der Bundeswehr
Universität München

Fachgruppe für Volkswirtschaftslehre
Economic Research Group

VOLKSWIRTSCHAFTLICHE DISKUSSIONSBEITRÄGE

WORKING PAPERS IN ECONOMICS

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22. Jg. (2010), Nr. 3

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Herausgeber / Editors

Bis zum Jahr 2008 (20. Jg.) erschien diese Reihe unter dem Titel:
Until 2008 published as:
„Diskussionsbeiträge des Instituts für Volkswirtschaftslehre der Universität der Bundeswehr München“

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Intermediation by Heterogeneous Oligopolists

Karl Morasch

December 2010

Abstract

In his book on "Market Microstructure" Spulber presented some strange results with respect to the impact of the substitutability parameter in an intermediation model with differentiated products and inputs. Intuitively, effects in the product and the input market should be similar: if firms become more homogeneous, they loose market power, which should yield lower bid-ask-spreads and higher output. However, in Spulber's analysis parameter changes in the product market yield qualitatively different results for bid–ask spreads and output than equivalent changes in the input market. The present paper shows that this outcome stems from an inadequate normalization of market size in upstream and downstream markets, respectively. By appropriately controlling for market size effects, intuitive results are obtained. Beyond that, a setting with appropriate normalization also allows to address the impact of changes in the number of competitors on the market outcome.

Keywords: intermediation, oligopoly, product differentiation

JEL–classification: D43, L13

Zusammenfassung

In seinem Buch „Market Microstructure“ analysiert Spulber ein auf den ersten Blick plausibel konstruiertes duopolistisches Intermediationsmodell mit differenzierten Gütern und Inputs. Eine Veränderung des Grades der Substituierbarkeit zwischen den Gütern bzw. zwischen den Inputs hat in diesem Modell jedoch intuitiv nicht nachvollziehbare Auswirkungen. Eigentlich würde man erwarten, dass Änderungen im Güter- und im Inputmarkt hier analoge Effekte haben: Wenn die Heterogenität zurückgeht, sollte sich die Marktmacht der Unternehmen verringern, was wiederum in geringeren Bid–ask–spreads und höherem Absatz resultieren sollte. Tatsächlich führen Parameteränderungen im Gütermarkt aber zu qualitativ anderen Effekten als entsprechende Änderungen im Inputmarkt. Im vorliegenden Papier wird gezeigt, dass dieses Resultat auf der mangelnden Normalisierung der Marktgröße im Downstream- und Upstream-Markt beruht. Wird für Marktgrößeneffekte angemessen kontrolliert, so ergeben sich im Gegensatz zu den Ergebnissen von Spulber intuitiv nachvollziehbare Resultate. Darüber hinaus kann in einer entsprechenden Modellierung auch untersucht werden, wie sich eine steigenden Anzahl von Wettbewerbern auf den Intermediationswettbewerb auswirkt.

Schlagwörter: Intermediation, Oligopol, Produktdifferenzierung

1 Competition and Intermediation - The Intuition

Intermediaries establish and operate markets by buying from producing firms and selling to consumers. A monopolistic intermediary sets its bid and ask prices in a way to maximize profits. It behaves simultaneously as a monopolist in the output market and as a monopsonist in the input market. By equating marginal revenue to marginal expenditures the intermediary determines the optimal quantity q. Bid and ask prices, w and p, are then determined by the resulting prices on the supply and demand schedules, respectively. Figure 1 shows the market diagram with an monopolistic intermediary. Intermediation is a viable option if the intermediation rent as displayed in the figure is high enough to cover the cost of intermediation.

What happens if there are two competing intermediaries? Competition between intermediaries reduces the market power relative to the monopoly setting. Bid–ask spreads should be lower and the quantity of the two intermediaries together should be higher than the quantity of a single intermediary. With homogeneous goods and identical marginal costs of intermediation, both firms would choose a bid–ask spread that equals marginal costs of intermediation. A more realistic setting would introduce some kind of differentiation or switching costs between intermediaries. Considering the case with differentiation, the individual demand and supply schedules of the intermediaries should be flatter (more elastic demand and supply, respectively) than the market demand and supply curves. While customers of a monopolistic intermediary have only the option to refrain from buying or selling the good, respectively, they could now also switch to the competing intermediary. As shown in figure 2, bid–ask spreads are then lower and the total quantity is higher than in the monopoly case.

In his book on "Market Microstructure" Spulber (1999) proposes a model with symmetric product differentiation where only two parameters – one for the demand side and the other for the supply side – determine the intensity of competition. Intuitively one would expect that bid–ask spreads would be reduced and output increased whenever intermedi-

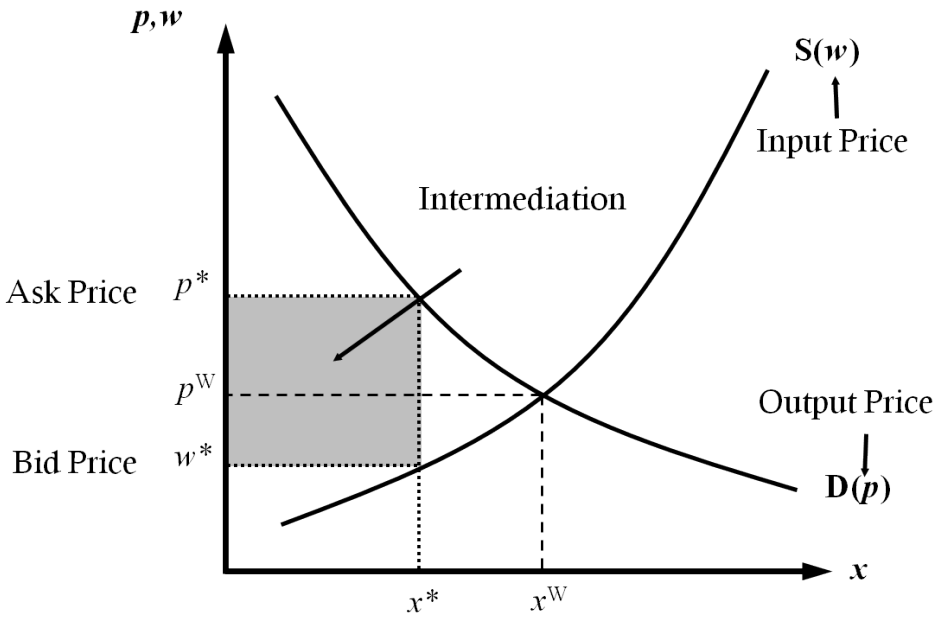

Figure 1: Price setting by a monopolistic intermediary

ation services on either the demand or supply side become closer substitutes. However, in Spulber's analysis bid–ask spreads actually rise if the intermediaries become closer competitors on the demand side. Beyond that, both bid and ask prices rise with closer substitutes on the supply as well as on the demand side. How can these counterintuitive results be explained? In the following it is shown that this is due to not properly controlling for the market size effect of changes in the demand and supply parameters.

2 Spulber's Intermediation Duopoly

Spulber normalized marginal intermediation costs to zero and used the following seemingly sensible specification for demand and supply:

$$q_i = D_i(p_1, p_2) = 1 - p_i + tp_j, \tag{1}$$

$$x_i = S_i(w_1, w_2) = w_i - \tau w_j \tag{2}$$

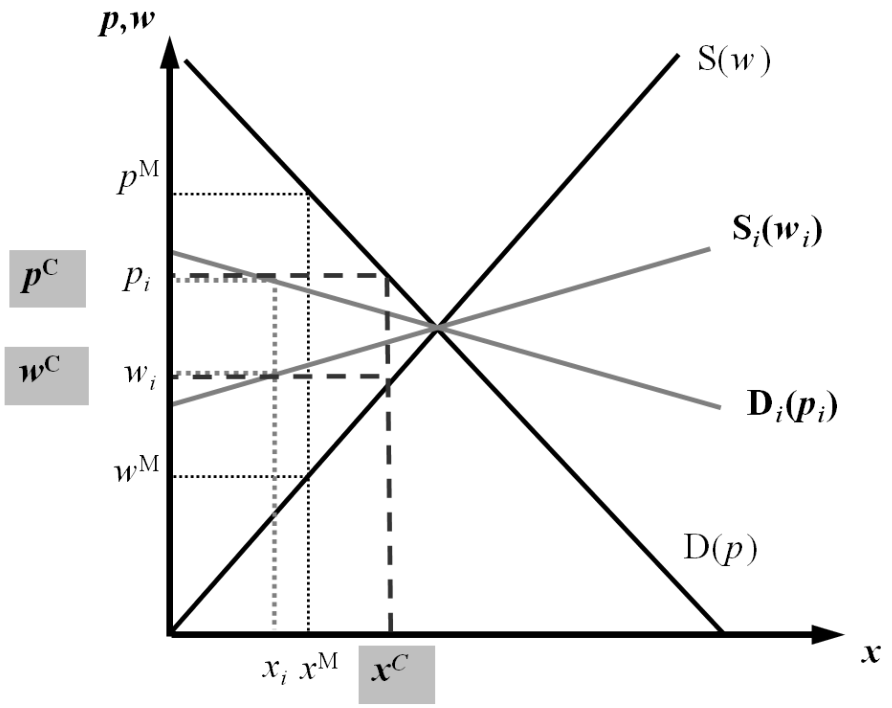

Figure 2: Competing intermediaries with heterogeneous services

with $i, j = 1, 2, i \neq j$, $0 < t < 1$, and $0 < \tau < 1$. If the parameters t and τ, respectively, take values close to zero, we approach independent intermediation services, if they take values close to one, the two services become almost perfect substitutes.

The two firms are assumed to choose output and input prices simultaneously. In an equilibrium $(w_1^*, p_1^*, w_2^*, p_2^*)$ firm 1 chooses prices (p_1^*, w_1^*) that maximize profits

$$\pi_1(w_1, p_1, w_2^*, p_2^*) = p_1 D_1(p_1, p_2^*) - w_1 S_1(w_1, w_2^*) \tag{3}$$

$$\text{such that} \quad S_1(w_1, w_2^*) \geq D_1(p_1, p_2^*) \tag{4}$$

where (p_2^*, w_2^*) indicates the equilibrium prices of firm 2. Due to symmetry firm two's problem is similar.

In equilibrium the stock constraint is binding and we obtain the following prices and the resulting outputs (the index is skipped as prices will be identical in a symmetric

equilibrium):

$$p^* = \frac{3 - 2\tau}{4 - 3(t + \tau) + 2t\tau} \tag{5}$$

$$w^* = \frac{1}{4 - 3(t + \tau) + 2t\tau} \tag{6}$$

$$q^* = \frac{1 - \tau}{4 - 3(t + \tau) + 2t\tau} \tag{7}$$

Looking at the equation for q^* one immediately notices that changes in substitutability in the input market have different impact than similar changes in the output market. Taking a closer look, one observes the peculiar result that all prices rise if intermediation services become closer substitutes in either output or input markets. However, while bid–ask spreads increase with rising t, they decrease when τ becomes larger.

What is the reason for these counterintuitive results? Changes in t and τ affect the degree of substitutability (the point we are interested in), but they also affect market size: For a given value of p_j the demand curve shifts outward by tp_j relative to the monopoly demand curve for $t = 0$ (market size increases). In the same manner the supply curve is shifted inward by a rise in τ (decreasing market size).

3 Proper Normalization With a Love of Variety Approach

As an alternative to Spulber's specification, we propose to start from a system of inverse demand and supply that is properly rooted in a utility maximization and cost minimization problem. To save space we will only explicitly consider the demand side that is based on the love of variety approach of product differentiation pioneered by Spence (1976) and Dixit and Stiglitz (1977). Here the consumption side is given by a representative consumer

with linear-quadratic utility

$$U(q_1, q_2; q_0) = \alpha(q_1 + q_2) - \frac{1}{2}(q_1^2 + q_2^2 + 2bq_1q_2) + q_0 \tag{8}$$

with q_1 and q_2 indicating the specific types of the differentiated good produced by firm 1 or 2, respectively, and q_0 a numeraire good which is assumed to be produced in another sector of the economy and has been added linearly to ensure that the marginal utility of income is equal to one. The parameter α is a measure of market size while b describes the degree of substitutability between the products of the two firms: If the products are perfect substitutes $b = 1$, if they are independent $b = 0$. For the ease of computation and to show the similarity to Spulber's setting, the market size parameter is normalized to $\alpha = 1$.

Given the utility function for $\alpha = 1$, the consumer maximization problem leads to linear inverse demand functions

$$p_i = 1 - q_i - bq_j \quad \text{with} \quad j \neq i. \tag{9}$$

Demand functions expressing quantity demanded as a function of the two prices are necessary to discuss intermediation. Based on the two inverse demand functions straightforward calculations yield

$$D_i(p_1, p_2) = \frac{1}{1 - b^2}[(1 - b) - p_i + bp_j]. \tag{10}$$

Note that this demand function only differs from the one used by Spulber with respect to the multiplicative term $1/(1 - b)$ and the normalized intercept $(1 - b)$. Applying similar reasoning on the supply side, we obtain supply functions

$$S_i(w_1, w_2) = \frac{1}{1 - \beta^2}[w_i - \beta w_j]. \tag{11}$$

The resulting prices and quantities in equilibrium are then given by the following expres-

sions:

$$p^* = \frac{3 - b^2 + \beta(1-\beta)}{4 + b(1-b) + \beta(1-\beta)} \tag{12}$$

$$w^* = \frac{1 + \tau}{4 + b(1-b) + \beta(1-\beta)} \tag{13}$$

$$q^* = \frac{1}{4 + b(1-b) + \beta(1-\beta)} \tag{14}$$

While the numerators for p^* and w^* still differ in a way that it is not immediately obvious that impacts of changes in supply and demand are similar, the formula for the equilibrium quantity q^* is perfectly symmetric. This implies that the same must be true for the bid–ask spread and by subtracting w^* from p^* and simplifying appropriately we actually obtain

$$p^* - w^* = \frac{2 - b^2 - \beta^2}{4 + b(1-b) + \beta(1-\beta)}. \tag{15}$$

Closer inspection shows that the bid–ask spread is indeed reduced whenever intermediary services become closer substitutes on the demand or the supply side.

A sensibly specified model should also behave reasonably at the limits of the parameter space. The Cournot oligopoly for example approaches the solution under perfect competition if the number of firms gets very large. For this reason we check what happens if b and β both simultaneously approach the limiting values of zero and one, respectively.

- For $b, \beta \to 0$ the services become independent and, as should be the case, we obtain the monopolistic intermediary solution for linear demand $D_i(p_i) = 1 - q_i$, namely $p_i^* = 3/4$, $w_i^* = 1,4$ and $q_i^* = 1/4$.

- In a similar manner $b, \beta \to 1$ yields the Walras equilibrium without any intermediary rents, i. e. $p_i^* = w_i^* = 1/2$ and $q_i^* = 1/2$.

4 Conclusion and extensions

While our approach yields reasonable and "well behaved" results, it should be noted, that market size is also changing here (but in a more sensible manner than in Spulber's analysis). Due to the assumption of love of variety the market with independent services is twice as large (two monopoly markets) than the market with homogeneous services (just one market with two firms). Beyond that a larger number of firms than two would also increase the market size in this setting.

There exists another differentiated products model due to Shubik and Levitan (1980) (see also Motta (2004) for applications in oligopoly theory and competition policy). This model is more complicated but still analytically tractable and has the nice property that aggregate demand does neither depend on the degree of substitution among products or services nor on the number of firms. As expected, using this kind of model yields qualitatively similar results with respect to bid–ask spread and quantity in the duopoly setting. Because it is not very reasonable to assume that demand and supply rises with the number of intermediaries, the approach by Shubik and Levitan seems to be preferable for extending the analysis to the oligopoly setting.

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