

**Exercise 4 (Individual, 24 Points Total)**  
**DATE: Tuesday, March 3, 5:30pm**

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### **PRICE WAR!!**

This exercise asks you to consider how the strategic pricing and location decisions of two rival gas station firms might be modeled using game theory under alternative demand scenarios. As will be seen later in the course (in particular Section IV.B), the issues raised in this exercise regarding spatial location, supply offers, network flows, transactions costs, and determination of true reservation values are also relevant for the location of GenCos on a transmission grid subject to congestion.

As depicted in the accompanying  $8 \times 8$  checkerboard graphic, suppose two rival profit-seeking gas stations, G1 and G2, are located along the boundaries of an urban downtown area (inner four squares) surrounded by a suburban residential area (surrounding 60 squares). Due to restrictive zoning laws, G1 and G2 are the ONLY gas stations permitted to locate within the indicated urban/suburban areas.

At the beginning of Day 1, G1 and G2 must post a gas price (\$/gallon) in an attempt to attract customers.

Suppose for simplicity that this price posted by G1 and G2 is restricted to two possible values:

- H=High Price (\$4.00/gallon) or
- L=Low Price (\$3.00/gallon),

and that whatever prices G1 and G2 post on Day 1 must be maintained forever afterwards.

Suppose, also, that gasoline can be stored indefinitely, and that G1 and G2 have identical variable production costs: namely, each gallon of gas they supply to a customer costs them \$1.00.

Finally, assume the daily flow of traffic into the urban downtown area along EACH major access road is 100 vehicles, with 10% in need of gas, and that each gas fill-up is for 10 gallons.

**Part A:[10 Points Total]** Consider the following demand scenario:

**Demand Scenario 1:** The ONLY vehicle traffic flowing into and out of the urban downtown area is along the two major access roads, and ALL vehicle owners in need of gas search for the LOWEST price of gas.

**Part A.1 (3 Points):** Given Demand Scenario 1, develop and justify a plausible daily payoff matrix for G1 and G2 that captures their strategic pricing problem.

**Part A.2 (5 Points):** Carefully analyze and describe the strategic structure of the resulting game. In particular, which price choices for G1 and G2 (if any) are Nash equilibria? Pareto efficient? Pareto dominated? Represent coordination failure? Also, does either G1 or G2 have a dominant price choice?

**Part A.3 (2 Points):** Carefully discuss the ECONOMIC implications of your findings.

**Part B:[10 Points Total]** Consider, instead, the following alternative demand scenario:

**Demand Scenario 2:** The ONLY vehicle traffic flowing into and out of the urban downtown area is along the two major access roads, and ALL vehicle owners in need of gas search for the NEAREST gas station.

**Part B.1 (3 Points):** Given Demand Scenario 2, develop and justify a plausible daily payoff matrix for G1 and G2 that captures their strategic pricing problem.

**Part B.2 (5 Points)** Carefully analyze the strategic structure of the resulting game. In particular, which price choices for G1 and G2 (if any) are Nash equilibria? Pareto efficient? Pareto dominated? Represent coordination failure? Also, does either G1 or G2 have a dominant price strategy?

**Part B.3 (2 Points)** Carefully discuss the ECONOMIC implications of your findings.

**Part C:[4 Points]** Finally, consider instead the following alternative demand scenario:

**Demand Scenario 3:** Vehicle traffic flows into and out of the urban downtown area along the SECONDARY roads as well as along the two major access roads. Vehicle owners in need of gas that enter downtown on SECONDARY roads (“the locals”) always search for a gas station with the LOWEST price, whereas vehicle owners in need of gas that enter downtown on a MAJOR ACCESS road (“the tourists”) always search for a NEAREST gas station.

Given Demand Scenario 3, G1 wants to choose a profitable pricing strategy – indeed, G1 would even be willing to relocate his gas station elsewhere in the urban downtown area or in the suburban residential area if this would ensure a suitably large increase in his profits.

However, G1 is unsure regarding relative traffic flows on secondary versus major access roads, relative demands for gas among locals versus tourists, and the intended pricing/location choices of his rival gas station G2.

To help with his pricing and location decisions, G1 decides to hire a consultant (YOU). He asks you to develop a “test bed” that he can use to explore the profitability of different possible combinations of pricing and location choices for his gas station under different plausible scenarios regarding gas customer search strategies, relative traffic flows, relative demands for gas, AND the pricing/location choices of G2.

Using simple diagrams and verbal descriptions, outline (one typed page max) a possible way that such a test bed might be developed for G1.

Keep in mind here that you are only being asked to outline and discuss how a test bed might be developed that would meet G1’s needs. You are not being asked to actually **develop** such a test bed!

# City Grid for Gas War

