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Imperfect competition with complements and substitutes ☆

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Abstract

I study price competition in settings where end products are combinations of components supplied by different monopolists, nesting standard models of perfect complements and imperfect substitutes. I show sufficient conditions for a discrete-choice demand system to yield demand for each product which is log-concave in price, and has log-increasing differences in own and another product's price, leading to strong comparative statics results. Many results familiar from simple models, like the price effects of mergers or changes in marginal costs, extend naturally to this more complex setting.

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1. Introduction

Much of our intuition for the effects of competition comes from the simple models of Cournot and Bertrand – models featuring just one type of competition, either substitutes or complements. For example, these models tell us that in a world where all products are substitutes, mergers lead to higher prices, while in a world where all products are complements, mergers lead to lower

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prices. Real-world settings, however, often include both complements and substitutes. An important question is whether the insights of these simple models apply in more complex situations.

Consider the following example, a variation on the setting studied empirically by Busse and Keohane [8].[1] A single city is served by three coal mines, each connected to the city by a separate, independently-owned railroad. Buyers in the city have four choices: to buy coal from Mine 1 and pay for transport on Railroad 1; to buy from Mine 2 and Railroad 2; to buy from Mine 3 and Railroad 3; or to do without coal. Coal from the different mines may be delivered to different points in the city and have different characteristics, and buyers have heterogeneous preferences among them, making the three "end products" imperfect substitutes.

In this paper, I consider a model of imperfect competition in prices that captures this type of situation. The products demanded by downstream consumers are non-overlapping sets of necessary elements, each supplied by a different monopolist. I show straightforward sufficient conditions on a discrete choice demand model under which our usual intuitions for complements and substitutes extend: under which a merger between Mine 1 and Railroad 1 would lead to lower equilibrium prices for customers of all three mines, while a merger between two of the railroads would lead to higher prices for everyone.

These results follow from two key properties of the demand system: that the log demand for each product is concave in its own price, and has increasing differences in its own and a competing product's price. I show that these two properties hold in a discrete choice setting if consumer preferences are independent across products and drawn from distributions satisfying a commonly-used regularity condition – log-concavity of both the cumulative distribution function and survival function. (A stronger sufficient condition is for each preference distribution to have a log-concave density function.)

Given log-supermodular demand, in the absence of complementarities – if only the coal mines, without the railroads, were being studied – price competition would be a supermodular game. With complementarities, the game is not supermodular – prices of different components of the same product are strategic substitutes. However, I show that the pricing game has the same equilibrium as a different, and simpler, supermodular game, leading to powerful comparative statics as well as intuition for why they hold.

Aside from settings like the coal example above, the model in this paper can also be seen as a model of retail competition among products containing elements supplied by other firms. We can think of different car companies or personal computer manufacturers: a single firm sets each retail price, but that price implicitly includes the prices of the various parts or components that went into the product – tires and windshields, or microchips and DVD drives, purchased from outside suppliers. The model also fits well with the licensing of intellectual property related to third-generation (3G) wireless communication technologies. 3G is not a single standard, but five different ones, each evolved from (and therefore backward-compatible with) one or more second-generation technologies. Quoting a Department of Justice Business Review Letter [20], "It is reasonably likely that essential patents associated with a single 3G technology... will be complements rather than substitutes... [But] There is a reasonable possibility that the five 3G radio interface technologies will continue to be substitutes for each other, and we would expect the owners of intellectual property rights essential to these technologies to compete, including through price..." These concerns led the DOJ to reject the proposed formation of a single plat-

[1] Busse and Keohane [8] study a single coal mine, serving several towns; there are two railroads, one or both serving each town.