Platforms as arbitrageurs and facilitators of arbitrage- a simple analysis

Michael Waterson[1*]

University of Warwick

March 2023

Preliminary- Do not quote

Abstract

This paper analyses the consumer impacts of arbitrage focusing on the significant role of internet platforms as monopolistic arbitrageurs between essentially competitive sub-markets that have not been previously linked. As arbitrageurs, there is the potential for them to create consumer benefit, but for a series of reasons, we show that consumer welfare may not be enhanced and that particular sections of the community may be disadvantaged by their actions.

Keywords: Arbitrage; Consumer welfare; Platforms; Two-sided markets.

JEL numbers: D51; L81; L86; D47; F11

* Michael.waterson@warwick.ac.uk. I would like to thank Pascal Courty, Lisa Flatley and Herakles Polemarchakis for helpful early discussions on aspects of this topic.

1. Introduction

Developments in the Internet and the growth of major firms such as Google and Facebook have led to a significant 21st century interest in two-sided markets and platform economics. With their development has come a significant economics literature on "two-sided platforms" (e.g.Rochet and Tirole, 2003; Armstrong, 2006; for a review see Jullien et al., 2021), seeking to understand the nature of the markets they and others serve. Taking this as a given, we investigate a neglected aspect of the structural change involved.

Much of the emphasis in the literature on platform economics has been on the question of whether to charge one side or the other for service and also pricing issues more generally. In the present paper, the focus is on arbitrage, a feature of many though not all platforms, that is arbitrage or facilitation of arbitrage between one side of the market and the other by the platform. We treat only the straightforward case where the platform is the arbitrageur and is the sole facilitator or active participant in connecting the sides, with the individuals on each side of the market having no market power. The two sides of the market were, by assumption, separated prior to the entry of the platform. We also work under the assumption that the presence of the arbitrageur does not, at least in the short-run, change the total supply function. The platform transfers or takes inventory from one part of the market and transfers or sells it to the other part, where on average it is higher-valued. We do not explicitly discuss network effects. Thus, whilst our emphasis is on transaction platforms as arbitrageurs, our analysis nevertheless intersects with platform economics, two-sided markets and models of arbitrage more generally.

As Schleifer and Vishny (2012) explain, although the typical textbook definition of arbitrage involves simultaneous sale and purchase at different prices, involving no risk, this is not in practice what happens even in simple cases- they point to an example of sale and purchase of futures contracts on different exchanges, with the purchase being at a lower price at a time t than the sale, both contracts for delivery at time $T>t$. Even in this case, and assuming the contracts are identical, there is some need for capital as deposit and if prices move adversely, the arbitrageur will need to make a greater outlay. An arbitrageur in the form of a platform such as we consider invests in the creation of the platform and acts as agent facilitating and actively encouraging the trade between the two sides, taking a cut of the proceeds, but if for some reason trade is suspended or the platform proves unpopular, the platform stands to make a loss.

A paradigmatic example is Airbnb, whose main business is arbitraging between people who have accommodation available to rent and consumers who wish to rent it short-term. By doing so, they cause some accommodation to be removed from the local longer-term rental market and to be supplied short-term (at a markup) to others for vacation or other purposes. They do not buy the accommodation on their own account, but encourage others to place accommodation and provide pricing and other advice to sellers and buyers, acting as an intermediary.[2] But there are many other examples: eBay sales of second-hand goods such as second-hand model railway equipment, removing it from sale locally to sell to a broad selection of model railway enthusiasts nationally, are an example. Of course, eBay also carries products

[2] During the Covid crisis, of course, trade was suspended in the vast majority of cases.

from merchants at fixed prices. Stubhub (in at least a part of its business) claims to be "fan to fan"- taking inventory of concert tickets from people who have them for sale (however obtained) and selling them to individuals who wish to attend.[3] But Viagogo, a sister site, has been alleged on evidence to engage in speculative trading, selling tickets they do not have and subsequently attempting to purchase them at face value, a risky business.[4] In addition, the sellers on such sites face the risk that the event proves unpopular (and it is possible these sales are on the site's own account), leaving them with useless excess inventory. We consider all these cases as examples of arbitrage by platforms mediating between two sides of a market/ operating in two markets. Other platforms have arbitrage as a major feature of their activity whilst having other business activity. Amazon arbitrages between goods sellers and buyers, by operating as a channel for retailing (as well as operating significantly on its own account); Google also has a similar role, through advertisement placement on its site featuring multiple suppliers.

Sometimes, platforms act to expand the market- Facebook and Twitter are two examples. Whether this expansion is viewed positively is moot, and involves questions that economists are not best-placed to answer within a conventional framework, for example the spread of free speech (positive in principle) which includes amplification of far right and misogynistic views facilitated or even encouraged by the platform. We do not consider this issue.

As a historical note, it is worth pointing out that although the interest of economists in two-sided markets and platform economics is largely a 21st century phenomenon, relating to late 20th and 21st century developments in the internet, arbitrage, platforms and two-sided markets have a much longer heritage. Arbitrage can be traced back to Greek city states (Poitras, 2021) and the first conscious two-sided market and platform can be dated back at least to the first half of the 19th century with Roland Hill's reforms of the Royal Mail in 1840. His two key linked reforms were to charge only the sending side of the market (rather than the mixed system that previously prevailed- Oxley, 1973) and to introduce adhesive stamps meaning posting could be carried out without taking items to an office. Again, a part of the activity enabled was arbitrage between different parts of the UK, meaning that once contact had been established, orders could be made through the postal service.

The paper with the greatest relevance to our current analysis is probably Leslie and Sorensen (2014). They study the primary and (part of) the resale market for a series of 56 rock music concerts in the summer of 2004 in the US, using a nicely nuanced model and a structural empirical framework. They have primary market ticketing data from Ticketmaster and resale market data from StubHub and eBay (then a major source of tickets), but not other resellers. They find, as expected, that gross surplus rises under reasonable assumptions as a result of the operation of the retail market. However, a point we develop later, the distribution of gross surplus is not Pareto-improving. Moreover, again discussed below, there are various sources of waste involved, estimated as amounting to over 1/3 of the gross gain. They point out that many

[3] The individuals with stock for sale may well not be fans; some may be "touts" who have bought inventory early, but the point remains true- the stock of tickets for an event at a particular venue and date is fixed.

[4] See e.g. "Viagogo accused of listing non-existent tickets on behalf of seller linked to firm", *Guardian* article 24/3/2021.

of the features they study apply to resale markets more generally. However, they do not make our general point that many other recent developments in the platform market arena are essentially set up to engage in or facilitate arbitrage. A major difference with our analysis is that they view the set of ultimate consumers all being a part of the same market, where resale is a response to suboptimal pricing in the primary market, whilst we incorporate the idea that arbitrage may join together otherwise separate markets.

Our analysis proceeds largely through a series of simple models, rather than a general framework, with the models being tailored to the particular point in question.

Of course, arbitrage, whether over time or space, dates back well before the Common Era. Grain stores featured in Egypt[5], keeping grain for use later in the year or transferring it from the countryside to cities. The Roman empire depended heavily on trade in grain to supply its capital city. Also, akin to present day activities, there was often an attempt, as with the spice trade through Venice in its heyday, to monopolise that trade (Turner, 2015). But arbitrage in the modern era, facilitated by the internet, has become ubiquitous. Again, there have been substantial attempts to monopolise particular activities, commonly by buying up potentially disruptive start-ups. There are also Google's alleged actions in entering into exclusivity agreements, tying and other arrangements forcing pre-installation and forbidding rival pre-installation (US Department of Justice, 2020) and Apple's behaviour in demanding fees for use of any app, the subject of Spotify and Epic Games (the producers of Fortnite) complaints against them, both of which are being pursued in court actions alleging monopolisation (European Commission, 2020; Epic Games v Apple, 2021). The purpose of this short paper is to examine some competition and distribution effects of this activity.

In economics, arbitrage is commonly treated, for example in textbooks, as a positive, without examination (Mankiw, 2007). Clearly, there are overall financial gains (at least in expectation) or it would not happen, but to whom do these accrue? This paper critically examines the general presumption that arbitrage is good for consumers, starting with the polar case where the seller/ providers and the buyer/receivers, both numerous, are connected through a monopoly arbitrageur (or one with significant market power). In doing so, we also reconsider the nature of what is represented by demand.

Analytically, we take the common case where the platform, whilst having market power itself through its frequency of use, intermediates between essentially competitive sellers and buyers. To give some illustrations, a second-hand book seller lists items on Amazon that a collector might buy; an individual anonymised eBay seller lists items they no longer want in the hope that others may want them; a holiday cottage owner lists their property on Airbnb to attract holidaymakers; a hotel owner lists on Expedia or Booking.com in order to attract custom; and an individual whose plans have changed lists concert or sports tickets they can no longer use on Stubhub for hopeful fans to buy. We treat only the simple case of the small seller and buyer. Thus, by assumption the seller forms part of a supply for the product whilst the buyer forms part of the demand curve. The value provided to them by the platform is of finding a match.

[5] See for example the Wikipedia entry on the Grain Trade.

The platform moves some product from one group and gives it to another, whilst of course taking a margin, even if its ostensible purpose is to facilitate competition (Ronayne, 2021).

In many of these cases, the supply is essentially fixed in the short-term. The second-hand bookseller uses Amazon rather than selling through a bookstore in Hay-on-Wye or another "book town"; the landlord lets her Barcelona property short-term to vacationers through Airbnb rather than a longer-term let to a local; the buyer of tickets for high demand events picks up four tickets on the day they go on sale, selling two later on to other people who want to attend. In other cases, the presence of the platform actively encourages the trade, so someone going on holiday for two weeks decides to let their property during their absence or a search in the attic reveals potentially sellable books; the sports season ticket holder decides it is possible to make money from their ticket for an included event on a day they cannot make. We work initially with the assumption that total supply is fixed, and the arbitrageur reallocates between consumers.

After setting out a simple diagrammatic example of the general framework under which we analyse the issue in section 2, we then examine formally what we dub "marginal arbitrage" in section 3 and in the subsequent four sections illustrate the analysis in terms of differences from the classical framework for arbitrage, which would essentially view the actions of firms in this respect with favour. In contrast we find several reasons to doubt this, concluding as such in section 8.

2. Analysis of arbitrage- the framework

We start by setting out analytically the framework envisaged. Arbitrage can be considered as a mechanism for reducing price discrimination, or differentiation, between groups of consumers; the type of price discrimination considered is third-degree. However, our setting is fundamentally different from the standard setting, where a monopolist, or more generally a firm with market power, supplying both markets, sees opportunities related to there being separate groups with different demand elasticities. Instead, we see the two consumer groups (sub-markets) as separate, but supplied in separate ways, each by firms with little market power (indeed, these "firms" may be individuals in possession of the product concerned). The arbitrage takes place through the medium of a monopolist (for analytic simplicity) who sees the opportunity of moving product from one market where the price is low to another where the price is high.

Suppose an anonymous, costless monopolist sees two separate groups/ markets of equal sizes at their respective prevailing prices, one where demand is relatively low, the other where it is relatively high. Total supply is fixed, but this assumption can easily be relaxed. By moving some product from the former group to the latter, without losses, the agent constrains demand by reducing supply in the low case and adds to supply in the high case, so raising price in the low case, thereby lowering consumer surplus, and reducing price (raising consumer surplus) in the high case. Suppose for the present that the *slope* of the demand curve (not the elasticity) in each case is the same. Then there is an gain in overall consumer surplus, because the absolute change in price is the same for both groups, but the price fall covers a larger number of people with equal-sized initial markets.

Figure 1 illustrates a simple example of arbitrage through a monopoly arbitrageur, as we conceive it. Total supply of the product is fixed at S. There are two separated markets for the product, represented by demand curves D_1 and D_2, with market 2 clearly the higher value one. As drawn, both have equal slopes, but market 1 is the larger (unlike the example in the previous paragraph). Originally, an amount S_1 is allocated to market 1, with the remainder going to market 2. Hence, market 1 has a price of H and market 2 a price of T. The arbitrageur takes $(S_1 - S_1')$ from market 1 and moves it to market 2, meaning that the price rises to E in market 1. This shift of product moves the origin of demand curve D_2 to the left, to make the demand curve D_2'. In turn, price in market 2 falls from T to U. Consumers in market 1 face a loss in consumer surplus measured by trapezoid EFGH, whilst consumers in market 2 have an increase in consumer surplus that can be represented by JKLM.[6] The arbitrageur makes an amount MNRF in transferring product from market 1 to market 2; here we represent the case where arbitrage is complete, in the sense that the market price in market 1, plus the arbitrageur's margin MF (equivalently, UE), equals the market price in market 2, all measured after the move.[7]

Clearly from our earlier point, by redrawing the figure, for example by modifying the market sizes, making market 2 much the larger, the consumer surplus loss EFGH, which in the figure is larger than the consumer surplus gain JKLM, can be made the smaller of the two. Therefore, there is no one answer to the issue of whether such arbitrage benefits consumers as a whole on average (clearly, it benefits the set of consumers plus arbitrageur). What remains true is that consumers at the lower segment of the market are always the losers. Beyond that, several comparative static points are noteworthy. First, the smaller is market 2 relative to market 1, the smaller is the absolute gain in market 2's consumer surplus, and vice versa. Second, as drawn, demand in market 2 is more inelastic at any price (relevant to both markets) than demand in market 1, but the elasticity of the curves will influence the outcome. Third, a point we return to later, if a proportion of the product is wasted or otherwise unused as a result of the transfer, the outcome is tilted away from consumers as a group becoming better off, whilst the opposite happens if the act of arbitrage causes an increase in total supply.

However, measuring in more conventional terms, that is treating sellers (not including the arbitrageur) and all buyers equally, the market as a whole benefits from the act of arbitrage, since the net gain in market 2 is KLW plus JXNM, whereas the net loss in market 1 is only the triangular area FGV. This is an example of the basis on which arbitrage activities are viewed positively, although it is dependent on the functional form for the demand functions, as we note in a later section.

What is missing in this analysis so far is the monopolist arbitrageur's determination of how much product to transfer between markets. To develop this, suppose for the purposes of this

[6] Sellers in market 1 experience a gain in surplus of EFVH, whilst those in market 2 experience a loss of XKWN; our main concern is not with sellers though.

[7] Notice of course that complete arbitrage does not bring prices in the two markets into line, because the arbitrageur is a monopolist, rather than being a costless competitive industry.

example that both demand curves are linear, with inverse demand functions, of potentially unequal slopes,

$p_2 = A_2 - \gamma q_2$
$p_1 = A_1 - \beta q_1$

and define $A \equiv A_2 - A_1 > 0$. Hence, the equivalent of distance XG in figure 1 can be written

$$A - (S - S_1)\gamma + S_1\beta = A - S\gamma + S_1(\gamma + \beta) \quad (1)$$

Call the amount transferred between the markets δ, so that distance $XN = \delta\gamma$ and $RG = \delta\beta$, whence distance *NR* is $A - S\gamma + (S_1 - \delta)(\gamma + \beta)$ from (1). The monopolist arbitrageur's problem can then be written

$$Max_\delta \ \delta[A - S\gamma + (S_1 - \delta)(\gamma + \beta)]$$

Solving, we obtain $\delta^* = \dfrac{A - S\gamma + S_1(\gamma + \beta)}{2(\gamma + \beta)}$ (2)

In terms of comparative statics, an increase in γ reduces optimal δ whilst the effect of an increase in β has indefinite sign.

Notice that if $S_1 = S/2$ and $\beta = \gamma$ then it is easily shown using (1) and (2) that distance *NR* in figure 1 equals $A/2$ whereas distances *XN* and *RG* both equal $A/4$, so the monopolist takes half the margin, as we would expect. We can further verify the statement regarding overall consumer impact made earlier, in the sense that if $\beta = \gamma$ then there is an overall consumer welfare gain assuming $S_1 = S/2$, but if S_1 much exceeds $S/2$, a consumer welfare loss ensues. More generally, of course, this will depend on the demand slopes; there is no reason to expect them to be equal.

3. Conventional arbitrage and variants

We now set out a formal condition that for small changes, the consumer welfare outcome depends on the relationship between elasticities of demand and supply at the relevant prices. The illustration assumes that the two sides of the market are perfectly competitive.

Actually, there are three alternative cases of arbitrage opportunities that are potentially relevant. One is where demand fluctuates over time, as in electricity, another where supply fluctuates over time, as for agricultural products. The third is where suppliers withdraw inventory from the lower market to sell to increase supply in the higher one through a platform. In the first two cases, futures markets exist that can render physical movements at different times simultaneous. We choose to illustrate the proposition using the "electricity" case, but the analytical proposition, suitably modified, applies also in the agricultural product case and the platform case, with these being given as corollaries. If we extend the analysis to consumers in different countries, it can be made to apply additionally in the context of

arbitrage in international trade.

In the electricity case, the arbitrageur takes a position, buying up capacity in the low demand market and placing it on supply in the high demand market. We can think of the owner of a battery store engaging in this.

Consider then figure 2, which illustrates arbitrage having a finite impact on the market, which we modify in formal analysis to an infinitesimal impact in order to use calculus methods. The market supply curve is S.[8] Demand fluctuates over time, for example the demand curve at night is D_L whereas demand in early evening is at D_H. The arbitrageur purchases Δq at night, shifting the demand curve upward to D_L', then adds to supply in early evening by an amount $\theta\Delta q$, where $\theta < 1$ is the round-trip efficiency of the operation (power out to power in). As a result of these operations, consumers are worse off at night by an amount represented in the diagram by the trapezoid LMNR, but are better off in the evening by an amount XWVU. Notice that the former is represented by a move up the supply curve, the latter by a move down the demand curve.

Proposition 1

The impact on consumers of a *marginal arbitrage* in "electricity" is positive if the elasticity of supply at the lower price, corrected for losses, is greater than the absolute elasticity of demand at the higher price.

By marginal arbitrage, we mean an arbitrage activity that is small in size and is just on the margin of being profitable. The proof follows.
For a small change in price, using the notation of the figure, the consumer surplus can be expressed as

$$CS_L = \int_{p_R}^{p_L} D_L(p).dp \quad (3)$$

Therefore, the change in consumer surplus when quantity is reduced by a small amount through the activities of an arbitrageur can be expressed as

$$-\frac{dCS_L}{dq_L} = -D_L(p)\frac{dp_s(q_L)}{dq_L} \quad (4)$$

because the change in price is occasioned by a movement up the supply curve. The small change in quantity taken from the market at q_L is translated into a smaller addition to quantity at the higher price, where the efficiency of the arbitrage process is given by $\theta < 1$.

At the higher price, utilising a similar expression to (3) the change in consumer surplus from the small increase in quantity represented by XWVU can be expressed as

[8] It is common in electricity markets to think of generators in a competitive market providing an upward sloping supply curve although in practice it is not smooth (Von der Fehr and Harbord, 1992).

$$\frac{dCS_H}{d\theta q} = -D(p_H).\frac{dp_D(q_H)}{d\theta q} \quad (5)$$

because the change in price is occasioned by a movement down the demand curve (so (5) is positive).

Rewriting (4), the loss in consumer surplus may be expressed as

$$-\frac{dCS_L}{dq} = -\frac{p_S(q_L)}{\varepsilon_{SL}} \quad (6)$$

where ε_{SL} is the elasticity of supply at the lower price level. Similarly, from (5) the gain in consumer surplus at the upper level in response to the same change in quantity can be expressed as

$$\frac{dCS_H}{dq} = \frac{\theta.p_D(q_H)}{\varepsilon_{DH}} \quad (7)$$

where ε_{DH} is demand elasticity at the higher price level, written as a positive number.

Note that for arbitrage to be profitable, it must be that

$$p(q_H) \geq p(q_L)/\theta \quad (8)$$

Thus for the *marginal arbitrage* that is just profitable, taking the sum of (6) and (7) and utilising (8) written as an equality, total consumer surplus increases as a result of the arbitrage if (7) + (6) > 0, that is, if

$$\frac{\varepsilon_{SL}}{\varepsilon_{DH}} > 1 \quad (9)$$

This demonstrates our proposition for the **electricity** case.

Remark 1: The efficiency of the process does not appear in (9) because there are two equal and opposite impacts. The lower the efficiency, the smaller the amount transferred to the higher-priced market. But at the same time, the lower the efficiency, the greater needs to be the price gap that enables arbitrage to be profitable.

Remark 2: Of course, if the arbitrage is strongly inframarginal, then it is possible for arbitrage of this type to increase consumer surplus even if (9) is violated.

Remark 3: In the electricity context, it is commonly assumed that demand is very inelastic with respect to price, and that the supply curve is relatively elastic at lower levels. Hence, condition (9) is likely to be met. However, this latter assumption may no longer hold as the electricity system moves to increasing amounts of renewable energy supply. The assumption may change if demand management (e.g. through "smart meters") increases.

A very similar analysis can be undertaken for the "agriculture" case. This time the movements are along the demand curve, occasioned by changes in supply. The arbitrageur adds to demand in conditions of high supply and contributes to supply in conditions of low supply. The former action involves a movement along the supply curve, the latter a movement down the demand curve, precisely the opposite of the electricity case. Hence we have the following

Corollary 1:

In the "agriculture" case, consumers as a whole are better off under a marginal arbitrage if

$$\frac{\varepsilon_{DH}}{\varepsilon_{SL}} > 1 \qquad (10)$$

In the platform arbitrageur case treated in the previous section, where the platform does not itself purchase inventory, individual landlords (for example) may decide to withdraw supply from the longer-term rental market to supply to the higher-priced holiday market through a platform. In that case, it is the supply curves that move so the movements are along the demand curves in each case. The condition for consumers as a group to be better off under marginal arbitrage is given in the following corollary.

Corollary 2:

In the "platform arbitrageur" case, consumers are better off under marginal arbitrage if

$$\frac{\varepsilon_{DL}}{\varepsilon_{DH}} > 1 \quad (11)$$

Since demand is likely to be much less elastic in the long-term market (L) than in the short-term market (considering for example the long-term rental market facing residents in a location, versus the short-term holiday market for that particular location), this condition is unlikely to hold for *marginal arbitrage,* so consumers as a whole are likely to be worse off.

Comparing this result at the margin with the special case depicted in figure 1, here we are considering the final, marginally profitable, arbitrage opportunity, not a finite opportunity of arbitrage, when the differences between prices may be substantial. But platforms are likely to move the process closer towards the marginal. Of course, in parallel with the earlier result, the smaller is the higher-priced market, the more elastic is demand there, all other things equal, so the less likely is (11) to hold.

4. Arbitrage under different conditions

As has been known for some time, when demand curves are linear in each of two markets, conventional arbitrage (*not* the type considered above) bringing prices into line and *away* from discrimination increases consumer surplus.[9] This is because total output does not change as between uniform and discriminatory pricing when demand curves are linear (Pigou, 1920), meaning that total welfare does not increase (Schmalensee, 1981), yet profits are higher with discrimination, so consumer surplus must fall with discrimination.

However, there are at least four reasons why even under standard conditions arbitrage may have a negative effect on consumers. The first, discussed below, follows from noting that the result, so easily shown when demands are linear, is not general and the set of counter-cases is non-empty (Cowan, 2012). The second relates to the nature of the different groups of consumers. The third is that the market with higher prices need not be "strong" in the Robinson (1933) sense if information is incomplete, whilst the fourth relates to waste. This paper explores the remainder of these in subsequent sections.

The conditions under which discrimination consumer welfare dominates uniform pricing depend heavily on the nature of demand, as discussed in detail in Cowan (2012) and not repeated here. Generally, it is more likely that consumer surplus is higher with discrimination when demands are convex. For example, "A striking application is that discrimination always increases [consumer] surplus for logit demand functions whose passthrough rates [from cost to price] exceed 0.5 …." (p. 334). We note that he is comparing discrimination with uniform pricing and in our framework, we are comparing discrimination to something less discriminating, but the condition appears monotonic, so the result follows. In addition, our framework is different. Nevertheless, we learn from Cowan's analysis that there are some demand conditions under which the uniform price does not need to be known where we can be confident that the outcome favours discrimination over uniform pricing, implying that a move away from discrimination (before arbitrage activity) reduces consumer surplus in conventional models in addition to ours.

[9] The proposition is usually expressed the other way around, of course.

5. Different groups of consumers

We turn to arguably a more significant issue. The conventional (Pareto) method of evaluating whether consumers are better off as a result of an action is when the gainers can, *in principle*, compensate the losers. In a situation where incomes are equalised across consumers, a rational consumer *A*'s marginal benefit from consuming various goods and services is, in theory, equalised across those goods. Therefore, *A* and another consumer *B* may make different choices of goods, but this reflects their differing tastes. *A* may prefer to attend a football match whilst *B* may prefer to go to the theatre (or may be indifferent between the two), so they spend their money differently. Hence a government initiative to subsidise one at the expense of the other would be a legitimate subject of debate, because it benefits people with one set of tastes at the expense of those with another. The debate would be particularly acute if, contrary to the assumption in this paragraph, the group of people like *B* had on average significantly higher incomes than the group of people like *A*. Such a debate would be unlikely if the action were taken by a (hypothetical) firm operating both the football club and the theatre.

The relevance of this observation to our discussion is the following. Suppose there are two groups of people, one group with many times more income than the other. The arbitrageur takes supply of the service from the poor individual/ group (*A*), so raising prices to them, and increases supply to the rich individual/group (*B*), reducing the prices they need pay. Nevertheless, the rich group still pay markedly more than the poor group, because the arbitrageur takes their margin. If challenged as to the fairness of their action, the arbitrageur may point out that, because they are willing to pay more, group B value the service more highly than group *A*. The counter to this argument is that it says nothing about the *relative* value groups *A* and *B* place on the service. Group *A* may well be willing to spend a higher proportion of their income on the service than group *B* would, so group *A* values the service relatively more highly than does group *B*. Therefore, reducing supply to *A* affects them relatively more negatively compared to the relative positive effect on utility experienced by group *B*. A very simple illustration of this point is provided using a Cobb-Douglas utility function[10]

$$U_i = q_{i1}^{\alpha i}.q_{i2}^{\beta i},\ i = A, B \qquad (12)$$

Thus, suppose of two individuals/ groups, *A* is relatively keen on product 1, meaning that $\alpha_A > 0.5 > \beta_A$, $\alpha + \beta = 1$,whereas *B* is equally keen on both, with $\alpha_B = 0.5 = \beta_B$ and *B* has relatively high income. (Product 2 represents the remainder of the economy.) Then the elasticity of *A*'s utility with respect to good 1, $\frac{\partial U_A}{\partial q_{A1}}.\frac{q_{A1}}{U_A} = \alpha_A$, is greater than the elasticity of *B*'s utility with respect to good 1, 0.5, so that a relative movement of good 1 from individual

[10] This example is not developed earlier in the context of figure 2 because the analysis is less transparent in demonstrating the point. However, (12) is a more useful functional form for the present point.

A to individual *B* has a relatively larger negative effect on person *A* than the positive effect on individual *B*. The result be illustrated also if we work with the respective indirect utility functions in terms of prices (price to *A* rising and to *B* falling) and income coming from (12). Since *B* is presumed to have significantly more income *I* then at a given price, *B* can easily have a significantly greater absolute demand for the product, given demand functions $q_{A1} = \alpha I_A / p_{A1}$ and $q_{B1} = 0.5 I_B / p_{B1}$ respectively, from (12), although *B*'s *proportion* of income spent on good 1 is lower.

A practical example is provided by the concert industry (although there are clearly others). "Touts" buy up tickets for concerts that will be in high demand and sell them later to consumers willing to pay higher prices (assuming demand appears to exceed the seats available at the posted price). But the consumers willing to pay higher prices may be a different set of individuals, not so much interested in the artist but more concerned to impress others, whereas the ardent but relatively poor fan of the act may miss out on a ticket due to the tout's action. Of course, the platform adds a substantial margin to the price the secondary buyer pays.

The general point is that, whilst no arbitrage action is neutral in its effect on some consumers, arbitrage that has the effect of raising prices for poor consumers to the benefit of the rich is likely to have significantly negative effects on relative utility levels across the groups. This is one way to explain the protests and protective actions taken against second homes in many vacation areas and protests against Airbnb in vacation cities such as Barcelona.[11] Another facet of this issue is covered in the next section.

6. Is the market with higher prices comparatively "strong"?

The standard textbook analysis of third-degree price discrimination has price higher in the "strong" market and lower in the "weak" market because demand is more elastic in the weak than the strong market in the Robinson (1933) sense. The relative elasticities provide the opportunity for the arbitraging firm selling into both markets to increase their overall profit by taking advantage of the markets' differences and separation. This assumes all suppliers and consumers have knowledge of the product, but arbitrage is not possible as between the consumer groups occupying the two sub-markets, perhaps because only some consumers can meet the required conditions for the cheaper sub-market. A classic example is prices for old age pensioners versus prices for those who are younger. The latter group cannot easily feign a higher age and, maybe because of higher average income, has a less elastic demand.

Our framework differs from the conventional framework in significant ways. A more restrictive possibility consistent with our framework is that (before the arbitrageur enters) suppliers have limited knowledge of the market as a whole. Some suppliers to the market at lower prices may be unaware that there are consumers who would be willing to pay more. Introduction of the arbitrageur market-making firm (Amazon marketplace, eBay, Airbnb)

[11] https://www.bloomberg.com/news/articles/2021-02-05/barcelona-s-new-plan-to-regulate-vacation-rentals

alerts some of those suppliers to the enhanced opportunities available. Hence, they transfer product previously destined for the weak market to the strong market, mediated by the arbitrageur.

In this case of limited market information, namely the situation that the two groups of suppliers are not aware of the opportunities in the other market, there is no necessary presumption that the weak market has more elastic demand than the strong one. It is simply that the limited information means a price-enhancing move by the seller remains unrecognised until the arbitrageur arrives. Indeed, in the case of the example of utility function (12) employed in the previous section, the two markets have equal elasticities of demand, so neither is the stronger. To see this, note that demand in each case is $q_{i1} = \alpha_i I_i / p_{i1}$ so that demand for good 1 is unit elastic with respect to price in both separated (*A* and *B*) submarkets. Nevertheless, at any given quantity, price can be much higher in one market than the other, so for example can be much higher in market *B* than *A*, due to the significantly higher incomes in *B*. Therefore, the opportunity exists for the arbitrageur profitably to shift product from *A* to *B*. Because demand in both sub-markets is unit elastic here, at any given quantity (for simplicity initially the same in both markets) removing a certain amount of product from market *A* raises price but leaves revenue unchanged in that market, whilst adding that quantity to market *B* lowers price but leaves revenue in market *B* unchanged, but revenue in market *B i*s higher by assumption since $0.5I_B > \alpha_A I_A$. To illustrate, with $0.5I_B = 50, \;\; \alpha I_A = 25$, and both markets initially at 6 units of output, moving one of those units from *A* to *B* leaves a gap between the resulting changed prices that can be captured by the arbitrageur. But this reduces relative utility for those in market *A*, of course.

Moreover, we can easily think of situations (by modification of the numbers in this particular example) where demand in the weak market is in fact quite inelastic, more so than in the strong market, consistent with price being higher in the more elastic market. An example relates to residential accommodation, where demand by citizens for local apartments is relatively inelastic, due to wanting to live near their work, whilst demand at higher prices is relatively elastic, due to holidaymakers not being committed to travelling to a particular location for their vacation.

7. The issue of waste

Arbitrage always has the potential to increase waste. Returning to a historic example of grain arbitrage, transport, storage and trans-shipment inevitably uses up resources and potentially causes losses of the good. Once in the grain store, vermin, water incursion, or fire threaten waste. The trade-off is clear here. Humans are incapable of eating their annual requirements whilst the product is harvested and overwintering on their fat, so some waste is an inevitable aspect of survival in an agrarian economy. In the present day, storing energy by pumping water into reservoirs so that it can be released when more electricity is demanded is similar- the round-trip is much less than 100% efficient, but if people want to be active in the hours of darkness, then inevitably demand will be relatively higher at such times of day. As can easily

be seen from modifications of figure 1, waste in transferring product between the markets militates against there being overall consumer benefits from such transfers, as well as militating against transfers which carry sufficient markups to be profitable. In the case of secondary tickets on platforms, there is at least anecdotal evidence that in the UK up to 50% of tickets posted remain unsold (Waterson, 2016). [12] This issue is exacerbated by the margin the arbitrageur demands, driving price up to a level at which occupation is less intensive, but more profitable. It is simply the monopolist's classic role of restricting price somewhat above marginal cost, so selling a suboptimal quantity.

Leslie and Sorensen (2014) make the additional important point that the fact there is money to be made itself generates wasteful activity in markets such as ticketing, not considered in the formal analysis here. As well as transaction costs (which in this market are high), there is the increased cost of effort in what they term the arrival game. Because there is often a rush to get the best concert seats, touts/ brokers allegedly engage in tactics that aim to tie up the sales website so that they gain inventory at the expense of the primary purchaser, for example by having multiple computers/ agents online at the time of onsale.[13]

Waste in the modern form of arbitrage also takes other subtler forms. One is increased movement of product, across continents in many cases and sometimes involving multiple trips before the product reaches the consumer. Buying product (for example fashion goods) online generates increased product returns, given that the item may not look as good on the purchaser as on the model, or given that the consumer may purchase several similar items intending to return all but one once they have made a decision at home. The apartment put on the holiday rental market is most probably occupied much less intensively by tourists than it would have been by a local tenant.

8. An assessment

Clearly, it does not make sense to condemn all arbitrage as exploitation, as the grain and electricity examples employed earlier imply- the classic case where consumers (by implicit assumption) have equal resources at their disposal or where gainers compensate losers, and the market is complete (i.e. sellers recognise their opportunities to move product) means arbitrage transfers product from those who value it relatively less to those who value it relatively more, so increasing overall consumer surplus, subject to relatively common features of demand function shape. Rather, the point of this short paper is simply to raise a number of factors associated with powerful platforms that should provide cause for thought

[12] Clearly, this aspect depends on the extent to which the stronger market is a fixed-price market. If the possibility exists to flex the price in this market, then the arbitrageur, recognising there is no sale once the date is passed, could tailor prices to demand in the strong market more precisely. An example might be the ticket tout who does not want to be left with unsold tickets once the event has started, so some subtlety is required in quoting prices to would-be attendees, something that is perhaps easier in the surroundings of the venue than on the internet. However, this scenario is somewhat outside our model.

[13] This is discussed in Waterson (2016)- Leslie and Sorensen refer to telephone sales amongst others, which was relevant at the time of their sample but not now.

as to whether their particular arbitrage activities are, as a superficial analysis might presume, a positive feature of modern life, or whether they reduce consumer welfare and, in particular, the welfare of certain groups of consumers. These include the degree to which arbitrage takes place (up to the point of marginal arbitrage?), the potential for consumers as a group to be harmed by this activity, the specific point that the losers may be rendered relatively worse off in terms of their utility as a result, and the issue of wasteful arbitrage. This makes it possible analytically to understand concerns about these arbitrage activities and, potentially, to evaluate the circumstances under which the arbitrage actions of powerful intermediaries are most likely to be harmful.

References

Armstrong, M. (2006), Competition in two-sided markets, *Rand Journal of Economics* 37(3), 668-691.

Cowan, S. (2012), Third degree price discrimination and consumer surplus. *Journal of Industrial Economics* 60, 333-345.

(US) Department of Justice (2020), Justice department sues monopolist Google for violating antitrust laws. DOJ Office of Public Affairs News, Washington DC.

Epic Games Inc. v Apple Inc. (2021), United States District Court for the Northern District of California, commencing May 3.

European Commission (2020), Antitrust: Commission opens investigation into Apple practices regarding Apple Pay. Brussels, Press release, 16 June.

Jullien, B., Pavan, A. and Rysman, M. (2021), Two-sided markets, pricing, and network effects. Working paper 1238, Toulouse School of Economics.

Leslie, P. and Sorensen, A. (2014), Resale and rent-seeking: An application to ticket markets. *Review of Economic Studies* 81(1), 266-300.

Mankiw, G. (2007), *Principles of Microeconomics* (4th ed.). South-western.

Oxley. G.F. (1973), The English provincial local posts 1765-1840. Postal History Society, Perth, Scotland.

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

Poitras, G. (2021), Origins of arbitrage. *Financial History Review* 28(1), 96-123.

Robinson, J. (1933), *The Economics of Imperfect Competition*, Macmillan, London.

Rochet, J-C. and Tirole, J. (2003) "Platform Competition in Two-Sided Markets", *Journal of the European Economic Association* 1(4), 990–1029.

Ronayne, D. (2021), Price comparison websites. *International Economic Review*, 62 (3), 1081-1110.

Schleifer, A. and Vishny, R.W. (2012), The limits of arbitrage. *Journal of Finance* 52(1), 35-55.

Schmalensee, R. (1981), Output and welfare implications of monopolistic third-degree price discrimination. *American Economic Review* 71(1), 242-247.

Turner, J. (2015), The spice that build Venice. *Smithsonian Journals Quarterly* 2, November.

Von der Fehr, N.H. and Harbord, D. (1993), Spot market competition in the UK electricity industry. *Economic Journal* 103(418), 531-546.

Waterson, M. (2016), *Independent review of consumer protection measures concerning online secondary ticketing facilities*. London, HMSO.

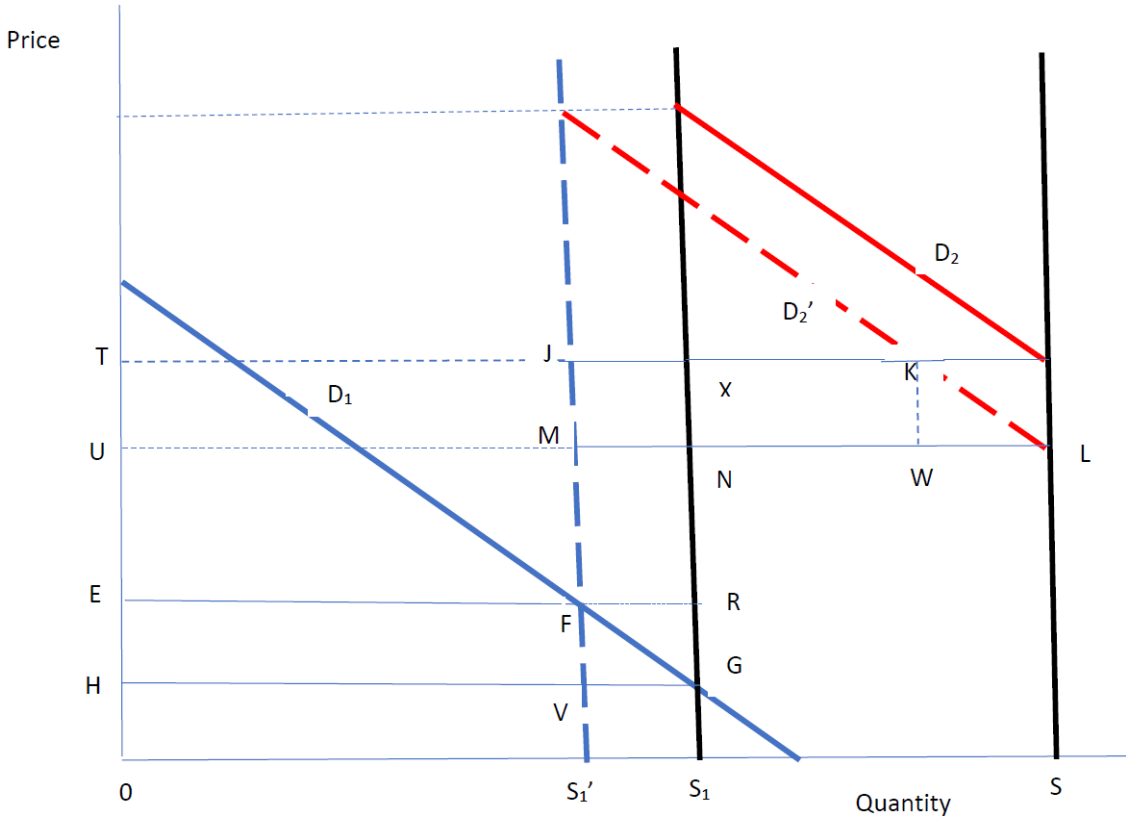

Figure 1: Illustrating the effects of profitable arbitrage opportunity for a monopolist moving output between two different markets.

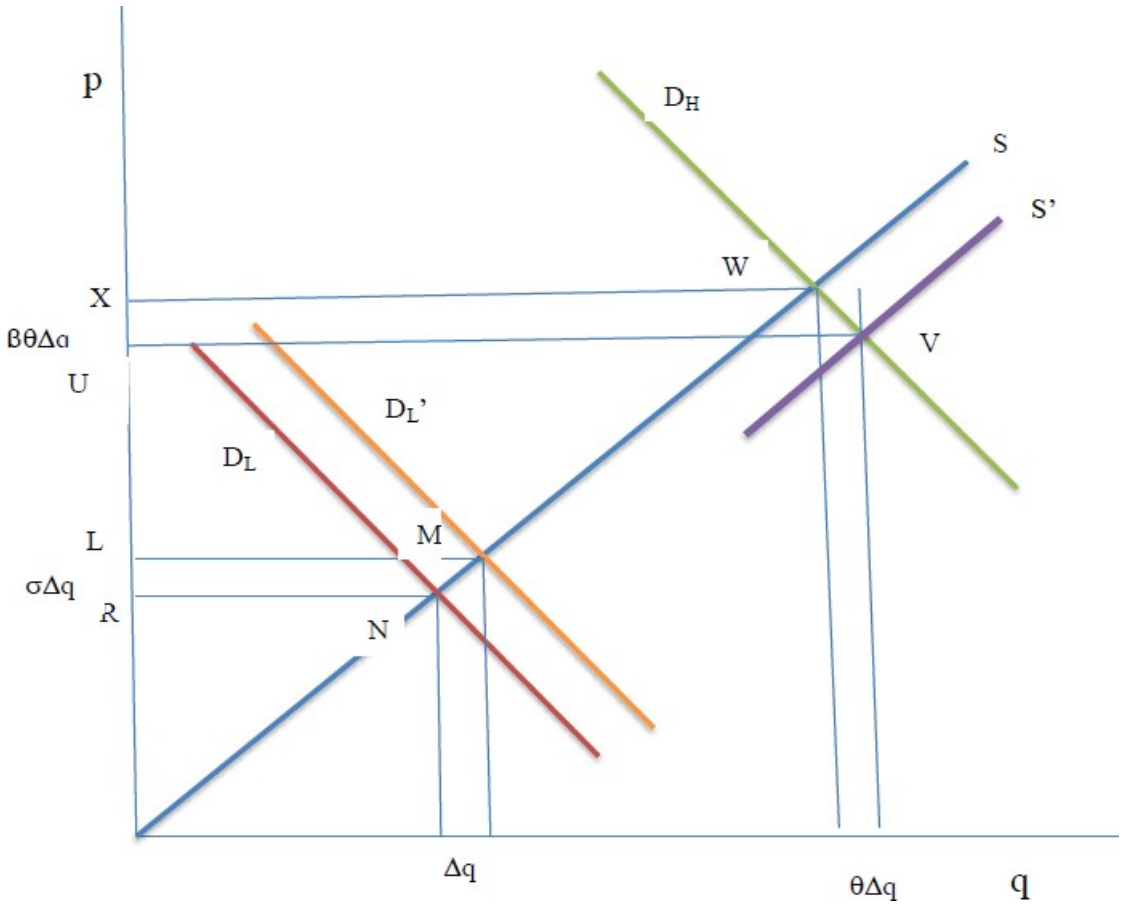

Figure 2: Finite arbitrage in the electricity case