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Output and misallocation effects in monopolistic third-degree price discrimination

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Abstract

This paper shows how the welfare effects of third-degree price discrimination may be decomposed into two effects: a misallocation effect and an output effect. It also presents a geometrical analysis which shows how the welfare properties of third-degree price discrimination must be assessed using nonlinear demands, and hence how linear demands are not suitable for the analysis.

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1 Introduction

Price discrimination under imperfect competition is an important area of economic research both theoretically and empirically.[1] This paper is concerned with third-degree price discrimination, which "is a major item under the rubric *special topics* in any standard neoclassical treatment of monopoly theory" (Battalio and Ekelund, 1972). Despite its importance, however, not much is known about the welfare effects of this type of price discrimination. One of the aspects that is known, for instance, although rarely explicitly showed, is that a move from uniform pricing to third-degree price discrimination generates two effects:[2] first, price discrimination causes a misallocation of goods from high to low value users (that is, output is not efficiently distributed to the highest-value end) and, second, price discrimination affects total output. Therefore, as price discrimination is viewed as an inefficient way of distributing a given quantity of output between different consumers or submarkets, a necessary condition for price discrimination to increase social welfare is that it increases total output.[3] Put differently, in order for price discrimination to increase welfare a positive output effect should offset the negative effect of the distributional inefficiency. As a result a focal point of analysis in the literature has been the analysis of the effects of price discrimination on output.[4] It is known from Pigou (1920) that under linear demands price discrimination does not change output.[5] Therefore, given that the output effect is zero, the case of linear demands, although it presents obvious analytical advantages, is not suitable for decomposing the welfare change into the two effects. In the general non-linear case, however, the effect of price discrimination on output may be either positive or negative.

This paper shows how the effect of third-degree price discrimination on social welfare may easily broken down into the two effects, a misallocation effect and an output effect, for the general case in which a monopolist sells a good in n perfectly separated markets. Further, the paper illustrates the usefulness of this decomposition by using a graphical representation and a numerical example. In particular, it considers one demand structure which even though it was already considered by Robinson (1933) it has been rarely used to explain price discrimination: namely we shall assume that all the strong markets (markets where the optimal discriminatory price exceeds the optimal single price) have concave demands whereas the weak markets (where the optimal discriminatory prices are lower than the single price) have convex demands, with at least one market with strict concavity or convexity. Under these circumstances third-degree price discrimination always increases total output, and therefore the comparison between the misallocation effect and the output effect is more interesting. Further, from an empirical perspective Robinson (1933) considers this case more realistic than the linear case.

[1] See Stole (2007) and Armstrong (2006) for excellent recent theoretical surveys, and Verboven (2006) for a review of recent empirical studies.

[2] Ippolito (1980), Schmalensee (1981) and Layson (1988) study this aspect. This paper generalizes and complements their analysis.

[3] See, for example, Robinson (1933), Schmalensee (1981), Varian (1985), Schwartz (1990) and more recently Bertoletti (2004).

[4] Since Robinson (1933) many papers have addressed this issue, including Edwards (1950), Schmalensee (1981), Shih, Mai and Liu (1988) and Cheung and Wang (1994), among others.

[5] It is assumed that all markets are served under both pricing regimes, uniform pricing and price discrimination.

2 Analysis

Consider a monopolist selling a good in n perfectly separated markets. The demand function in market i $(i = 1, ..., n)$ is given by $D_i(p_i)$, where p_i is the price charged in that market and the inverse demand function is $p_i(q_i)$, where q_i is the quantity sold. Unit cost, c, is assumed to be constant.

Under price discrimination, the optimal policy for the monopolist is given by $(p_i^d - c)/p_i^d = 1/\varepsilon_i(p_i^d)$, $i = 1, ..., n$, where p_i^d denotes the optimal price in market i, and $\varepsilon_i(p_i^d) = -[D_i^{'}(p_i)p_i]/D_i(p_i)$ is the price-elasticity in market i. That is, the Lerner index in each market is inversely proportional to its elasticity of demand and the monopolist, therefore, sets a higher price in the market with the lower elasticity of demand. The quantity sold in market i is q_i^d, $i = 1, ..., n$. The total output under price discrimination is $Q^d = \sum_{i=1}^{n} q_i^d$.

Under unifom pricing, the optimal policy is given by $(p^0 - c)/p^0 = 1/\varepsilon(p^0)$, where p^0 denotes the uniform price and $\varepsilon(p^0)$ is the elasticity of the aggregate demand at p^0. If we let $D(p) = \sum_{i=1}^{n} D_i(p)$ denote the aggregate demand, then this elasticity is simply the weighted average elasticity: $\varepsilon(p^0) = \sum_{i=1}^{n} \alpha_i(p^0)\varepsilon_i(p^0)$, where the elasticity of market i is weighted by the "share" of that market at the optimal uniform price, $\alpha_i(p^0) = D_i(p^0)/\sum_{i=1}^{n} D_i(p^0)$. Let q_i^0 denote the quantity sold in market i, $q_i^0 = D_i(p^0)$ $(i = 1, ..., n)$, and Q^0 denote the total output, $Q^0 = \sum_{i=1}^{n} D_i(p^0)$, under uniform pricing.

A move from uniform pricing to price discrimination generates a welfare change equal to:

$$\Delta W = \sum_{i=1}^{n} \left\{ \int_{q_i^0}^{q_i^d} [p_i(z) - c] \, dz \right\}, \tag{1}$$

that is, the change in welfare is the sum across markets of the cumulative difference between price and marginal cost for each market between the output under single pricing and the output under price discrimination.[6] Two types of markets are distinguished: strong markets and weak markets. The set of strong markets collects markets where the optimal discriminatory price exceeds the optimal single price, that is $S = \{i/p_i^d > p^0\}$, and the set of weak markets consists of those where the optimal discriminatory prices are lower than the single price, $W = \{i/p_i^d < p^0\}$. Therefore the change in welfare in (4) can be expressed as

$$\Delta W = \sum_{s \in S} \left\{ \int_{q_s^0}^{q_s^d} [p_s(z) - c] \, dz \right\} + \sum_{w \in W} \left\{ \int_{q_w^0}^{q_w^d} [p_w(z) - c] \, dz \right\}, \tag{2}$$

where $s \in S$ denotes the representative strong market and $w \in W$ the representative weak markets. As output decreases in each strong market and increases in each weak market, the first term in (2) is the aggregate welfare loss across strong markets, whereas the second term is the aggregate welfare gain across weak markets. It is useful to distinguish a submarket $\underline{w}$ (for example, it might be the market with the highest elasticity demand) from other weak markets, so we can express the change in welfare as:

[6] As is standard in the literature, it is considered the case of quasilinear-utility function, with an aggregate utility function of the form $\sum_{i=1}^{n}[u_i(q_i)+y_i]$, where q_i is the consumption in submarket i and y_i is the amount to be spent on other consumption goods, $i = 1, .., n$. It is assumed that $u_i^{'}(.) > 0$ and $u_i^{''}(.) < 0$, $i = 1, .., n$.

$$\Delta W = \sum_{s\in S}\left\{\int_{q_s^0}^{q_s^d} p_s(z)dz\right\} + \sum_{w\in W-\{\underline{w}\}}\left\{\int_{q_w^0}^{q_w^d} p_w(z)dz\right\}$$
$$+\int_{q_{\underline{w}}^0}^{q_{\underline{w}}^o-\Delta Q_{-\underline{w}}} p_{\underline{w}}(z)dz + \int_{q_{\underline{w}}^0-\Delta Q_{-\underline{w}}}^{q_{\underline{w}}^d} \left[p_{\underline{w}}(z)-c\right]dz, \quad (3)$$

where $\Delta Q_{-\underline{w}} = \sum_{i\neq \underline{w}} \Delta q_i = \sum_{s\in S}\Delta q_s + \sum_{w\in W-\{\underline{w}\}}\Delta q_w$ and $\Delta q_i = q_i^d - q_i^0$, $i = 1,..,n$. It is easy to obtain expression (3) from condition (2) if we take into account that $\int_{q_{\underline{w}}^0}^{q_{\underline{w}}^d} p_{\underline{w}}(z)dz = \int_{q_{\underline{w}}^0}^{q_{\underline{w}}^0-\Delta Q_{-\underline{w}}} p_{\underline{w}}(z)dz + \int_{q_{\underline{w}}^0-\Delta Q_{-\underline{w}}}^{q_{\underline{w}}^d} p_{\underline{w}}(z)dz$ and that the change in total cost is given by $c\Delta Q = c(\Delta q_{\underline{w}} + \Delta Q_{-\underline{w}}) = \int_{q_{\underline{w}}^0-\Delta Q_{-\underline{w}}}^{q_{\underline{w}}^d} cdz$. Without loss of generality, it is assumed that $\Delta Q_{-\underline{w}} < 0$. Note that when output increases with price discrimination it must occur that $\Delta Q = \Delta q_{\underline{w}} + \Delta Q_{-\underline{w}} > 0$. Taking into account that $q_i^d = q_i^0 + \Delta q_i$ and $p_i(q_i) = u_i^{'}(q_i)$, $i = 1,..,n$, the change in social welfare becomes:

$$\Delta W = \sum_{s\in S}\left\{\int_{q_s^0}^{q_s^0+\Delta q_s} u_s^{'}(z)dz\right\} + \sum_{w\in W-\{\underline{w}\}}\left\{\int_{q_w^0}^{q_w^0+\Delta q_w} u_w^{'}(z)dz\right\}$$
$$+\int_{q_{\underline{w}}^0}^{q_{\underline{w}}^0-\Delta Q_{-\underline{w}}} u_{\underline{w}}^{'}(z)dz + \int_{q_{\underline{w}}^0-\Delta Q_{-\underline{w}}}^{q_{\underline{w}}^d} \left[u_{\underline{w}}^{'}(z)-c\right]dz. \quad (4)$$

Given that $\Delta Q_{-\underline{w}} = \Delta Q_s + \Delta Q_{w-\{\underline{w}\}}$ and taking into account that the optimal uniform price satisfies $p^0 = u_s^{'}(q_s^0) = u_w^{'}(q_w^0)$, $s \in S$ and $w \in W$, we can express the change in welfare as:

$$\Delta W = ME + OE, \quad (5)$$

where the misallocation effect, ME, and the output effect, OE, are given by:

$$ME = \sum_{s\in S}\left\{\int_{q_s^o}^{q_s^0+\Delta q_s} \left[u_s^{'}(z)-u_s^{'}(q_s^0)\right]dz\right\} + \sum_{w\in W-\{\underline{w}\}}\left\{\int_{q_w^0}^{q_w^0+\Delta q_w} \left[u_w^{'}(z)-u_w^{'}(q_w^0)\right]dz\right\}$$
$$+\int_{q_{\underline{w}}^0}^{q_{\underline{w}}^0-\Delta Q_{-\underline{w}}} \left[u_{\underline{w}}^{'}(z)dz - u_{\underline{w}}^{'}(q_{\underline{w}}^0)\right]dz,$$

$$OE = \int_{q_{\underline{w}}^0-\Delta Q_{-\underline{w}}}^{q_{\underline{w}}^d} \left[u_{\underline{w}}^{'}(z)-c\right]dz.$$

The misallocation effect, ME, is always negative and represents the welfare loss due to the misallocation of goods from high to low value users. It corresponds with the social loss due to the transfer of $|\Delta Q_s| = \left|\sum_{s\in S}\Delta q_s\right|$ units of production from the strong markets to the weak markets. The two-market case may be lighting up given that the misallocation effect would be $ME = -[u_1(q_1^0) - u_1(q_1^0 - |\Delta q_1|)] + [u_2(q_2^0 + |\Delta q_1|) - u_2(q_2^0)]$ and, therefore, the misallocation effect might be interpreted as the welfare loss due to the transfer of units of production from the strong market (market 1) to the weak market (market 2). The output effect, OE, can be interpreted as the effect of additional output on social welfare. Obviously, if the quantity effect is positive, $\Delta Q = \Delta q_{\underline{w}} + \Delta Q_{-\underline{w}} > 0$, the output effect on social welfare is positive because the social valuation of the increase in output exceeds the marginal social cost. Note that given that the misallocation effect is always negative, a necessary, but of course not sufficient, condition for third-degree price discrimination to increase social welfare is an increase in total output. Note from (5), therefore, that the linear-demand case is not suitable to illustrate the two effects of price discrimination on social welfare, given that the output effect is zero. The following example illustrates how the misallocation effect and the output effect can be differentiated.

Example

Assume that the demand functions are given by $D_1(p_1) = (1 - p_1)^{\frac{1}{2}}$, $D_2(p_2) = (1 - p_2)$ and $D_3(p_3) = (1 - p_3)^2$ and unit cost is $c = 0.1$. Discriminatory prices are $p_1^* = 0.7 > p_2^* = 0.55 > p_3^* = 0.4$ and the uniform price is $p^0 = 0.578$. The strong market, market 1, has strictly concave demand, and there are two weak markets: market 2 has linear demand and market 3 (the most elastic) has strictly convex demand. When all weak markets have strictly convex demands ($D_w'' > 0$) or linear and all the strong markets strictly concave demands ($D_w'' < 0$) then price discrimination increases total output.[7] A move from uniform pricing to price discrimination generates the following changes in output: $\Delta q_1 = -0.101$, $\Delta q_2 = 0.028$, $\Delta q_3 = 0.181$ and $\Delta Q_{-3} = \Delta q_1 + \Delta q_2 = -0.073$. Note that price discrimination increases total output $\Delta Q = \Delta Q_{-3} + \Delta q_3 = 0.108$. The misallocation effect and the output effect are given by $ME = -0.009$ and $OE = 0.037$. Therefore, given that the output effect is greater than the misallocation effect, $OE > |ME|$, price discrimination increases social welfare, $\Delta W = 0.027$.

Figure 1 shows the welfare effect of third-degree price discrimination and its decomposition into the misallocation effect, which is the sum of the red areas, and the output effect, which is represented by the blue area.[8] As in the numerical example, the figure shows a case which the output effect is greater than the misallocation effect.

The decomposition of the change in social welfare into two effects, a misallocation effect and an output effect, depends on the choice of submarket $\underline{w}$ which we have interpreted, for instance, as the market with the highest elasticity demand. We have defined the output effect as the social valuation of an increase in output: therefore, we follow the convention to evaluate the increase in production according to the preferences of the consumers in the more weak market. Other convention would affect the relative importance of the misallocation effect in comparison with the output effect but the change in social welfare would maintain unaltered.

[7] See, for example, Robinson (1933), Edwards (1950), Schmalensee (1981) or Shih, Mai and Liu (1988).

[8] Other interesting geometrical analysis can be found in Robinson (1933), Battalio and Ekelund (1972), Schmalensee (1981) and Layson (1988). This note is more closely related with the geometrical analysis by Ippolito (1980).

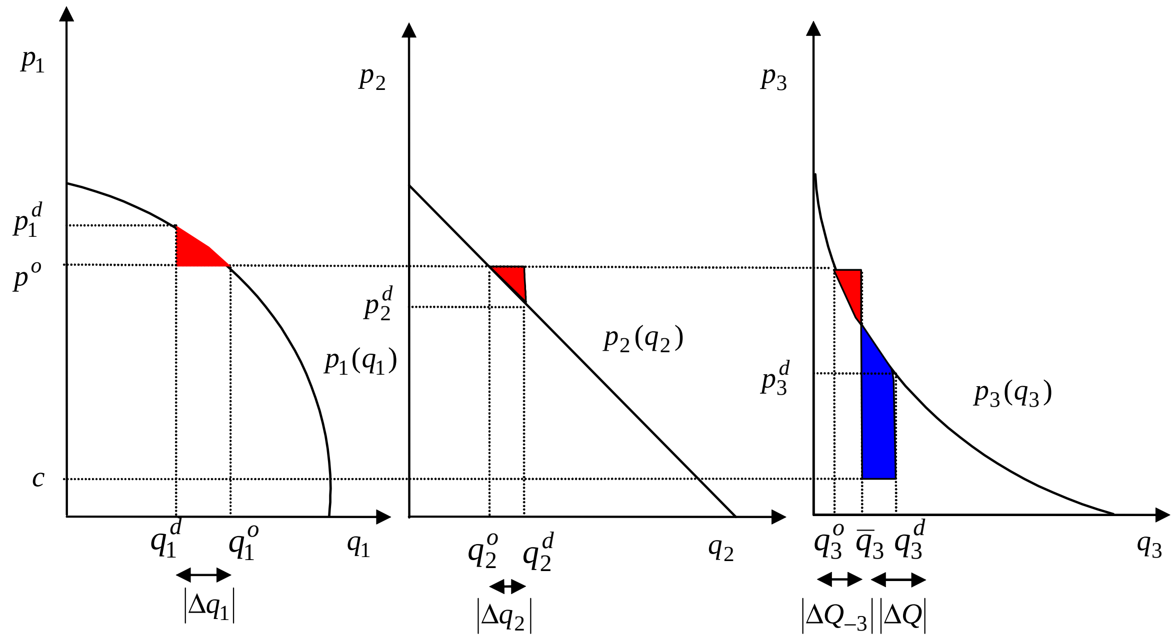

Figure 1. Price discrimination and welfare: output and misallocation effects.

3 Discussion

In this section, we discuss some implications of the above analysis from a theoretical perspective and from an empirical point of view.

3.1 Theoretical considerations

Schmalensee (1981) stated that when the demands of submarkets are all concave or convex then total output, and therefore welfare, may either increase or decrease. Shih *et al.* (1988) and Cheung and Wang (1994) address partially this problem of indeterminacy. Their analysis, however, is far for complete, since they are unable to explain, for example, why under constant elasticity demands third-degree price discrimination always increases total output. Aguirre (2007) shows that when both marklets have strictly concave (convex) demands a sufficient (necessary) condition for price discrimination to increase total output is that the demand of the strong market is more concave than the demand of the weak market. Along this line of research, Cowan (2007) analyzes the welfare effects of third degree price discrimination when demand in one market is a shifted version of demand in the other market. He assumes that demand is $Q = a + bq(p)$ where $a \geq 0$, $b > 0$ and $q(p)$ is the underlying demand function. He shows that the welfare effect of price discrimination is negative if discriminatory welfare, as a function of the shift factor, is concave and that two sufficient conditions for concavity are that the slope of demand is log-concave and the convexity of demand is non-decreasing in the price. Since all demand functions commonly used in models of imperfect competition satisfy one or both of these conditions, and given that the conditions for price discrimination to raise welfare are rather stringent in his model, Cowan (2007) concludes that "the expectation is that discrimination will reduce welfare". Therefore, if demand are affine transformations one to another then it should be expected that third-degree price discrimination yield a welfare loss. Put differently, the output effect (that in the Cowan context may be even negative) does not offset the negative effect of the distributional inefficiency. However, although very interesting, the analysis of Cowan seems restrictive. The following two examples illustrate how the output effect may be positive and potentially dominate the misallocation effect when all markets have strict convex demands or strict concave demands.

A) *Constant elasticity demand curves*

Assume that the demand function in market i $(i = 1, 2)$ is given by $D_i(p_i) = a_i p_i^{-\varepsilon_i}$, where a_i is a positive parameter and $\varepsilon_2 > \varepsilon_1 > 1$ is the elasticity of demand. Third-degree price discrimination always increases total ouput with this kind of demands.[9] This result constrasts with that of Cowan (2007): he obtains the result that when the underlying demand function is iso-elastic output and, therefore, welfare decreases. It should be pointed out that under iso-elastic demands the demand of the strong market is a concave transformation of the demand of the weak market: $D_1(p) = \Psi(D_2(p)) = k(D_2(p))^{\frac{\varepsilon_1}{\varepsilon_2}}$, where $k = a_1(a_2)^{-\frac{\varepsilon_1}{\varepsilon_2}} > 0$, $\Psi^{'} > 0$ and $\Psi^{''} < 0$. Given that the output effect is positive this family of demands is appropriate to analyze the trade-off between output and misallocation effects.

B) *Constant adjusted concavity demand curves*

Shih *et al.* (1988) propose the following class of constant adjusted-concavity demand curves: $p_i = a_i - b_i q_i^{A+1}$ $(i = 1, .., n, A > -1)$, where $q_i \left[p_i^{''}(q_i)/p_i^{'}(q_i)\right] = A$ is the Robinson's adjusted-concavity term. Shih *et al.* (1988) shows that when $A > 0$ (that is, with strictly concave demand curves) price discrimination reduces output. Note that weak markets have more demand concavity than strong markets. It is easy to find examples where this result is reversed. For example, assume that the inverse demand functions are given by $p_1 = 1 - q_1^4$ and $p_1 = 1 - q_1^2$. Note that the demand in submarket 1 is a strictly concave transformation of the demand in submarket: $D_1(p) = \Psi(D_2(p))$, with $\Psi^{'} > 0$ and $\Psi^{''} < 0$. Price discrimination increases total output: $\Delta q_1 = -0.046$, $\Delta q_2 = 0.065$ and $\Delta q = 0.019$.

3.2 Empirical implications

In section 2, we have argued that the case in which all the strong markets have concave demands and the weak markets convex demands, with at least one market with strict concavity or convexity, is more interesting that the linear case. Under these conditions third-degree price discrimination increases total output, and therefore the comparison between the misallocation effect and the output effect is more meaningful. From an empirical perspective Robinson (1933) also considers this case more interesting and more realistic. Of course, the shape of the demands in the different submarkets is entirely an empirical question. Unfortunately, to the best of my knowledge there are no studies in the literature analyzing the relation between price elasticity and curvature of the submarkets demand.[10]

[9] Formby, Layson and Smith (1983), using Lagrange techniques, demonstrated that monopolistic price discrimination increases output over a wide range of constant elasticities. Aguirre (2006) provides a more general and simple proof by using the Bernoulli inequality. Cowan and Vickers (2007) provide an easier proof.

[10] This aspect, however, has been analyzed in some general equilibrium macro models. Recent works introduce a kinked demand curve as a way to obtain real rigidities in order to explain the failure of nominal frictions to generate persistent effects of monetary policy shocks. Dossche *et al.* (2006), for instance, use scanner data from a large euro area supermarket chain in search of empirical evidence on the existence

The analysis of Acquaye and Traxler (2005) provide some empirical evidence on the Robinson's conjecture. They use data from Hubbell *et al.* (2000) to examine the case of potential price discrimination in Bt cotton. Hubbell *et al.* present the Bt cotton demand of cotton growers considering two regions: Upper South (Noth Carolina and South Carolina) and Lower South (Alabama and Georgia) with different levels of insect resistance to pesticides and therefore with two derived demand curves. The total Bt cotton seed demand for the region comprises the Upper South with no resistance experience (US/NR) and the Lower South with some resistence experience (LS/R). Demand for Bt cotton is less elastic when insects are resistant to chemical pesticides. Acquaye and Traxler use the demand curves for US/NR and LS/R from Hubbell *et al.* (2000) and determine the effects of price discrimination on quantities, prices and welfare. They find that price discrimination would result in an increase in total output and welfare.[11] Figure 2 (which is based on the Fig. 1 in Acquaye and Traxler) shows the decomposition of the change in welfare into output and misallocation effects. The initial situation is that under uniform pricing the monopolist states of 32$/acre, selling quantitites a and b in the two markets (with a marginal cost of about $16.88/acre). Following Acquaye and Traxler's computations, under price discrimination the price in the more elastic market (US/NR) would decrease (to point c, about $25.92/acre) and the quantity would increase while the price in the less elastic market (LS/R) would increase (point d, about $33.09/acre) and the quantity would decrease. Price discrimination would then increase welfare because the positive output effect (blue area) would offset the negative effect of the distributional inefficiency (red areas). (See Table 2 in Acquaye and Traxler).

4 Concluding remarks

Understanding the welfare effects of monopolistic third-degree price discrimination is at the heart of much theoretical and empirical research concerning price discrimination under imperfect competition and also an important issue for public policy since policy towards price discrimination should be based on good economic knowledge of markets. This paper shows how the welfare effects of third-degree price discrimination may be decomposed into two effects: a misallocation effect and an output effect. It also presents a geometrical analysis which is valuable to illustrate the advantage of using nonlinear demands, instead of linear demands, in order to understand the welfare properties of third-degree price discrimination.

of the kinked demand curve and on the size of its curvature. Their results are taken to support the introduction of a kinked (concave) demand curve in macro models. Unfortunately, however, their analysis does not provide information concerning the relationship between the elasticity of demand and curvature of strong markets in comparison with weak markets.

[11] Acquaye and Traxler (2005) make an exercise of simulation. In the Bt cotton case, the fact that the innovator (Monsanto) was not price discriminating at the time the data for that study were collected may have been due to the difficulty in preventing arbitrage between markets.

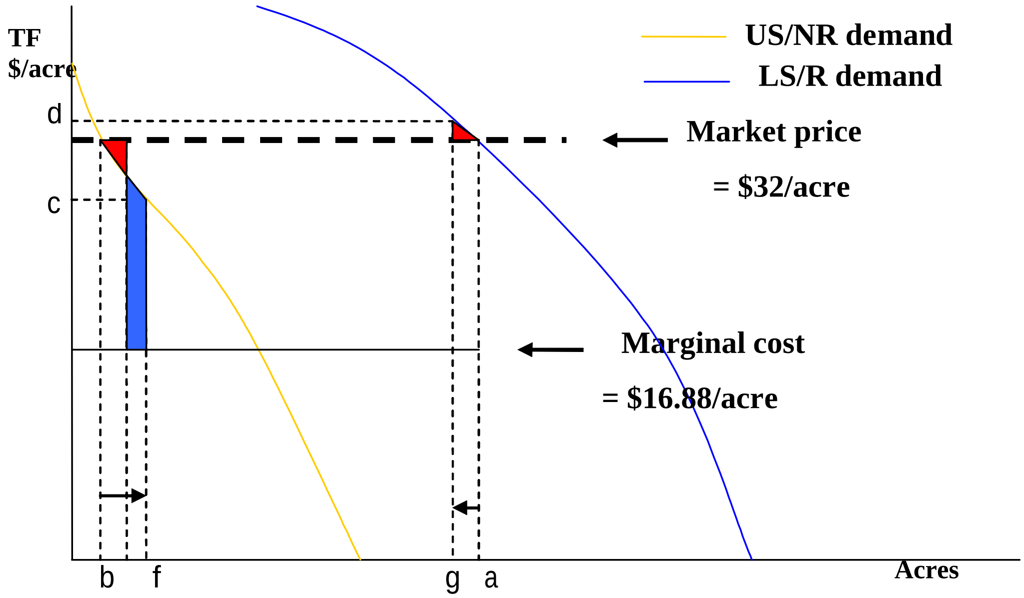

Figure 2. Output and misallocation effects due to price discrimination of Bt cotton seed in Southern US. Note. Based on the graphical analysis by Acquaye and Traxler (2005, Figure 1). (TF: Technology fee $/acre).

5 References

Acquaye, A., and G. Traxler (2005). "Monopoly power, price discrimination, and access to biotechnology". *AgBioForum,* Vol. 8, pp. 127-133.

Aguirre, I. (2006). "Monopolistic price discrimination and output effect under conditions of constant elasticity demand". *Economics Bulletin*, Vol. 4, 1-6.

Aguirre, I. (2007). "Joan Robinson was almost right. Output under third-degree price discrimination", mimeo.

Armstrong, M. (2006). "Recent developments in the economics of price discrimination". Forthcoming in *Advances in Economics and Econometrics: Theory and Applications: Ninth World Congress*, eds. Blundell, Newey and Persson, Cambridge University Press.

Battalio, R.C., and Ekelund, R. B. (1972). "Output change under third degree discrimination". *Southern Economic Journal*, Vol. 39, 285-290.

Bertoletti, P. (2004). "A note on third-degree price discrimination and output". *Journal of Industrial Economics*, v. 52, No. 3, 457; available at the "Journal of Industrial Economics (JIE) Notes and Comments page"http://www.essex.ac.uk/jindec/notes.htm.

Cheung, F. K., and Wang, X. (1994). "Adjusted concavity and the output effect under monopolistic price discrimination". *Southern Economic Journal*, vol. 60, 1048-1054.

Cowan, S. (2007). "The welfare effects of third degree price discrimination with non-linear demand functions". *Rand Journal of Economics*, vol. 38, 419-428.

Cowan, S., and J. Vickers (2007). "Output and welfare effects in the classic monopoly price discrimination problem". Discussion Paper Series, n^o 355, University of Oxford, Department of Economics.

Dossche, M., Heylen, F. and Van den Poel, D. (2006). "The kinked demand curve and price rigidity: evidence from scanner data". Working Paper Universiteit Gent.

Edwards, E. O. (1950). "The analysis of output under discrimination". *Econometrica*, vol. I, 161-172.

Formby, J.P., Layson, S.K. and Smith, W.J. (1983). "Price discrimination, adjusted concavity, and output changes under conditions of constant elasticity". *Economic Journal*, Vol. 93, 892-899.

Hubbell, B.J., Marra, M.C. and Carlson, G.A. (2000). "Estimating the demand for a new technology: Bt cotton and insecticide policies". *American Journal of Agricultural Economics*, Vol. 82, 118-132.

Ippolito, R. A. (1980). "Welfare effects of price discrimination when demand curves are constant elasticity". *Atlantic Economic Journal*, vol. 8, 89-93.

Layson, S.K. (1988). "Third-degree price discrimination, welfare and profits: a geometrical analysis". *American Economic Review*, vol. 78, 1131-1132.

Pigou, A.C. (1920). *The Economics of Welfare*. London: Macmillan.

Robinson, J. (1933) (1969, 2ed.). *The Economics of Imperfect Competition*. London: Macmillan.

Schmalensee, R. (1981). "Output and welfare implications of monopolistic third-degree price discrimination". *American Economic Review*, vol. 71, 242-247.

Schwartz, M. (1990). "Third-degree price discrimination and output: generalizing a welfare result". *American Economic Review*, vol. 80, 1259-1262.

Shih, J., Mai, C. and Liu, J. (1988). "A general analysis of the output effect under third-degree price discrimination". *Economic Journal*, vol. 98, 149-158.

Stole, L. (2007). "Price discrimination in competitive environments", in *Handbook of Industrial Organization: Vol. III*, ed. By M. Armstrong and R. Porter. North-Holland, Amsterdam.

Varian, H.R. (1985). "Price discrimination and social welfare". *American Economic Review*, vol. 75, 870-875.

Verboven, F. (2006). "Price discrimination (empirical studies)". Forthcoming in: *The New Palgrave: a Dictionary in Economics*, MacMillan.