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Vertical Integration, Collusion Downstream, and Partial Market Foreclosure

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ABSTRACT

This paper proposes a model where an upstream monopolist sells an input to a downstream industry, which may alternatively acquire a perfect substitute for the monopolist's input from a competitive industry. By vertically integrating with a downstream firm, the upstream monopolist may charge a wholesale price above marginal cost, even if the competitive industry is as efficient as the monopolist. This result was not obtained under vertical separation. Furthermore, provided that the number of downstream firms is not too high, the range of values of the discount factor that sustain the monopoly price in the downstream market is enlarged by the introduction of the marked-up wholesale price.

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1 Introduction

This paper studies how vertical integration can allow an upstream monopolist to charge a wholesale price above that of an alternative, equally efficient competitive source. The model considers an infinitely-repeated game where an upstream monopolist posts a wholesale price, and downstream firms decide whether to purchase the input from the upstream firm or from a competitive industry, which supplies a perfect substitute for the monopolist's input at marginal cost. It will be shown that, in the case of vertical separation, the upstream monopolist will not be able to induce downstream firms to purchase at a price above that of the alternative source. However, if the upstream monopolist is vertically integrated with one of the downstream firms, this vertical structure might profitably introduce a wholesale price above marginal cost. Posting a marked-up wholesale price has two effects. On the one hand, it expands the range of values of the discount factor for which the monopoly price in the downstream market is sustainable. On the other hand, input sales will allow the upstream monopolist to extract rents downstream and thus obtain more than proportional profits for values of the discount factor where the monopoly price is sustainable. Vertical integration provides the upstream monopolist with production capabilities that allow it to punish deviating firms, and thus induces them to purchase above the price posted by alternative suppliers.

This paper is related with the literature on market foreclosure, summarized in Rey and Tirole (2003). Hart and Tirole (1990) focuses specifically on the effect on foreclosure of vertical integration. Conversely, Hardt (1995) presents several alternatives to vertical integration to obtain market foreclosure, and Aghion and Bolton (1987) show that contracts can effectively foreclose a potential entrant in the upstream industry. Nocke and White (2004) study the effect of vertical mergers on upstream collusion, considering several models where upstream firms offer two-part tariff contracts to downstream firms, which compete either in quantities or in prices. Similarly, Normann (2004) proposes another model where foreclosure may facilitate collusion. Chemla (2003) considers a single upstream firm, and studies its incentives to integrate vertically as a function of the level of competition among downstream firms. Sandonís and Faulí-Oller (2005) present a model where vertical integration causes partial foreclosure, using two-part tariffs.

This paper is organized as follows: section 2 describes the model employed in the following two sections. Section 3 considers the case of vertical separation, while Section 4 considers vertical integration of the upstream firm with one of the downstream firms. Finally, Section 5 presents some conclusions.

2 The model

Consider a single upstream firm that produces an input that is used by N downstream firms to produce a final good that is sold to consumers. The downstream firms may acquire a perfect substitute for the monopolist's input from a perfectly competitive industry. Both the upstream monopolist and firms in the competitive industry have zero marginal costs. Downstream firms, which compete in quantities, transform the input into the final product on a one-to-one basis. Transformation costs are zero, and thus, downstream firms' marginal costs are just the price at which they purchase the input. Let $p(q)$ be the inverse demand for the final product.

The game has an infinite number of periods, with three stages in each period, similar to those in Nocke and White (2004)[1]. The three stages are:

[1] The 2005 version of Nocke and White (2004) slightly modifies the timing of the game.

1. The upstream firm decides whether to service downstream firms. If it decides to do so, it posts a wholesale price $w > 0$.

2. Each downstream firm decides the amount of input to purchase and whether to acquire it from the upstream monopolist and/or from the competitive industry.

3. Production takes place, downstream firms collect revenues from sales of the final product, and pay for the inputs that they purchased in the previous stage.

The upstream firm observes the amount of input that each downstream firm purchased from it, but not whether downstream firms procure any input from the competitive industry. Downstream firms do not observe other downstream firms' input procurement activities, only their output levels.

In the case of vertical integration, it will be assumed that the vertical structure can make receipts from the sale of the input contingent on its level of output. In particular, it is credible and enforceable that the wholesale price will be w provided that the vertical structure's output does not exceed a given level, and zero otherwise.

Downstream firms may tacitly collude in the production stage. Collusive outcomes will be sustained by reverting to single-period Nash reversion outcomes, as first suggested in Friedman (1971). In the Nash equilibrium, all firms produce the Cournot output at zero marginal cost. This note considers two cases: vertical separation and vertical integration of the upstream monopolist with one of the downstream firms. The next two sections examine these cases in turn.

3 Vertical separation

Suppose initially that all downstream firms purchase the input from the competitive industry at zero price, which becomes their marginal cost of production. Let $q^*(\delta)$ be each firm's production in a symmetric equilibrium where each firm obtains maximum collusive profits given the discount factor, $\pi^*(\delta)$. Let $R\left((N-1)q^*(\delta), 0\right)$ be a deviating firm's reaction to the remaining firms producing $q^*(\delta)$ each, with the deviating firm's marginal cost being zero. This defines deviation profits

$$\pi^D\left((N-1)q^*(\delta), 0\right) = p\left[R\left((N-1)q^*(\delta), 0\right) + (N-1)q^*(\delta)\right] R\left((N-1)q^*(\delta), 0\right) \tag{1}$$

which are decreasing in the rest of the firms' output. Then, $\pi^*(\delta)$ satisfies

$$\pi^*(\delta) = (1-\delta)\pi^D\left((N-1)q^*(\delta), 0\right) + \delta\pi^C(N) \tag{2}$$

where $\pi^C(N)$ is single-period Cournot profits, should all firms produce with zero marginal cost.

If the upstream firm posts a wholesale price $w > 0$, the constraints that must be simultaneously satisfied to induce acceptance by each of the downstream firms and ensure that no firm deviates are :

$$\pi^w \geq \pi^*(\delta) \tag{3}$$

$$\pi^w \geq \pi^D\left((N-1)q^w, 0\right)(1-\delta) + \delta\pi^C(N) \tag{4}$$

where π^w are collusive profits given that every downstream firm purchases from the domestic upstream firm at the wholesale price w, producing q^w each. The optimal single-period deviation implies procuring the input from the competitive source, while the rest of the downstream firms purchase at $w > 0$.

The upstream firm will be unable to post a price $w > 0$ accepted by downstream firms. The reason is that raising rivals' costs increases deviation profits. To see this, fix at $\pi^*(\delta)$ the profit to be sustained using $w > 0$. If marginal costs were zero, each firm would produce $q^*(\delta)$. With marginal cost $w > 0$, they must reduce output to obtain $\pi^*(\delta)$, hence, $q^w < q^*(\delta)$. But this output reduction increases individual profits from procuring the input from the competitive industry, thus violating the incentive constraint. Therefore, the upstream firm will not be able to post a positive wholesale price that is accepted by the downstream firms.

4 Vertical integration

Now consider a situation where the upstream monopolist is vertically integrated with one of the downstream firms. Call this vertically integrated firm vertical structure. This section studies sustainability of the monopoly price p^M by posting a positive wholesale price. Other collusive outcomes with prices lower than p^M could be sustainable, thus enlarging the range of values of δ for which the vertical structure posts a positive wholesale price. In such collusive outcomes, each nonintegrated firm produces α, and the vertical structure produces $q^M - (N-1)\alpha$. It will be shown that the vertical structure will make p^M sustainable for some values of the discount factor $\delta \leq \underline{\delta}(N)$, where $\underline{\delta}(N)$ is the minimum value of the discount factor that sustains p^M, should the N downstream firms produce with zero marginal cost. A crucial assumption is that the vertical structure may make revenues from the sale of its input contingent on its own level of output. In particular, it is assumed that a contract where the vertical structure forfeits input revenues in case of expanding its output is enforceable.

Nash reversion implies that, starting from the period after deviation, every downstream firm makes Cournot profits with zero marginal cost forever. Nonintegrated firms revert to the Nash equilibrium following a deviation in output by any firm. The vertical structure reverts to the Nash equilibrium after deviation by a nonintegrated firm. This deviation may take two forms. First, failure to purchase the input from the vertical structure causes it to expand output in that same period, since the vertical structure observes this rejection before deciding its output level. If the remaining downstream firms produce α each, then, the deviating nonintegrated downstream firm makes duopoly profits taking the production of the $(N-2)$ non-deviating firms as given, and Cournot profits forever starting the period after deviation. Call these duopoly profits $\pi_2\left((N-2)\alpha, 0\right)$.

Second, the deviating nonintegrated firm could procure α units of the input from the upstream monopolist, and some extra amount from the competitive industry, at zero price. Since these additional purchases are not observed, retaliation begins in the period after deviation. Hence, the deviating firm makes profits $\pi^D\left(q^M - \alpha, 0\right) - w\alpha$ in the deviation period, and Cournot profits forever starting the period after deviation. It is not easy to compare profits from the two deviation strategies, since the values of w and α are yet to be determined. Assume for the moment that it is always optimal for a deviating firm to follow the second strategy, so as to avoid its retaliation in the deviation period. If this is the case, then w and α must satisfy nonintegrated firms' incentive constraints, which can be written as:

$$\left(p^M - w\right)\alpha \geq (1-\delta)\left[\pi^D\left(q^M - \alpha, 0\right) - w\alpha\right] + \delta\pi^C(N) \tag{5}$$

which imposes an upper bound on w, namely,

$$w \leq \overline{w}(\alpha) \equiv \frac{1}{\delta\alpha}\left[p^M\alpha - (1-\delta)\pi^D\left(q^M - \alpha, 0\right) - \delta\pi^C(N)\right] \tag{6}$$

It is shown next that it is optimal for the vertical structure no to produce at all, and thus set $\alpha = \frac{q^M}{N-1}$. To see this, take the partial derivative of downstream firms' per period profits with respect to α, computed at $w = \overline{w}(\alpha)$. This yields

$$\frac{\partial \left[(p^M - \overline{w}(\alpha))\alpha\right]}{\partial \alpha} = p^M - \overline{w}(\alpha) - \frac{\partial \overline{w}(\alpha)}{\partial \alpha}\alpha \tag{7}$$

and given the expressions for $\overline{w}(\alpha)$ its partial derivative with respect to α, it can be seen that

$$\frac{\partial \left[(p^M - \overline{w}(\alpha))\alpha\right]}{\partial \alpha} = \frac{1-\delta}{\delta}\left[\frac{\partial \pi^D}{\partial \alpha} - p^M\right] \leq 0 \tag{8}$$

since p^M is an upper bound on the derivative of deviation profits with respect to α. Thus, the vertical structure is best off letting nonintegrated firms produce the whole output, since the vertical structure's profits are monopoly profits minus nonintegrated firms' profits. Hence, for each value of the discount factor, the vertical structure will choose

$$\alpha = \frac{q^M}{N-1}, \quad w = \overline{w}\left(\frac{q^M}{N-1}\right) = \frac{p^M}{\delta} - \frac{N-1}{\delta q^M}\left[(1-\delta)\pi^D\left(\frac{(N-2)}{N-1}q^M, 0\right) + \delta \pi^C(N)\right] \tag{9}$$

if the vertical structure finds it optimal to service nonintegrated firms. The expression for the wholesale price shows that the vertical structure will find it more difficult to profitably introduce a positive wholesale price the larger N. This limits the ability of the vertical structure to extract downstream output by means of input sales.

Given that $\alpha = \frac{q^M}{N-1}$ and $w = \overline{w}\left(\frac{q^M}{N-1}\right)$, nonintegrated firms' optimal deviation will be to purchase $\frac{q^M}{N-1}$ from the vertical structure and procure $R\left(\frac{N-2}{N-1}q^M, 0\right)$ from the competitive suppliers as long as deviation profits following this strategy exceed profits from failing to purchase the input from the vertical structure. This is true as long as

$$\pi^D\left(\frac{(N-2)}{N-1}q^M, 0\right) - \overline{w}\left(\frac{q^M}{N-1}\right)\frac{q^M}{N-1} \geq \pi_2\left((N-2)\alpha, 0\right) \tag{10}$$

Recall that, from nonintegrated firms' incentive constraints,

$$\overline{w}\left(\frac{q^M}{N-1}\right)\frac{q^M}{N-1} = \frac{1-\delta}{\delta}\pi^D\left(\frac{(N-2)}{N-1}q^M, 0\right) - \frac{p^M}{\delta}\frac{q^M}{N-1} + \pi^C(N)$$

and hence, the previous expression can be rewritten as

$$p^M\frac{q^M}{N-1} - \pi^D\left(\frac{(N-2)}{N-1}q^M, 0\right) \geq \delta\left[\pi_2\left((N-2)\alpha, 0\right) + \pi^C(N) - 2\pi^D\left(\frac{(N-2)}{N-1}q^M, 0\right)\right]$$

whose right-hand side decreases in the discount factor. Notice that, for $\delta = 1$, the inequality is always satisfied. In the case of a linear demand, it will be satisfied whenever the vertical structure posts a positive wholesale price.

On the other hand, the vertical structure's incentive constraint must also be satisfied. The vertical structure could deviate by increasing its own output, provided that nonintegrated downstream

firms produce α each. This implies expanding its output to $R\left(q^M, 0\right)$ and making single-period profits $\pi^D\left(q^M, 0\right)$. This defines the vertical structure's incentive constraint as:

$$q^M \overline{w}\left(\frac{q^M}{N-1}\right) \geq (1-\delta)\pi^D\left(q^M, 0\right) + \delta\pi^C(N) \tag{11}$$

Additionally, the vertical structure must be better off posting $w > 0$ than not servicing nonintegrated firms, letting them procure the input from the competitive industry and acting like any other downstream firm in the product market. In this case, the vertical structure would make $\pi^*(\delta)$. Hence, a necessary condition for the vertical structure to post $w > 0$ is

$$\pi^*(\delta) \leq \overline{w}\left(\frac{q^M}{N-1}\right) q^M \tag{12}$$

Thus, combining the vertical structure's constraints determine the range of values of the discount factor for which the monopoly price is sustainable. For these values of the discount factor, the vertical structure introduces a positive wholesale price. For this to occur, δ must be such that

$$\overline{w}\left(\frac{q^M}{N-1}\right) \geq \frac{1}{q^M} \max\left\{\pi^*(\delta), (1-\delta)\pi^D\left(q^M, 0\right) + \delta\pi^C(N)\right\} \tag{13}$$

In the particular case of a linear demand function $p = a - bq$, recall that, given demand, the monopoly output, price and aggregate profits are:

$$q^M = \frac{a}{2b},\ p^M = \frac{a}{2},\ \pi^M = \frac{a^2}{4b}$$

whereas the Cournot outcome with N firms in the industry, in terms of output and profits per firm is:

$$q^C = \frac{a}{b(N+1)},\ \pi^C = \frac{a^2}{b(N+1)^2}$$

With a positive wholesale price, nonintegrated firms' market shares and wholesale price are:

$$\alpha = \frac{a}{2b(N-1)}, \quad w = \overline{w}\left(\frac{a}{2b(N-1)}\right) = a\left[\frac{1}{2\delta} - \frac{(1-\delta)N^2}{8\delta(N-1)} - \frac{2(N-1)}{(N+1)^2}\right]$$

and notice that the wholesale price which goes to minus infinity as N increases. Thus, the success of vertical structure's strategy of introducing a positive wholesale price depends on the number of firms.

Considering deviation profits, first the downstream firm may reject the upstream monopolist's offer. In this case, the vertical structure responds by expanding output in that same period. If the remaining downstream firms produce $\frac{a}{2b(N-1)}$ each, then, both the vertical structure and the deviating nonintegrated downstream firm make

$$\pi_2 = \frac{1}{b}\left(\frac{aN}{6(N-1)}\right)^2$$

which is just duopoly profits with the residual demand that results from substracting non-deviating downstream firms' output $\frac{(N-2)}{N-1}q^M$.

Second, if the deviating nonintegrated firm procures $\frac{a}{2b(N-1)}$ units of the input from the upstream monopolist, and some extra amount from the competitive industry, at zero price, Nash reversion occurs starting the following period. This second strategy will be optimal for the nonintegrated firm as long as

$$\pi^D\left(\frac{(N-2)}{N-1}q^M, 0\right) - \overline{w}\left(\frac{a}{2b(N-1)}\right)\frac{a}{2b(N-1)} \geq \frac{1}{b}\left(\frac{aN}{6(N-1)}\right)^2$$

implying that

$$1 \geq \frac{N^2}{(N-1)}\left(\frac{1}{4} - \frac{7\delta}{18}\right) + \frac{4\delta(N-1)}{(N+1)^2}$$

which holds in all cases where the vertical structure posts a positive wholesale price.

Considering the vertical structure's constraints, it will introduce a positive wholesale price as long as:

$$\overline{w}\left(\frac{a}{2b(N-1)}\right) \geq \frac{2b}{a}\max\left\{\pi^*(\delta), (1-\delta)\frac{a^2}{16b} + \delta\frac{a^2}{b(N+1)^2}\right\}$$

which determines the range of values of δ for which the vertical structure posts $\overline{w}\left(\frac{a}{2b(N-1)}\right)$ and hence the equilibrium price is p^M.

[insert figures 1, 2, and 3 here]

As an illustration, Figures 1 and 2 compare the vertical structure's profits from introducing the optimal wholesale price with the best profits that it would obtain in a collusive equilibrium with zero wholesale price, as a function of the discount factor. In both cases, demand is $p = 1 - q$. Maximum profits with zero wholesale price are $\pi^*(\delta)$ if $\delta \leq \underline{\delta}(N)$, and profits in the best sustainable asymmetric collusive outcome if $\delta > \underline{\delta}(N)$. Figure 1 considers the case $N = 3$ and Figure 2, the case $N = 5$. Figure 3 plots the wholesale price posted by the vertical structure, for $N = 3$ and $N = 5$.

For low values of the discount factor, the vertical structure chooses not to service nonintegrated firms. This is the region in Figures 1 and 2 where the two curves are superposed. For a high enough δ, the vertical structure is better off posting $w > 0$. This occurs for $\delta \geq 0.42$ when $N = 3$ and for $\delta \geq 0.62$ when $N = 5$, as can be observed in Figure 3. Recall that $\underline{\delta}(3) = 0.571$ and $\underline{\delta}(5) = 0.643$, thus in both cases the vertical structure is able to expand the range of values of the discount factor for which p^M is sustainable. However, this interval shrinks with the number of firms. In both figures, for $\delta > \underline{\delta}(N)$, the vertical structure is better off posting $w > 0$ than even in the best asymmetric production profile that sustains p^M, should all firms produce with zero marginal costs. This can be seen by the existence of a gap between the solid and the dotted lines in figures 1 and 2. The vertical structure's production capabilities constitute an effective instrument that allows it to achieve two goals. First, to expand the range of parameter values for which the monopoly price is sustainable, and second, to extract rents from nonintegrated firms by means of sales of input whenever p^M was sustainable under vertical separation.

For example, with $N = 3$, if $\delta = \frac{1}{2} < \underline{\delta}(3)$, $p^M = \frac{1}{2}$ is sustainable if $w = 0.1875$, and each of the nonintegrated firms produces $\alpha = \frac{1}{4}$. Each nonintegrated firm makes 0.078125 per period, whereas the vertical structure makes 0.09375 per period, better than maximum collusive profits $\pi^*(\delta) = 0.08291$. Furthermore, also for $N = 3$, if $\delta = \frac{3}{4} > \underline{\delta}(3)$, the vertical structure would make

at most 0.1041 per period, which is the best asymmetric collusive outcome for the vertical structure, given the discount factor. However, by posting $w = 0.2292$, which is accepted by nonintegrated firms, the vertical structure makes 0.11458 per period. In all cases considered, nonintegrated firms would be better off deviating after purchasing the input from the vertical structure than failing to purchase from the vertical structure at $w > 0$.

Sales of the input at the posted wholesale price are a mechanism to transfer profit from nonintegrated downstream firms to the vertical structure. The fact that the vertical structure is able to be active in the product market provides it with an instrument to discipline nonintegrated firms, allowing it to extract these rents. This instrument did not exist in the case of vertical separation, and this is the reason why the upstream monopolist could not extract rents from downstream firms, since they could always purchase from the competitive industry at zero price.

In this model, the upstream monopolist is able to raise the price of the input above the price of the competitive industry. In this sense, vertical integration generates partial foreclosure. Notice the fact that there is no difference in efficiency between the upstream monopolist and the competitive industry that justifies this difference in wholesale prices.

Finally, although this model considers a linear wholesale price, the same result could be obtained by means of a fixed fee $f = w\frac{q^M}{N-1}$, or by any two-part tariff such that total revenues per firm equal $w\frac{q^M}{N-1}$. Notice that wholesale prices play no role in the determination of downstream firms' output, since in equilibrium, shares are fixed, and should the firm deviate, it would optimally procure some units of the input at zero cost, not at the higher wholesale price w.

5 Conclusions

This paper considers a mechanism by which vertical integration may generate partial market foreclosure in the presence of an alternative, equally efficient competitive source. It is shown that a vertically integrated firm can post a positive wholesale price that is accepted by nonintegrated downstream firms, even if they could purchase the input at zero price. Furthermore, the price in the downstream market is set at the monopoly level, for some realizations of the discount factor where this outcome would not be sustainable if downstream firms procured the input at zero cost. It is shown that the vertical structure is best off letting nonintegrated downstream firms produce the whole output, and thus acting as a supplier for them. The ability of the vertical structure to produce the final product and, thus, to retaliate possible deviations by nonintegrated firms allows the vertical structure to profitably introduce the positive wholesale price and extracts rents by means of input sales. Indeed, this threat makes nonintegrated downstream firms worse off than in the case of vertical separation.

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Figure 1. Case N=3

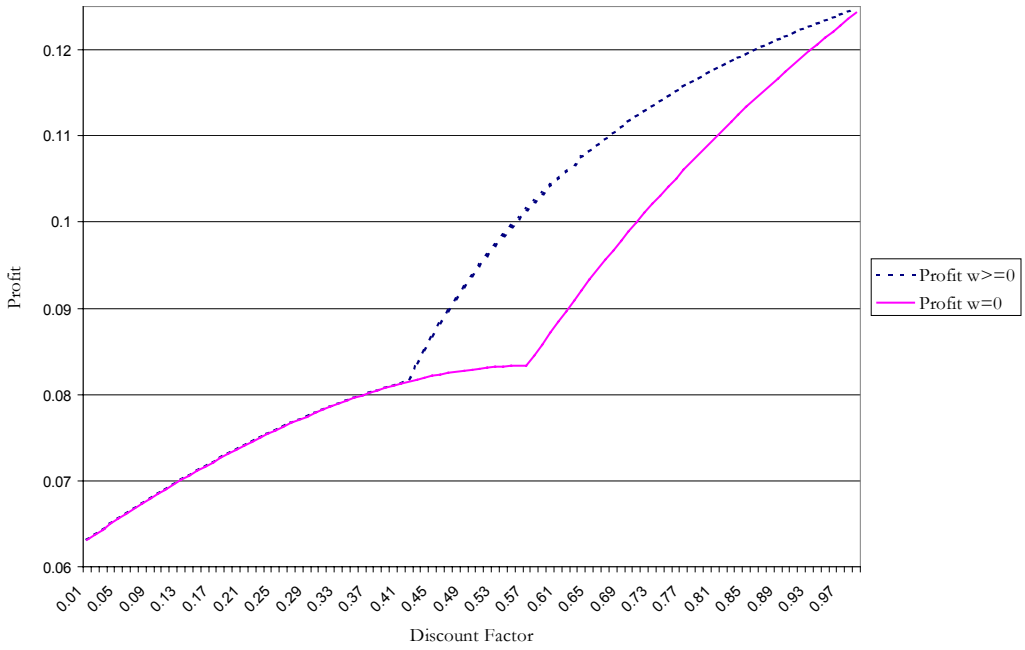

Figure 2. Case N=5

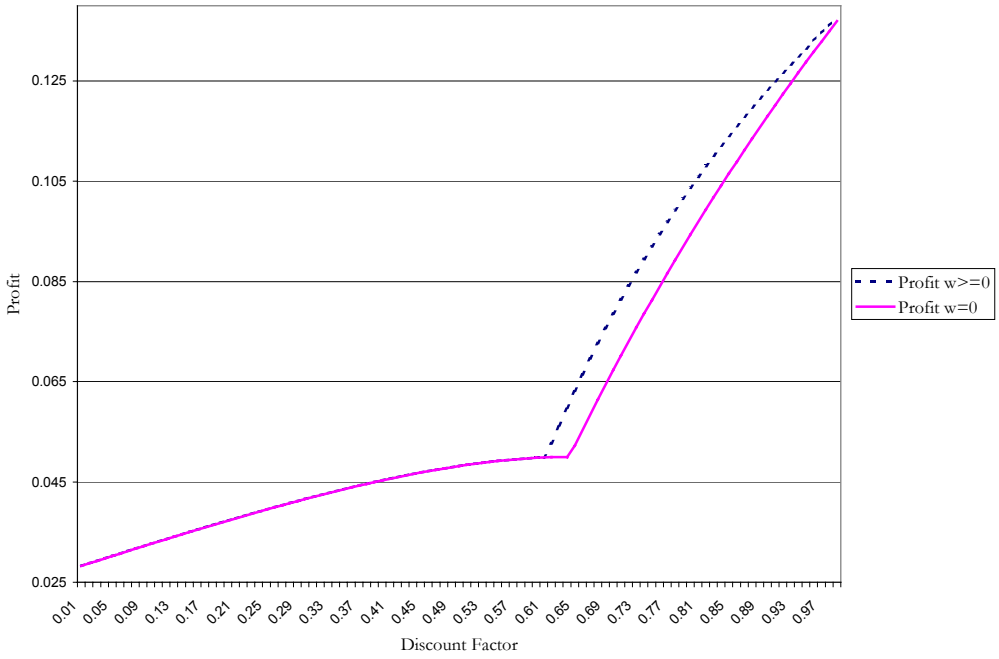

Figure 3. Posted wholesale price