusive contracts when product quality is low, but the relationship is reversed when product quality is high. This is because when product quality is low, the total demand is low under the exclusive contracts. In this case, the variety effect and intra-brand competition dominate the internalization effect, and the market penetration effect is strong. As a result, the demand is less elastic in the non-exclusive contracts than the exclusive contracts. When product quality is high, the market penetration effect is weak because the variety effect and the intra-brand competition effect are small, and the internalization effect dominates. In this case, the retailers pass more of the wholesale prices to the retail prices, and the demand becomes more sensitive to the wholesale price than in the exclusive contracts. Therefore, Assumption 2 holds when product quality is low.

Assumption 3 requires a manufacturer's marginal profit to increase with the opponent's wholesale price under the non-exclusive contracts. This assumption holds for all the parameter values in this example.

Figure OA.2: Wholesale Price Demand Elasticities at the Exclusive Equilibrium Wholesale Prices

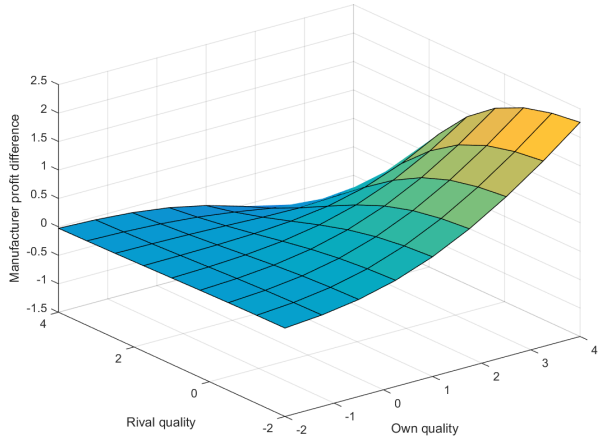


OB Symmetric Contracts with Asymmetric Manufacturers

This appendix section describes the results of asymmetric manufacturers in the logit model in Section 5.2. Specifically, the manufacturers are asymmetric in either the product quality or the product costs. We compare the equilibrium outcome when the manufacturers both choose the non-exclusive contracts to the outcome when they both choose the exclusive contracts.

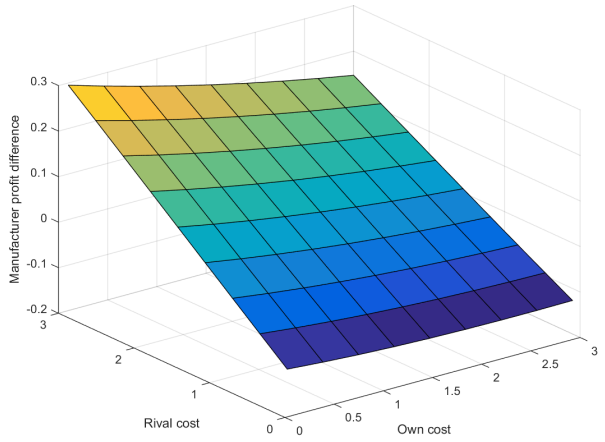
In Figure OB.1, we show the profit differences of a manufacturer between the two types of contracts when the manufacturers have products with different quality. We find that, when one manufacturer's product quality is high and the other's is low, then the manufacturer with a high quality product prefers the non-exclusive contracts because the market penetration effect dominates the inter-brand competition, and the manufacturer with a low quality product prefers the exclusive-contracts because the inter-brand competition reduces its total demand substantitally.

Figure OB.1: Differences in Manufacturers' Profits with Asymmetric Product Quality



In Figure OB.2, we show the differences in manufacturer profits between the two types of contracts when the manufacturers have different product costs. We find that, when a manufacturer has a low cost while the other firm has a high cost, the manufacturer with the low cost prefers the non-exclusive contracts because its lower equilibrium retail price can capture most of the market demand with non-exclusive contracts. The market penetration effect is strong for the low cost product. The manufacturer with the high cost prefers the exclusive contracts because the market penetration effect is weak.

Figure OB.2: Differences in Manufacturers' Profits with Asymmetric Product Costs



OC Equilibrium with Asymmetric Product Quality or Costs

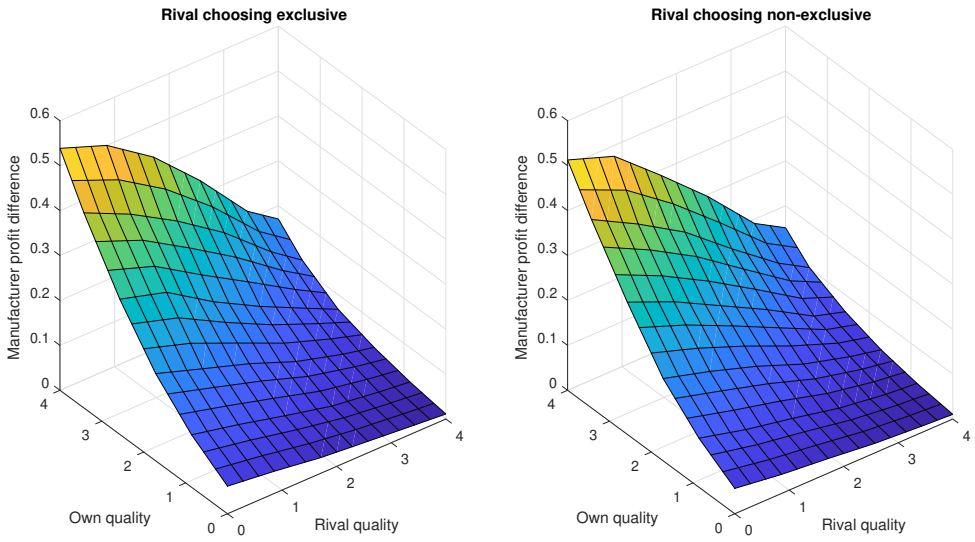
OC.1 Equilibrium with Asymmetric Product Quality

This appendix section describes the results of asymmetric manufacturers in the three stage model as discussed in Section 6.2, where the manufacturers are asymmetric in product quality. In contrast to Section OB, we compare the equilibrium outcomes when the contract choices are endogenously chosen by the manufacturers. In this asymmetric setup, the key parameters are

(δ_a, δ_b). We consider wide ranges of their values.[29] For each combination of (δ_a, δ_b), we solve the three-stage game backward.

The results show that NE is still the dominant strategy. This is again because the variety effect and intra-brand competition effect dominate the disagreement value effect. Figure OC.1 plots the differences in manufacturer A's profits between choosing NE and E for a range of (δ_a, δ_b). The left graph shows the difference when B chooses E, and the right graph is the difference when B chooses NE. Regardless of B's contract choice, A always gets a higher profit by choosing NE. For a fixed δ_b, the difference in A's profits between NE and E increases with δ_a. This is because A's wholesale prices and the equilibrium demand for its product increase with δ_a. For a fixed δ_a, the difference decreases with δ_b because A's wholesale price and the demand for A's product decrease as δ_b increases.

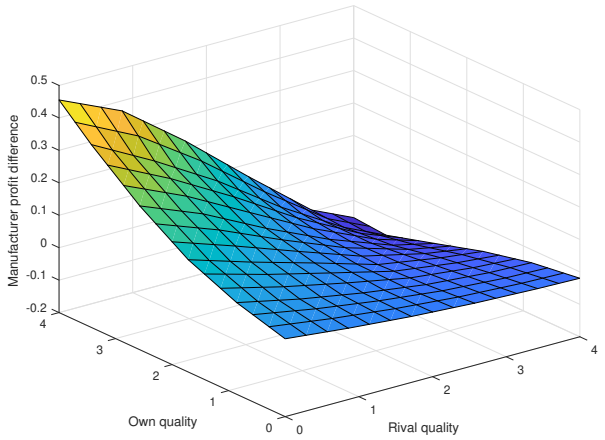
Figure OC.1: Non-Exclusive as a Dominant Strategy: Asymmetric Product Quality



The prisoners' dilemma occurs when both manufacturers have high product quality because the market penetration effect is small when product quality is high. In particular, as a determinant of the market penetration effect, the variety effect is small when both products have high quality. That is, (NE, NE) does not significantly increase the demand for the products when compared with (E, E). Also, the disagreement value effect of the non-exclusive contracts significantly lowers the wholesale prices. Overall, Figure OC.2 shows the differences in manufacturer A's profit between (NE, NE) and (E, E) for different product quality levels. When δ_b is low, the profit difference is positive because B's market share is small under (E, E) and the market penetration effect from choosing NE for A is large. When δ_b is high, the difference is negative because B has a large market share under (E, E) and the market penetration effect for A is small. The same mechanism applies to B as well. Therefore, the prisoners' dilemma occurs when δ_a and δ_b are high.

[29] The range for δ_a and δ_b is 0 to 4. The other parameters are $c_a = c_b = 0$, $\alpha = 1$, and $\rho = 0.5$.

Figure OC.2: Profit Difference between Choosing NE and E: Asymmetric Product Quality



OC.2 Equilibrium with Asymmetric Product Costs

We investigate the equilibrium of the setup with asymmetric costs for the two manufacturers.[30] We find that the non-exclusive contract is still a dominant strategy in all the asymmetric values of c_a and c_b under consideration. Thus, (NE, NE) is always the equilibrium contract outcome. In addition, the prisoners' dilemma occurs if both manufacturers have low costs. In particular, when the costs are low, the non-exclusive contracts strengthen the competition between A and B, and thus increases the intra-brand competition. As a result, the wholesale prices and retail prices are relatively low, and the variety effect of the non-exclusive contracts is small because most consumers would buy the products even under the exclusive contracts. These results are similar to the ones in Section 6.2, when manufacturers have asymmetric product quality. The following two figures reflect the results.

Figure OC.3 shows that NE is the dominant strategy for all (c_a, c_b) in the example. The left graph shows the difference in manufacturer A's profits between choosing NE and E when B chooses E, and the right graph shows the difference when B chooses NE. The difference is always positive, implying that NE is the dominant strategy. The profit difference decreases with A's cost and increases with B's cost. As A's cost goes up, the equilibrium wholesale and retail prices increase, and the variety effect of the non-exclusive contract becomes smaller. As B's cost goes up, the wholesale price and the demand for A's product increases. Thus, the variety effect increases and the difference in A's profit increases, as c_b rises.

[30] The range of the costs are $c_a, c_b \in [0, 0.5]$. We fix other parameters at: $\delta_a = \delta_b = 2.5$, $\alpha = 1$, $\rho = 0.5$.

Figure OC.3: Non-Exclusive as a Dominant Strategy: Asymmetric Product Costs

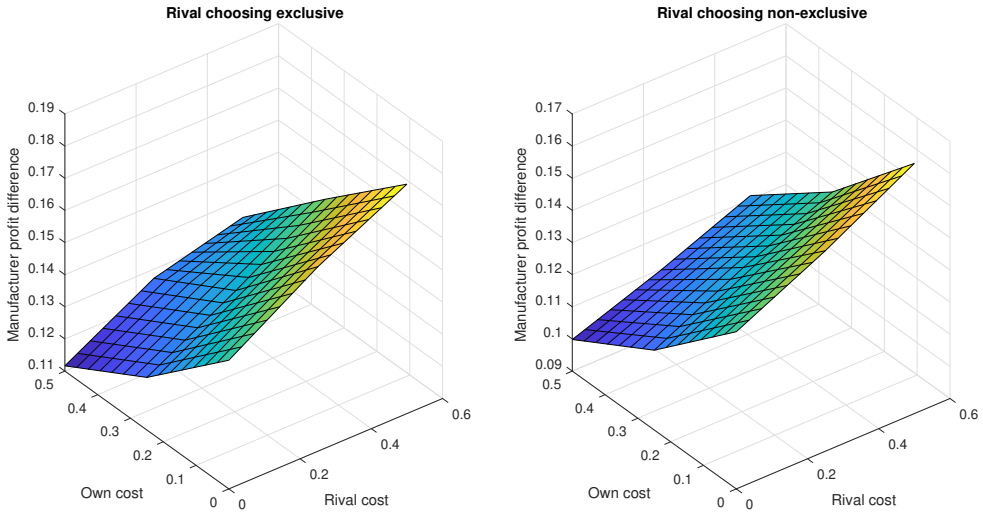
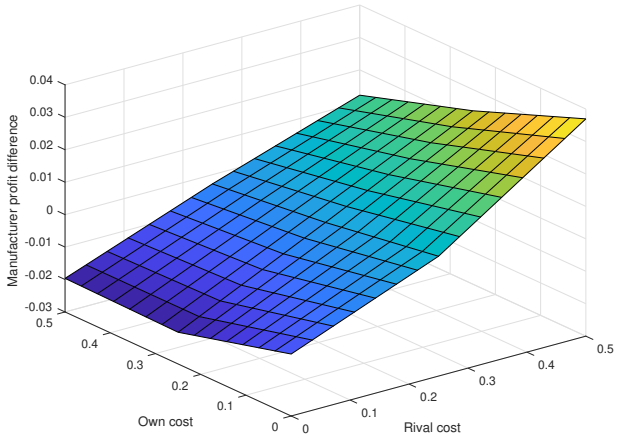


Figure OC.4 shows that A's profit is lower under (NE, NE) than under (E, E) when c_b is small. Similarly, B's profit is lower under (NE, NE) when c_a is small. Thus, when c_a and c_b are both small, A and B get lower profits under (NE, NE), which implies that the prisoners' dilemma occurs. This echoes to the case when (δ_a, δ_b) are large. When c_b is small, B's market share is large under (NE, NE), so the market penetration effect of NE for A is small and A gets lower profits under (NE, NE) than under (E, E). The difference in A's profits decreases with c_a. When c_b is large, B has a small market share under (NE, NE), so the market penetration effect for A is large and A gets more profits under (NE, NE) than (E, E). The difference in A's profits decreases as c_a increases.

Figure OC.4: Profit Difference between Choosing NE and E: Asymmetric Product Costs



In addition, we find that under the (NE, NE) contracts, the manufacturer with the lower cost sets a lower wholesale price than the opponent. The manufacturer's wholesale price increases with the opponent's cost due to strategic complementarity. Under the asymmetric contracts, (NE, E) and (E, NE), the manufacturer that chooses NE charges higher wholesale prices than the opponent, and it also sets a higher price for the retailer who only sells its product, conditional on the

product costs. For example, when A chooses NE and B chooses E, the equilibrium wholesale prices satisfy $w_{ac} > w_{ad} > w_{bd}$. This is because that the manufacturer can internalize the competition effect. Among the four contract combinations, a manufacturer always gets the highest profit when it chooses NE and the opponent chooses E. For example, (NE, E) gives A the highest profit. However, (NE, E) cannot be equilibrium because NE is the dominant strategy.