Market frictions: A unified model of search and switching costs

Chris M Wilson

Loughborough University

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Chris M. Wilson

Loughborough University*

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Abstract

It is well known that search costs and switching costs can create market power by constraining the ability of consumers to change suppliers. While previous research has examined each cost in isolation, this paper demonstrates the benefits of examining the two types of friction in unison. The paper shows how subtle distinctions between the two costs can provide important differences in their effects upon consumer behaviour, competition and welfare. In addition, the paper also illustrates a simple empirical methodology for estimating measures of both costs while demonstrating the potential bias that can arise in approaches that consider only one cost.

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1 Introduction

As recognised by the 2010 Nobel prize, the study of market frictions has generated rich insights in many areas of economics, especially macroeconomics, labour economics and monetary theory.[1] In industrial organisation, analysis has focussed on understanding how market frictions can create a source of market power by restricting consumers' ability to change suppliers. Two different forms of friction have been studied. One literature has considered the search costs that consumers face in gathering information about alternative suppliers, while another literature has focussed on the switching costs that consumers may incur as a direct result of changing suppliers, perhaps due to additional effort, lost compatibility or lost loyalty discounts.[2] It is surprising that these two literatures have remained largely independent of each other. As a consequence, very little is known about the potential differences or interactions between the two forms of friction. This is an important omission because in many markets, consumers are often constrained by *both* search costs and switching costs. For example, in order to change suppliers in a market for a financial product or utility, consumers may have to first spend time searching for information about an alternative, before then incurring switching costs by completing the necessary forms and paperwork. Indeed, the importance of considering both forms of friction within the same market is highlighted by a number of competition policy investigations, not least in the banking sector, where the UK and EU authorities remain concerned over both the transparency of price information and difficulties within the switching process (OFT 2009, EC 2009)[3].

In contrast to the existing literature, this paper demonstrates the benefits of examining the effects of search costs and switching costs in unison. It makes two contributions. The main contribution consists of the construction of an oligopoly model where consumers can be constrained by both forms of friction. The model shows how subtle distinctions between the two costs can provide important differences in their effects on consumer behaviour, competition and welfare. Indeed, in many, but not all cases, the levels of competition and

[1] For more see `http://nobelprize.org/nobel_prizes/economics/laureates/`.

[2] Waterson (2003) offers a useful overview. For more detailed reviews see Baye et al (2006) on search costs and Klemperer (1995) or Farrell and Klemperer (2007) on switching costs.

[3] Related issues have also occurred in the UK mobile phone market where the regulator has recently introduced legislation to improve the switching process by requiring providers to port switching consumers' phone numbers to their new provider within one working day (in line with similar moves by the EU and US), while at the same time expressing concerns over the accessibility of price information (OFCOM 2010). Other UK cases where both search and switching costs have been an important issue include the investigations into extended warranties, storecards and payment protection insurance.

welfare are shown to be more sensitive to the level of search costs rather than the level of switching costs. In relation to the concerns over European bank markets or indeed any other market, this finding suggests that competition authorities may prefer to focus their resources on improving consumers' information by reducing search costs rather than on the regulation of switching costs.

As a secondary contribution, the paper then uses some results from the theoretical model to offer a simple empirical methodology for simultaneously estimating measures of both costs. The method is very practical as it is quick to use and only requires some aggregate survey data. In contrast to most of the previous literature that attempts to estimate only one of the costs (as reviewed in the next section), our methodology emphasises the potential importance of accounting for both frictions. Indeed, by attributing any market imperfection to only one cost, we demonstrate that a 'single-cost' methodology can exhibit an upward bias.

The theoretical model is presented in Section 4. While it is customary to think of switching costs in a dynamic setting, we argue that research has yet to fully understand the static effects of market frictions. Hence, we focus on presenting a static model of a mature oligopoly market where each consumer already faces costs of searching and/or switching away from their existing supplier. However, we later argue that the introduction of dynamic effects is only likely to strengthen the results. Within the model, consumers view each firm's product as differentiated (*à* la Perloff and Salop, 1985). By paying a search cost, c, a consumer can learn her willingness to pay for an alternative firm's product and the firm's price. The consumer can search any number of alternative firms sequentially at a cost of c each time. After having chosen to stop searching, the consumer must then decide whether to remain with her existing supplier or, for an extra switching cost, s, trade with a previously-searched alternative firm. Section 5 presents the equilibrium of a game where firms simultaneously select prices and consumers select their search and switching strategies. The equilibrium generalises the results of some standard models that consider only one cost, such as Wolinsky (1986) and Anderson and Renault (1999).[4]

[4]The use of a framework with product differentiation prompts the existence of a pure-strategy price equilibrium and contrasts to the more traditional search models of price dispersion (e.g. Stahl 1989). Although similar results can also be produced in a price dispersion model, we later show how the chosen framework is more suited to examining the effects of the two costs by providing a fuller analysis of consumer behaviour. Related frameworks are being used increasingly to study other issues including prominence (Armstrong et al, 2009) and advertising (Haan and Moraga-González, 2009).

Section 6 examines some comparative statics. First, we compare how the two costs affect the equilibrium price. While a unit increase in either cost raises the equilibrium price, the paper shows that the underlying mechanisms differ substantially. A rise in search costs deters consumers from starting to search beyond their existing firm and prompts searching consumers to search fewer firms. A rise in switching costs also deters consumers from initiating any search activity, but has no effect on the number of firms that searching consumers choose to search. Instead, a rise in switching costs encourages consumers that have searched the entire market to remain loyal to their existing firm. These mechanisms are so different that parameters can be selected such that a unit increase in either cost can have the larger relative impact on the equilibrium price. Nevertheless, the paper shows that in many cases, search costs have the more powerful effect on market power.

Second, the paper considers how the two costs affect welfare. This is more complex as changes in either cost affect not only the equilibrium price but also consumers' searching, switching and purchase decisions. However, we show that whenever search costs have the relatively larger effect on the equilibrium price, they also have the relatively larger impact on consumer surplus, profits and total welfare. Hence, within the context of the model, a competition authority may prefer to focus their resources on improving consumers' information rather than regulating switching costs. While the authorities would often like to reduce both costs, in practice, they may have to choose where to focus their resources. Subject to the relative resource costs of policy implementation, the paper suggests that a reduction in search costs may provide higher relative benefits to competition and welfare than an equivalent reduction in switching costs. In Section 7, we then show that this result is robust to a variety of extensions, including the possibility of price discrimination.

Finally, Section 8 uses the model to present a quick 'back of the envelope' methodology for simultaneously calculating measures of both search and switching costs. This methodology builds on a useful feature of the theoretical model where consumers differ in their expost equilibrium behaviour - a fraction of consumers do not search, a fraction of consumers search and switch and a fraction of consumers search but refrain from switching. Using data from eight UK markets, we then show how one can use some of these equilibrium restrictions with aggregate consumer survey data to recover separate measures for the two costs.

2 Previous Literature

Two previous papers have offered a theoretical analysis of search costs and switching costs. Schlesinger and von der Schulenburg (1991) analyse a circular city model where a number of entrants are located evenly between some market incumbents. Consumers must incur a search cost to discover an entrant's price and then further incur a switching cost to trade with the entrant. Their paper is substantially more restrictive than ours and fails to capture the full effects of the two costs in two respects. First, the circular model implies that consumers only consider purchasing from the entrant or the incumbent adjacent to their location and thus rules out the possibility of incurring search costs across multiple firms. Further, the model produces the unrealistic outcome that all consumers who search in equilibrium also decide to switch, such that consumers artificially view the two costs as equivalent.[5] Sturluson (2002) considers competition between an entrant and an incumbent. Increases in search costs or switching costs are shown to raise prices but no direct comparison of their relative effects is provided. Any potential results are also limited by the focus on a duopoly which minimises the role of multiple searches, and by the fact that equilibrium existence requires a tight parameter condition. In contrast to these papers, the richness of our model allows a detailed comparison of all the effects of the two frictions, and not just on market competition, but also on welfare.

The empirical literature has received somewhat more previous attention. One strand of this literature uses reduced form analysis.[6] Of more relevance to our paper is a second strand that performs structural estimations of the actual value of search and switching costs. In contrast to most studies that only estimate one form of friction (e.g. Moraga-González and Wildenbeest, 2008, Shy, 2002 or Kim et al, 2003), two studies, like our paper, offer methodologies to estimate the level of both costs separately. First, Moshkin and Shachar (2002) develop a discrete-choice model capable of identifying whether consumer behaviour

[5] Using our later terminology, these features limit the comparison of effects by minimising the impact of Distinctions 2,3 and 4.

[6] This dates back to Calem and Mester (1995) who offered support for Ausubel's (1991) assertion that price stickiness and supranormal profits in the credit card market could be explained by the existence of search costs and switching costs. Further contributions include Knittel (1997) who demonstrates a positive relationship between price-cost margins and proxies for search costs and switching costs in the US telephone market, and Giulietti et al (2005) who show how proxies are negatively related to the propensity for consumers to switch in the UK gas market. In a different vein, Giulietti, Otero and Waterson (2010) use observations of tariff dispersion within the UK electricity market to make some separate inferences about the trends of search and switching costs over time.

is more consistent with the existence of search costs or switching costs. Using a panel dataset of individuals' television viewing patterns, they suggest that 71% of consumers behave in a way that is more consistent with search costs.[7] Second, using data on individual consumers' search behaviour and their final purchase decisions, Honka (2010) estimates both levels of friction in the auto insurance market. These two papers provide sophisticated methodologies that can estimate the levels of friction faced at the level of each individual consumer. The aim of our empirical contribution is much more modest. We propose a rough 'back of the envelope' methodology that uses data on aggregate consumer behaviour. While this methodology is clearly less powerful, it can be conducted quickly with easily accessible consumer survey data and may be more practical to competition authorities or other organisations.

3 Definitions and Distinctions

While previous papers appear to agree on the differences between search costs and switching costs, this section attempts to offer a more formal distinction between the two costs. Farrell and Klemperer (2007, p.1977) suggest 'a consumer faces a switching cost between sellers when an investment specific to his current seller must be duplicated for a new seller'. Search costs could appear consistent with this definition. Indeed, in order to change suppliers, a consumer must first incur search costs in order to find and/or process some necessary information about an alternative supplier. However, it is this informational role that produces a key difference between search costs and switching costs. Specifically, this leads to five distinctions. While these distinctions could be viewed as arbitrary, care is later taken to demonstrate the importance of each distinction on each of our results. First, unlike switching costs, search costs cannot be incurred by a consumer who is already fully informed (Distinction 1). Second, a consumer is less informed when making a decision to incur search costs than when making a decision to incur switching costs (Distinction 2). Third, unlike switching costs, search costs can be incurred without then choosing to switch suppliers. That is, expenditure on search costs is a necessary, but not a sufficient, condition for switching suppliers (Distinction 3). Fourth, this then implies that, unlike switching costs, a consumer

[7] In a related study, Dubé et al (2010) use a discrete-choice model with panel data to provide a clever study of consumer inertia. Rather than considering the two costs separately, they estimate a money-metric value of loyalty which they then interpret as a switching cost rather than a search cost because it remains unaffected by the presence of in-store advertising.

can incur search costs more than once by searching across multiple firms (Distinction 4). And finally, in a dynamic context, unlike switching costs that are only active after an initial market purchase, search costs may be incurred both pre- and post-purchase (Distinction 5). For the purposes of this paper, the two costs can therefore be defined as follows.

Search costs are the costs incurred by a consumer in identifying a firm's product and price, regardless of whether the consumer then buys the product from the searched firm or not.

Switching costs are the costs incurred by a consumer in changing suppliers that do not act to improve the consumer's pre-purchase information, such as the costs from arranging the actual switch, lost compatibility or lost loyalty discounts.

4 Model

The model introduces search and switching costs into a version of Perloff and Salop's (1985) model of oligopoly with differentiated products. Let there be $n \geq 2$ firms that each sell a single good with zero production costs. A unit mass of consumers have a zero outside option and each possess a unit demand for the market good. With quasi-linear preferences, let consumer m gain an indirect utility (excluding any search or switching costs) of $u_{mi} = \varepsilon_{mi} - p_i$ if she chooses to buy from firm i at price p_i, where her 'match value', ε_{mi}, is an independent draw from a distribution $G(\varepsilon)$ with positive density $g(\varepsilon)$ on $[\underline{\varepsilon}, \overline{\varepsilon}]$, where $\overline{\varepsilon} > \underline{\varepsilon}$.

The market is assumed to be mature in the sense that each consumer is already partially locked-in to their 'local' firm. Each consumer is free to search and trade with their local firm but faces positive costs of searching and/or switching in regard to any other 'non-local' firm. In line with standard search models (e.g. Stahl 1989), the main model focuses on a symmetric configuration such that $(1/n)$ consumers are 'local' to each firm.[8] More formally, if consumer m is local to firm i, she can learn her match value and the price at firm i, $\{\varepsilon_{mi},\, p_i\}$, at zero cost and is also free to trade with firm i. However, in order to switch to any non-local firm $j \neq i$, she must first incur $c \geq 0$ to learn her match value and firm j's price, $\{\varepsilon_{mj},\, p_j\}$, and then further incur $s \geq 0$ if she still wishes to trade with firm j. Search is assumed to be sequential with costless recall. Hence, consumer m is able to search any number of non-local firms one by one, incurring a cost of c each time, before choosing

[8] Asymmetric configurations and the impact of positive local search costs are considered in Section 7.

whether to purchase from her local firm i or, for an extra cost of s, from a searched non-local firm $j \neq i$.

A one-shot static game is considered where the players select the following strategies simultaneously. Firms each select a single price, p_i.[9] While, at the same time, consumers form conjectures about the firms' pricing strategies and select their 'search to switch' strategies. A 'search to switch' strategy must prescribe the extent to which the market will be searched, which firms will be searched and which firm, if any, the consumer will trade with. As consumers will consider all non-local firms as identical ex ante in any symmetric price equilibrium, they will remain indifferent over the choice of which non-local firm to search. Consequently, after observing their local firm's offer, $\{\varepsilon_{mi}, p_i\}$, a 'search to switch' strategy will only need prescribe whether consumer m should start searching beyond their local firm (Step 1), when to stop searching amongst non-local firms (Step 2) and which firm to then trade with (Step 3).

5 Equilibrium Analysis

5.1 Optimal Search to Switch Strategies

This section begins the equilibrium analysis by considering the optimal search to switch strategy for a given consumer. For simplicity, we will assume that the consumer correctly conjectures that all her non-local firms set a price equal to the symmetric equilibrium price, p^*, such that $E(p_j) = p_j = p^* \ \forall j \neq i$. However, in order to help analyse firms' subsequent pricing decisions, no restrictions are placed on the price of the consumer's local firm, p_i.

To ease the exposition, it is first worth recalling a well-known feature of the optimal strategy in the standard case without switching costs. In particular, suppose a consumer has previously searched a number of non-local firms and that her highest discovered non-local offer, $(\varepsilon - p^*)$, exceeds both her outside option and her original local offer, $\max\{0, \varepsilon_i - p_i\}$. Kohn and Shavell (1974) demonstrate that the consumer should then continue to search amongst any remaining unsearched non-local firms only if her highest previously discovered match value, ε, is less than a threshold level or 'reservation utility', $\widehat{x}$, as defined in Definition 1.

[9] Dynamic effects and the possibility of price discrimination are discussed separately in Section 7.

Definition 1. *The reservation utility, $\widehat{x}$, is the unique value of x that solves $c = \int_x^{\overline{\varepsilon}}(\varepsilon - x)g(\varepsilon)d\varepsilon$.*[10]

The derivation of this stopping rule is surprisingly simple. First, suppose that the number of remaining unsearched non-local firms, β, equals one. The decision to further search then reduces to a comparison between the highest existing offer, $(\varepsilon - p^*)$, and the net benefits of conducting a single search, where for a cost of c, a new offer of $(\varepsilon' - p^*)$ can be discovered. If $\varepsilon' > \varepsilon$, this new offer will be preferred to the existing offer. However, if $\varepsilon' \leq \varepsilon$, the consumer will optimally use her free recall to maintain the existing offer. Using the notation $x \equiv \varepsilon'$ for convenience, the consumer will therefore be indifferent over conducting the single search when $(\varepsilon' - p^*) = -c + \int_x^{\overline{\varepsilon}}(\varepsilon' - p^*)g(\varepsilon')d\varepsilon' + \int_{\underline{\varepsilon}}^{x}(\varepsilon - p^*)g(\varepsilon')d\varepsilon'$. Through simplification, this expression reduces to that used in the definition for the reservation utility. On finding a match value lower (higher) than this reservation utility, it follows that further search will be strictly optimal (suboptimal). One can then use an inductive argument to show that this stopping rule is indeed optimal more generally for any larger number of remaining firms, $\beta \geq 1$.[11]

Lemma 1 will now show how the logic of this strategy can be extended to allow for positive switching costs. Intuitively, the existence of switching costs implies that the decision of whether to further search will now depend upon whether the highest discovered offer originates from a local or a non-local firm. In particular, Lemma 1 demonstrates that the consumer should now employ two different reservation utilities. The consumer should first decide whether to search beyond her local firm in Step 1 by comparing her local offer to a 'local' reservation utility, $\widehat{x} - s$. If the consumer decides to search, she should then choose whether to further search amongst the non-local firms in Step 2 by comparing her best existing match value with a second reservation utility, $\widehat{x}$. Finally, after having chosen to stop

[10] Due to the assumption that $c \geq 0$, it must be that $\widehat{x} \leq \overline{\varepsilon}$. Further, if $\widehat{x} < \underline{\varepsilon}$ then search cannot be optimal and $\widehat{x}$ can be set equal to $\underline{\varepsilon}$ without loss.

[11] The presented stopping rule suggests further search should be undertaken only if $\varepsilon < \widehat{x}$. As demonstrated, this stopping rule is optimal when $\beta = 1$. To see its optimality more generally, first suppose $\beta = 2$. If $\varepsilon < \widehat{x}$, it must remain optimal to search. If search is optimal when $\beta = 1$ then it must also be optimal when $\beta = 2$. If $\varepsilon \geq \widehat{x}$, the presented stopping rule would suggest stopping. If instead, the consumer chose to search, it would be optimal to search only once. To understand why, note that after making one search, only one unsearched firm would remain ($\beta = 1$) and, as the consumer would have a best match value of at least $\widehat{x}$, it would be optimal to stop. Hence, the decision of whether to further search when $\beta = 2$ is, in fact, only a decision between stopping immediately and making one more search, where the presented stopping rule has already been shown to be optimal. This argument can then be expanded for higher levels of β.

searching or having searched the entire market without stopping, the consumer will have discovered some number, $J \in [0, n-1]$, of non-local firm offers (indexed by subscript j). The decision of which searched firm to trade with in Step 3 is trivial. The consumer should trade with the firm offering the best deal net of switching costs, $b = \max\{\varepsilon_i - p_i, \varepsilon_j - p^* - s\}$ $\forall j \neq i$, as long as such a deal is preferred to the outside option of zero.[12]

Lemma 1. *Given a search cost, c, and switching cost, s, the optimal search to switch strategy consists of the following.*

Step 1: Refrain from searching any non-local firm if $\max\{0, \varepsilon_i - p_i\} + p^* \geq \widehat{x} - s$*,(or* $\widehat{x} - s < \underline{\varepsilon}$*). Otherwise search any unsearched non-local firm.*

Step 2: Stop searching amongst the non-local firms only if some firm j is found such that $\varepsilon_j \geq \widehat{x}$ *or if all firms have been searched.*

Step 3: Having stopped searching, trade with the searched firm offering the best deal, $b = \max\{\varepsilon_i - p_i, \varepsilon_j - p^* - s\}$ $\forall j \neq i$*, iff* $b > 0$*. Otherwise take the zero outside option.*

The derivation of Steps 1 and 2 is now discussed in detail. However, a consideration of their implications and the roles played by Distinctions 1-4 is best left until we cover the comparative statics of the full model in Section 6.

First, consider Step 2. Having started a non-local search, Lemma 1 suggests that the consumer should stop searching on the discovery of a non-local match value, ε, greater than the reservation utility, $\widehat{x}$. This implies that the marginal decision to search further amongst non-local firms is actually independent of the level of switching costs and is, in fact, equivalent to that discussed above for the standard case without switching costs. To understand why, first note that in order to have reached Step 2, the consumer must have decided to initiate a non-local search in Step 1. This required the consumer to have received a sufficiently low local offer, $\max\{0, \varepsilon_i - p_i\} + p^* < \widehat{x} - s$. Therefore, any subsequent discovery of a non-local match value, $\varepsilon > \widehat{x}$, must yield an offer, $(\varepsilon - p^* - s)$, that is necessarily larger than the local offer and the outside option, $\max\{0, \varepsilon_i - p_i\}$. This implies that the decision to further search reduces to a comparison between stopping immediately to collect the best existing offer, $(\varepsilon - p^* - s)$, and continuing to search further non-local

[12] To motivate his empirical analysis, Knittel (1997) also provides a theoretical description of consumers' optimal behaviour under search and switching costs. However, his analysis only goes as far as presenting the equivalent of our Step 1.

firms. Hence, it is certain that the consumer will trade with a non-local firm and definitely incur switching costs such that switching costs become irrelevant in the marginal decision to further search. More formally, suppose that the number of remaining unsearched non-local firms, β, equals one. The consumer will then be indifferent over whether to search the remaining non-local firm in order to discover some offer, $(\varepsilon' - p^* - s)$, when $(\varepsilon - p^* - s) = -c + \int_x^{\overline{\varepsilon}} (\varepsilon' - p^* - s) g(\varepsilon') d\varepsilon' + \int_{\underline{\varepsilon}}^x (\varepsilon - p^* - s) g(\varepsilon') d\varepsilon'$. The level of switching costs, s, drops out and the expression reduces to the same reservation utility, $\widehat{x}$, as that described in Definition 1. This logic can then be extended for $\beta \geq 1$ using the inductive arguments described previously. Finally, consider the case where, contrary to that above, the highest previously discovered non-local offer does not exceed the local offer, $(\varepsilon - p^* - s) < \max\{0, \varepsilon_i - p_i\}$. Here, the marginal benefits from further search are equivalent to those where the consumer has only discovered her local offer and has yet to make any non-local searches. This scenario is now considered in Step 1 below.

In Step 1, the consumer must choose whether or not to initiate a non-local search. In contrast to Step 2, switching costs now become important because the consumer must compare between i) collecting the existing local offer which excludes switching costs, $\max\{0, \varepsilon_i - p_i\}$, and ii) searching to discover some non-local offer(s) which include switching costs. Lemma 1 suggests that the consumer should not initiate a non-local search if her local offer (or outside option), normalised for the expected difference between local and non-local prices, $\max\{0, \varepsilon_i - p_i\} + p^*$, is greater than or equal to a 'local' reservation utility, $\widehat{x} - s$. To understand why, first suppose that $\beta = 1$ such that there is only one (unsearched) non-local firm. If the consumer decides to initiate search she will incur c in order to discover a single offer, denoted by $(\varepsilon_1 - p^* - s)$. This new offer will only improve upon the local offer if $\varepsilon_1 > \max\{0, \varepsilon_i - p_i\} + p^* + s$. Denote $x_1 \equiv \max\{0, \varepsilon_i - p_i\} + p^* + s$. The consumer will then be indifferent when $\max\{0, \varepsilon_i - p_i\} = -c + \int_{x_1}^{\overline{\varepsilon}} (\varepsilon_1 - p^* - s) g(\varepsilon_1) d\varepsilon_1 + \int_{\underline{\varepsilon}}^{x_1} \max\{0, \varepsilon_i - p_i\} g(\varepsilon_1) d\varepsilon_1$. On simplification this condition becomes $c = \int_{x_1}^{\overline{\varepsilon}} (\varepsilon - x_1) g(\varepsilon) d\varepsilon$ and provides an expression for the local reservation utility, $\widehat{x}_1$. It will then be optimal to refrain from searching whenever $x_1 \equiv \max\{0, \varepsilon_i - p_i\} + p^* + s \geq \widehat{x}_1$. However, as the expression for $\widehat{x}_1$ is identical to that used for $\widehat{x}$ in Definition 1, this stopping rule can be re-stated to suggest that search is optimal whenever $\max\{0, \varepsilon_i - p_i\} + p^* \geq \widehat{x} - s$, as in Lemma 1.[13] Although slightly more complicated, similar inductive arguments to those used previously can then be employed to show the optimality of this step for $\beta \geq 1$.

[13] In parallel to footnote 10, the assumptions that $c, s \geq 0$ ensure $\widehat{x} - s \leq \overline{\varepsilon}$. If $\widehat{x} - s < \underline{\varepsilon}$ then search cannot be optimal and $\widehat{x}$ can be set equal to $\underline{\varepsilon} + s$ without loss.

5.2 Equilibrium Pricing Decisions

This section considers the firms' optimal pricing decisions. As adopted in other recent search models (e.g. Armstrong et al, 2009), attention is now focused on the uniform distribution to improve tractability and ease interpretation; $G(\varepsilon) = (\varepsilon - \underline{\varepsilon})/(\overline{\varepsilon} - \underline{\varepsilon})$ and $g(\varepsilon) = 1/(\overline{\varepsilon} - \underline{\varepsilon})$. From Definition 1, $\widehat{x}$ then reduces to (1).

$$\widehat{x} = \overline{\varepsilon} - \sqrt{2c(\overline{\varepsilon} - \underline{\varepsilon})} \tag{1}$$

From Lemma 1, one can first note that no consumer will wish to search in a symmetric price equilibrium (where $p_i = p^*$) when $\max\{\underline{\varepsilon}, p^*\} \geq \widehat{x} - s$. Without any consumer search, the firms will be able to sustain the monopoly price. To avoid this less interesting possibility, we concentrate on the case where some positive fraction of consumers do search beyond their local firm in equilibrium. This is ensured by Condition 1.

Condition 1. *In equilibrium,* $\max\{\underline{\varepsilon}, p^*\} < \widehat{x} - s$.

Under this condition, we now establish the equilibrium price. To do so, one must first derive the residual demand for firm i. Given a price of p_i for firm i and a price of p^* for all other firms, the residual demand for firm i, $D_i(p_i, p^*)$, comprises of the sum of four segments as denoted in (2).

$$D_i(p_i, p^*) = F_{Li}(p_i, p^*) + F_{NLi}(p_i, p^*) + R_{Li}(p_i, p^*) + R_{NLi}(p_i, p^*) \tag{2}$$

Firm i's local fresh demand, $F_{Li}(p_i, p^*)$, is described by (3). It derives from firm i's $(1/n)$ local consumers who choose to buy without searching elsewhere. Any given local consumer chooses not to make a non-local search if $\max\{0, \varepsilon_i - p_i\} + p^* \geq \widehat{x} - s$ and opts to buy from firm i if $\varepsilon_i - p_i > 0$. From Condition 1, the first requirement always ensures the second, and so such local consumers buy with $\Pr(\varepsilon_i > \widehat{x} - s + p_i - p^*) = 1 - G(\widehat{x} - s + p_i - p^*)$.

$$F_{Li}(p_i, p^*) = (1/n)[1 - G(\widehat{x} - s + p_i - p^*)] \tag{3}$$

Firm i's non-local fresh demand, $F_{NLi}(p_i, p^*)$, is presented in (4). It stems from the consumers who are not local to firm i but choose to visit firm i during their search process and find it optimal to stop and buy. The total number of visits to firm i made by non-local consumers can be expressed as $(1/n)[G(\widehat{x}-s)+G(\widehat{x}-s)G(\widehat{x})+\ ...\ G(\widehat{x}-s)G(\widehat{x})^{n-2}] = (G(\widehat{x}-s)/n)\sum_{k=0}^{n-2} G(\widehat{x})^k$. The probability of optimally stopping at firm i conditional on visiting, equals $\Pr(\varepsilon_i > \widehat{x}+p_i-p^*)$. It is then trivial to show that having stopped at firm i it will then be optimal to buy from firm i.

$$F_{NLi}(p_i,p^*) = \frac{G(\widehat{x}-s)}{n}\sum_{k=0}^{n-2} G(\widehat{x})^k \cdot (1-G(\widehat{x}+p_i-p^*)) \tag{4}$$

In contrast to these two components of fresh demand, firm i's return demand consists of consumers who start searching but never find an offer worth stopping for. They end up searching the entire market before then realising that firm i offered the best deal and returning to buy from firm i. Depending upon whether such consumers are local or non-local to firm i, this demand is denoted as local return demand, $R_{Li}(.)$, as expressed in (5), or non-local return demand, $R_{NLi}(.)$, as described in (6). The formal derivation of these two terms is more complicated and is contained within Appendix A.

$$R_{Li}(p_i,p^*) = \frac{1}{n(\overline{\varepsilon}-\underline{\varepsilon})}\int_{\max\{\underline{\varepsilon},p_i\}+p^*-p_i+s}^{\widehat{x}} G(\varepsilon)^{n-1}d\varepsilon \tag{5}$$

$$R_{NLi}(p_i,p^*) = \frac{(n-1)}{n(\overline{\varepsilon}-\underline{\varepsilon})}\int_{\max\{\underline{\varepsilon},p^*\}+s}^{\widehat{x}} G(\varepsilon)^{n-2}G(\varepsilon-s)d\varepsilon \tag{6}$$

Given the residual demand function presented in (2)-(6), one can now explore the firms' optimal pricing decisions using the standard FOC, $p^* = -D_i(p^*,p^*)/D_i'(p^*,p^*)$. Equilibrium existence is hard to fully demonstrate in models such as these (see Appendix B for a detailed discussion). However, Proposition 1 suggests that when it exists, the unique equilibrium price breaks down into two possible cases, depending on the relative magnitude of p^* and $\underline{\varepsilon}$. (Throughout the paper, all omitted proofs are contained in Appendix C).

Proposition 1. *When a symmetric equilibrium exists, the equilibrium price is unique and is characterised by (7), where $I(p^* \le \underline{\varepsilon}) = 1$ iff $p^* \le \underline{\varepsilon}$ and zero otherwise.*

$$p^* = \frac{1-G(\max\{\underline{\varepsilon},p^*\})G(\max\{\underline{\varepsilon},p^*\}+s)^{n-1}}{(\overline{\varepsilon}-\underline{\varepsilon})^{-1}[1+G(\widehat{x}-s)\sum_{k=0}^{n-2}G(\widehat{x})^k - I(p^*\le\underline{\varepsilon})G(\underline{\varepsilon}+s)^{n-1}]} \tag{7}$$

In the first case, when $p^* \leq \underline{\varepsilon}$, all consumers will, at least, be willing to purchase from their local firm and the market will be covered. Each firm will then have an equilibrium demand, $D_i(p^*, p^*)$, equal to $(1/n)$ and the price under market coverage, p_C^*, will reduce to (8). Note that as market frictions tend to zero, such that $\widehat{x}$ and $\widehat{x} - s$ tend to $\overline{\varepsilon}$, the equilibrium price converges to $(\overline{\varepsilon} - \underline{\varepsilon})/n$. This price corresponds to that found in Perloff and Salop (1985) and reflects the market power that derives purely from product differentiation.

$$p_C^* = \frac{1}{(\overline{\varepsilon} - \underline{\varepsilon})^{-1}[1 + G(\widehat{x} - s)\sum_{k=0}^{n-2} G(\widehat{x})^k - G(\underline{\varepsilon} + s)^{n-1}]} \tag{8}$$

In the second case, where $p^* > \underline{\varepsilon}$, some consumers will fail to find any offer worthy of purchase and the market can no longer be covered. In accordance with intuition, the expression for each firm's equilibrium demand, now reduces to $(1/n)[1 - (\Pr(\varepsilon < p^*)\Pr(\varepsilon < p^* + s)^{n-1})]$. An explicit expression for the equilibrium price, p_{NC}^*, is hard to obtain, but the expression for the equilibrium price in (7) now collapses to (9).

$$p_{NC}^* = \frac{1 - G(p_{NC}^*)G(p_{NC}^* + s)^{n-1}}{(\overline{\varepsilon} - \underline{\varepsilon})^{-1}[1 + G(\widehat{x} - s)\sum_{k=0}^{n-2} G(\widehat{x})^k]} \tag{9}$$

Finally, before examining the comparative statics in detail, it is worth considering some special cases. First, if one sets switching costs to zero, the price derived in (7) offers an original unification of the equilibrium prices found in the search models of Anderson and Renault (1999) and Wolinksy (1986) that assume market coverage and non-market coverage, respectively. Second, by setting search costs to zero, such that $\widehat{x} = \overline{\varepsilon}$, the model collapses to a static analysis of switching costs which shares some similar features to that used in some recent dynamic studies, such as Cabral (2008) and Dubé et al (2009).

6 Comparative Statics

In this section, we examine the relative mechanisms by which changes in the level of search costs and switching costs affect the equilibrium price and welfare. Sections 6.1 and 6.2 consider how the costs affect the equilibrium price under market coverage and non-market coverage respectively. Condition 1 is maintained throughout. Without it, firms can sustain the monopoly price and increases in either cost will have no effect on the equilibrium price. Finally, Section 6.3 analyses the effects on welfare.

6.1 Market Coverage

The case of market coverage is simplest to analyse. Here, as market demand equals unity by assumption, any changes to the equilibrium price, (8), will only occur through the effects on the price sensitivity of demand, $D'(p_C^*, p_C^*)$. Some preliminary results are presented in Proposition 2.

Proposition 2. *The equilibrium price under market coverage, p_C^*, is increasing in both the level of search costs, c, and the level of switching costs, s, for all $n \geq 2$.*

While Proposition 2 is somewhat trivial and unsurprising, our interest is more in the differences between the underlying mechanisms that generate such effects. To compare these differences further in as clean a way as possible, it is useful to define $A = \partial(1/p_C^*)/\partial c - \partial(1/p_C^*)/\partial s$ such that search (switching) costs will have the larger relative marginal effect if A is negative (positive). As shown in (10), A (multiplied by $(\bar{\varepsilon} - \underline{\varepsilon})$ for convenience) can be arranged to consist of three expressions. We will now demonstrate that each expression has a full economic intuition that relates to the four (static) distinctions made between the two costs in Section 3.

$$\begin{aligned} A \cdot (\bar{\varepsilon} - \underline{\varepsilon}) \quad = \quad & \left(\frac{(n-1)}{(\bar{\varepsilon} - \underline{\varepsilon})} \right) G(\bar{\varepsilon} + s)^{n-2} \\ & + G(\widehat{x} - s) \frac{\partial \sum_{k=0}^{n-2} G(\widehat{x})^k}{\partial c} \\ & + \sum_{k=0}^{n-2} G(\widehat{x})^k \left(\frac{\partial G(\widehat{x} - s)}{\partial c} - \frac{\partial G(\widehat{x} - s)}{\partial s} \right) \end{aligned} \tag{10}$$

The first expression is positive and concerns the effect of an increase in switching costs on encouraging consumers that have searched the entire market to remain loyal to their local firm. No such effect is generated from an increase in search costs due to the assumption that only switching costs are active when a consumer is fully informed (Distinction 1).

The second expression is negative and relates to the effect of an increase in search costs on reducing the extensiveness of any existing search activity. Holding constant the fraction of consumers who do start searching, $G(\widehat{x} - s)$, this effect prompts such consumers to search fewer non-local firms by decreasing the reservation utility, $\partial \widehat{x}/\partial c < 0$. This results in each firm receiving fewer visits from non-local consumers, $\partial \sum_{k=0}^{n-2} G(\widehat{x})^k / \partial c < 0$, and a reduced incentive for each firm to decrease their price. No such effect is created by an increase in switching costs because we know from Lemma 1 that the marginal decision to make a further non-local search, via $\widehat{x}$, is independent of s. This follows from the the assumption that only search costs can be incurred across multiple suppliers (Distinction 4).[14]

The final expression is negative and concerns the net impact of search costs relative to switching costs on deterring consumers from initiating any non-local search activity. Holding constant the extensiveness of any non-local search activity (via $\widehat{x}$), a growth in either search costs or switching costs reduces the incentive to start searching via a reduction in the local reservation utility, $\partial(\widehat{x}-s)/\partial c < 0$ and $\partial(\widehat{x}-s)/\partial s < 0$. Consequently, a rise in either cost reduces the fraction of consumers who begin a non-local search, $\partial G(\widehat{x}-s)/\partial c < 0$ and $\partial G(\widehat{x}-s)/\partial s < 0$, and lessens the incentive for firms to decrease their price. However, one can show that a unit rise in search costs acts to deter consumers by a larger amount than a unit increase in switching costs, such that $|\partial G(\widehat{x}-s)/\partial c| > |\partial G(\widehat{x}-s)/\partial s|$. This difference is key and relates to a combination of Distinctions 2 and 3. To best understand it, recall the expression for the net benefits of a first non-local search, $-c+\int_{x_1}^{\overline{\varepsilon}}(\varepsilon_1-p^*-s)g(\varepsilon_1)d\varepsilon_1+\int_{\underline{\varepsilon}}^{x_1}\max\{0,\varepsilon_i-p_i\}g(\varepsilon_1)d\varepsilon_1$. Within this expression, first note that the consumer expects to incur search costs with probability one, regardless of whether or not the discovered non-local offer is attractive. This derives from the fact that the decision to incur search costs must be made when the consumer is relatively uninformed (Distinction 2). Second, note, in contrast, that the consumer expects to incur switching costs only if the discovered offer is attractive, which occurs with a probability less than one. This stems from the fact that the consumer is able to decide not to switch after searching (Distinction 3). Hence, in evaluating whether or not to initiate a non-local search, the consumer places a greater per-unit weight on search costs rather than on switching costs, making them particularly powerful in deterring search activity and generating market power.

Therefore, in aggregate, a comparison of the relative marginal effects comprises of an evaluation of the effects of switching costs (via Distinction 1), versus the net effects of search costs (via Distinctions 2-4). Proposition 3 can be stated.

[14] In support of our chosen framework, note that the first two expressions in (10) that relate to Distinctions 1 and 4 would be difficult to analyse within an alternative price dispersion framework with homogeneous goods framework, where it is very difficult to obtain costly consumer search as an equilibrium outcome (e.g. Stahl 1989).

Proposition 3. *Under market coverage, the marginal effects from of the two costs on the equilibrium price cannot be consistently ranked in order of magnitude. However, there exists* n^* *such that for all* $n > n^*$ *and for all* $c, s \geq 0$*, the marginal effect from an increase in search costs on price is always larger than the marginal effect from an increase in switching costs.*

Far from having equivalent effects, the mechanisms by which search and switching costs affect competition are so different that the two costs can have significantly different marginal effects on the equilibrium price. When the number of firms is small, either cost can have the larger marginal effect. However, when the number of firms is larger than some threshold, n^*, search costs have the consistently larger impact on market power. This follows from two effects. First, as the number of options grows, consumers that have searched the entire market become more price sensitive and are less affected by the loyalty-inducing effects of switching costs. Second, an increase in the number of firms tilts the relative composition of each firms' demand towards non-local consumers and enhances the effects of search costs on deterring search activity. Proposition 3 can offer no general characterisation of the threshold number of firms, but simulations suggest that n^* can often be as low as four.[15]

6.2 Without Market Coverage

An increase in switching costs creates an additional effect if not all consumers purchase in equilibrium. Once this extra mechanism is taken into account, the effects of the two forms of frictions on the equilibrium price, (9), can be consistently ranked, as suggested in Proposition 4.

Proposition 4. *Under non-market coverage, the marginal effect from an increase on search costs,* c*, on the equilibrium price,* p^*_{NC}*, is larger than that from an increase in switching costs,* s*, for all* $n \geq 2$*.*

A unit increase in switching costs now makes consumers less likely to find an option that is more attractive than their outside option and thereby reduces the proportion of consumers that buy from any firm i in equilibrium, $D_i(p^*, p^*) = (1/n)[1 - (\Pr(\varepsilon < p^*_{NC}) \Pr(\varepsilon < p^*_{NC} + s)^{n-1})]$. This additional effect creates a downward pressure on the equilibrium price, $p^* = -D_i(p^*, p^*)/D'_i(p^*, p^*)$, and allows the marginal effects to be consistently ranked.[16]

[15] For example, within the assumptions of the model, $A < 0$ when $n = 4$, for all $\widehat{x} \in (\underline{\varepsilon}, \overline{\varepsilon}]$, and for all levels of $\underline{\varepsilon}$ that permit market coverage, $\underline{\varepsilon} \in [(\underline{\varepsilon}/2), \overline{\varepsilon})$, using $\overline{\varepsilon} = 5, 10, 15, 20, 25, 50, 75$ or 100.

[16] Within this setting of non-market coverage, we also note an extra result that appears to have been

6.3 Welfare

In many cases, search costs appear to be the relatively more powerful determinant of market power. To be better able to provide policy advice, this subsection now considers their relative marginal effects on welfare. Proposition 5 follows and applies to both the cases of market coverage and non-market coverage.

Proposition 5. *If the marginal effect from an increase in search costs on price is larger than the marginal effect from an increase in switching costs,* $\partial p^*/\partial c > \partial p^*/\partial s \geq 0$*, then, relative to a unit increase in switching costs, a unit increase in search costs generates a greater reduction in consumer surplus,* CS*, a greater decrease in total welfare,* W*, and a greater increase in industry profits,* Π*, if* $c > 0$*, such that* $\partial CS/\partial c < \partial CS/\partial s$*,* $\partial W/\partial c < \partial W/\partial s$*, and* $\partial \Pi/\partial c > \partial \Pi/\partial s$*.*

Proposition 5 can be explained as follows. First, let total consumer surplus be expressed by $CS = [E(\varepsilon|Buy) - p^*]D(p^*, p^*) - \gamma c - \varphi s$, where $E(\varepsilon|Buy)$ is the expected match value for a consumer who purchases in equilibrium, where $D(p^*, p^*) = nD_i(p^*, p^*)$ is the equilibrium proportion of consumers who buy in the market, and where γ and φ are the expected aggregate number of non-local searches and switches made in the market, respectively. Now consider a unit increase in either of the two costs denoted by $\eta = s, c$. This increase will affect consumer surplus not only through its effects on the equilibrium price but also through a wide variety of effects on the equilibrium value of $E(\varepsilon|Buy)$, $D(p^*, p^*)$, γ and φ. However, the proof uses an envelope-style argument to suggest that only two effects are of a first-order magnitude. Any increase in $\eta = s, c$ will reduce consumer surplus by i) raising the price faced by existing buyers, $-D(p^*, p^*) \cdot \partial p^*/\partial \eta$, and ii) if $\eta > 0$, by increasing the total cost of existing search and switching activity, $\partial(\gamma c - \varphi s)/\partial \eta$. Consequently, a unit increase in search costs will reduce consumer surplus by an amount larger than that

overlooked within the switching cost literature. As a special case when $n = 2$ and $\underline{\varepsilon} = 0$, it follows that $p^*_{NC}/(\overline{\varepsilon}^2 - p^{*2}_{NC}) = 1/(\overline{\varepsilon} + \widehat{x})$. As long as the switching costs are low enough such that the monopoly price cannot be sustained, via Condition 1, this suggests that the equilibrium price is actually independent of the level of switching costs. This result is not dependent of the existence of search costs, as it remains true even when $\widehat{x} = \overline{\varepsilon}$. Instead, it follows from the fact that an increase in switching costs can reduce both price sensitivity and the size of demand in a way that leaves the equilibrium price unchanged. While recent dynamic models have stressed the possibility that switching costs can enhance competition because the incentive to 'invest' in future market share may be larger than the incentive to 'harvest' locked-in consumers (e.g. Dubé et al 2009 and Cabral 2008), this effect occurs within a static context.

generated from a unit increase in switching costs when i) $\partial p^*/\partial c > \partial p^*/\partial s \geq 0$ and ii) $\partial(\gamma c - \varphi s)/\partial c = \gamma > \varphi = \partial(\gamma c - \varphi s)/\partial s$. Intuitively, Proposition 5 then follows due to the fact that the latter condition, $\gamma > \varphi$, always holds because there are always more searches than switches in equilibrium. This arises from a combination of Distinctions 2-4 - a searching consumer may not always switch and a switching consumer may search more than one firm. These arguments are also sufficient to demonstrate that total welfare, $W = [E(\varepsilon|Buy)]D(p^*, p^*) - \gamma c - \varphi s$, is relatively more sensitive to changes in search costs as $\partial W/\partial \eta \approx \partial(\gamma c - \varphi s)/\partial \eta$.[17]

Finally, consider industry profits, defined as $\Pi = p^* D(p^*, p^*)$ where $D(p^*, p^*) = 1 - G(\max\{\underline{\varepsilon}, p^*\})G(\max\{\underline{\varepsilon}, p^*\} + s)^{n-1}$. It then follows that, if switching costs have the relatively weaker effect on the equilibrium price then they must also have the relatively weaker effect on industry profits because, unlike search costs, switching costs may also reduce the size of the market.

To summarise, Propositions 2-5 suggest that in many cases, search costs are the more powerful determinant of market power, profits, consumer surplus and total welfare. These results have practical implications. First, competition authorities may wish to focus their limited resources on reducing search costs rather than switching costs. While the authorities' optimal decision will also depend upon the associated resource costs of each policy intervention, our results suggest that the benefits from a unit reduction in search costs may outweigh the benefits from a unit reduction in switching costs. The authorities may prefer to improve, say, the provision of consumer information rather than legislating to ease the switching process. Second, the results also suggest that industries that wish to (collusively) increase market profits may prefer to focus their attempts on increasing market-level search costs rather than switching costs. Under this logic, industry agreements to curb levels of informative advertising may appear particularly potent, provided they do not reduce the size of the market. Competition authorities should be watchful for such strategies.

7 Extensions

This section now uses the basic model to consider five extensions, i) costly local search, ii) asymmetric consumer locations, iii) price discrimination, iv) switching without searching

[17] These arguments also ensure that the spirit of Proposition 5's results about consumer surplus and total welfare can extend to the case where Condition 1 does not apply and where increases in either of the costs have no effect on the equilibrium price.

and v) dynamic effects.

7.1 Costly Local Search

It was originally assumed that consumers could search their local firms without cost. We will no show that the introduction of costly local search makes no difference to the pricing equilibrium and actually strengthens the comparative static results on welfare. If a local search now costs the same as a non-local search, $c > 0$, a consumer's decision to enter the market is no longer trivial. The consumer must choose between i) staying out of the market to receive the zero outside option, ii) making a first search to their local firm to discover an offer with expected value, $E(\varepsilon_i) - p^*$ and iii) making a first search to a non-local firm to discover an expected offer, $E(\varepsilon_j) - p^* - s$. Option iii) is dominated. However, if the consumer chooses to search its local firm, the offer will only be attractive relative to the outside option if $\varepsilon_i > p^*$. By letting $x \equiv p^*$, we know that the consumer will be indifferent between options i) and ii) when $0 = -c + \int_x^{\overline{\varepsilon}} (\varepsilon_i - x) g(\varepsilon_i) d\varepsilon_i$. The value of x that solves this expression, $\widehat{x}$, coincides with the definition for the standard reservation utility in Definition 1. Search will then be optimal whenever $x < \widehat{x}$ or equivalently, when $0 < \widehat{x} - p^*$. However, this condition is always trivially satisfied through Condition 1: $\max\{\underline{\varepsilon}, p^*\} < \widehat{x} - s$, and so all consumers will always make a first search to their local firm as observed in the main model. It then follows that the equilibrium pricing equilibrium remains unchanged. However, any increase in the level of search costs will now generate additional reductions in consumer surplus and total welfare by increasing the cost of existing local searches, such that the welfare-damaging effects of search costs are enhanced relative to switching costs.

7.2 Asymmetric Consumer Locations

As in standard search models, the basic model assumed that each firm was endowed with a symmetric share of local consumers. However, in practice, it may be the case that all consumers are local to the *same* firm. For example, after a monopoly market has been liberalised all consumers may face costs of search and switching away from the incumbent. To show how our results are robust in such a setting, consider an equilibrium where the incumbent, say Firm 1, sets a price, p_1^*, and where the $(n-1)$ entrants, with no local consumers, each set some price, p_2^*. As before, we must assume that some non-local search takes place in order to avoid a monopoly price equilibrium. This now requires $\max\{\underline{\varepsilon}, p_2^*\} < \widehat{x} - s$. Further, to offset the additional complexity, we focus on the case where n is large.

Proposition 6 follows.

Proposition 6. *Consider the incumbent model with $n \to \infty$ and $c > 0$. Then, relative to a unit increase in switching costs, a unit increase in search costs generates a larger increase in equilibrium prices and industry profits, and a greater reduction in consumer surplus and total welfare.*

To understand why the incumbent's price and the entrants' prices are more sensitive to search costs rather than switching costs, note that when n is large, any consumer who searches beyond the incumbent will always find an attractive non-local offer and never return to the incumbent. This makes Distinction 1 inactive. Now consider the incumbent's choice of price. Its demand derives solely from consumers that wish to buy without starting a non-local search. From previous results, we know that an increase in search costs provides the relatively stronger effect in deterring consumers from starting such a search via Distinctions 2 and 3. Consequently, an increase in search costs will also provide the relatively stronger effect in raising the incumbent's price. To consider the entrants' price, note that each entrant's demand derives solely from consumers that did start to search beyond the incumbent and decided to stop after visiting the entrant. A rise in search costs deters consumers from pursuing further non-local searches and allows each entrant to increase its price. However, a rise in switching costs has no such effect on the incentives to further search via Distinction 4 and so leaves entrants' prices unchanged. Finally, having confirmed the relative effects on prices, the relative effects on welfare can also be established using similar arguments to those used in Proposition 5.

7.3 Price Discrimination

Contrary to the original model, it is sometimes possible for firms to discriminate between their local and non-local consumers. We will now demonstrate that our results remain robust when any firm i can set a price, p_{iL}, to its local consumers and a price, p_{iNL}, to its non-local consumers. To avoid the monopoly price equilibrium, we assume $\max\{\underline{\varepsilon}, p^*_{NL}\} < \widehat{x} - s$. Further, to offset the added complexity, we again focus on the case where n is large. Within this setting, it is also possible to allow a very general configuration of consumer locations, where firm i has a proportion of local consumers equal to any a_i, such that $\sum_{i=1}^{n} a_i = 1$.

Proposition 7. *Consider the price discrimination model with $n \to \infty$ and $c > 0$. Then, relative to a unit increase in switching costs, a unit increase in search costs generates a larger increase in equilibrium prices and industry profits, and a greater reduction in consumer surplus and total welfare.*

The intuition for this result is surprisingly similar to that in Section 7.2. First consider local prices. Each firm's local demand derives from consumers that wish to purchase without starting a non-local search. Via Distinctions 2 and 3, a rise in search costs deters consumers from starting to make a non-local search and raises the optimal local price by an amount greater than that generated by a rise in switching costs. Second, consider non-local prices. Each firm's non-local demand derives from consumers that have started a non-local search and then decided to stop. A rise in search costs deters consumers from pursuing further non-local searches and raises the equilibrium non-local price, but an increase in switching costs has no such effect via Distinction 4. Finally, the results on welfare again follow easily using similar arguments to those used in Proposition 5.

7.4 Switching without Searching

In the vast majority of industries, it is clear that consumers will necessarily have to incur positive costs in gathering and processing some information before switching suppliers. However, in some cases it may be possible for a consumer to bypass any such activity by blindly switching to an alternative firm without first knowing its price or characteristics. For example, this possibility is discussed in Giulietti, Waterson and Wildenbeest's (2010) study of search costs in the UK electricity market where there are high levels of doorstep selling activity. The basic model can be shown to still apply in such situations provided the level of search costs is sufficiently small as to ensure consumers still find it optimal to search before switching.[18]

7.5 Dynamic Effects

Finally, the original model was based within a static framework. By deliberately neglecting the consideration of any dynamic effects, the paper has been able to provide a complete anal-

[18] In particular, consider an equilibrium under market coverage. Following from previous results, the consumer will be indifferent over starting a non-local search when $\epsilon_i - p^* = \widehat{x} - s - p^*$. Hence, the expected benefit from searching equals $\widehat{x} - s - p^*$. The expected benefit from switching to a random alternative without searching equals $E(\epsilon) - s - p^*$. Searching will be preferred when $\widehat{x} > E(\epsilon)$ or $c < (\underline{\epsilon} + \overline{\epsilon})/8$.

ysis of the subtle differences between the two frictions. While the introduction of dynamic effects would bring many technical challenges, we expect that it would only strengthen our findings due to the nature of Distinction 5. By definition, switching costs are only active after a consumer has made an initial market purchase. Consequently, standard results suggest that the introduction of dynamic competition often erodes the anti-competitive impact of switching costs by inducing firms to compete fiercely for the future profits of new consumers that are yet to be locked-in (Farrell and Klemperer, 2007). In contrast, Distinction 5 suggests that search costs are often active both before and after an initial market purchase, such that the anti-competitive effects of search costs are not eroded in the same way as switching costs. Consequently, the introduction of dynamic effects may actually widen the gap between the anti-competitive and welfare-damaging effects of search costs relative to switching costs.

8 Data Application

As a secondary contribution, this final section considers a data application. In contrast to the previous empirical literature, we show how some restrictions from the consumers' optimal search to switch strategy can be used with aggregate consumer survey data to recover a set of practical 'back of the envelope' measures for both search costs and switching costs. By doing so, we also highlight the potential pitfalls of single-cost studies by showing how estimates that fail to account for both forms of friction can exhibit an upward bias.

The methodology is extremely simple. In equilibrium, the theoretical model makes several predictions that link the underlying levels of search costs and switching costs to aggregate consumer behaviour. Under the assumption that a given market can be described by such an equilibrium, one can then use aggregate data on consumer behaviour to infer the levels of the two frictions.

Specifically, we make use of two equilibrium predictions, that both continue to hold regardless of the number of firms or the market coverage assumption. First, the model predicts that the proportion of consumers who choose not to search beyond their local firm in equilibrium, a, should be described by (11), as any consumer should not search in equilibrium (where $p_i = p^*$) if they receive a local match value higher than $\widehat{x} - s$. Note the identification of the the two costs will later rest on the fact that $\partial a/\partial c > \partial a/\partial s > 0$, which follows from Distinctions 2 and 3 as discussed previously.

$$a = 1 - G(\widehat{x} - s) \tag{11}$$

Second, the model predicts that any given consumer should switch after making only one non-local search if they discover a local match value lower than $\widehat{x} - s$ and a first non-local offer exceeding $\widehat{x}$. Hence, the proportion of consumers who choose to switch after only one non-local search, b, should be described by (12). Once again, identification hinges on the fact that the two costs affect this proportion differently. Increases in either cost prompt fewer consumers to start searching (but this effect is weaker for switching rather than search costs), while an increase in search costs, but not switching costs, also prompts searching consumers to search fewer firms (via Distinction 4).

$$b = (1 - G(\widehat{x} - s))G(\widehat{x}) \tag{12}$$

If both these equilibrium predictions hold, one can simultaneously solve (11) and (12), together with the definition for the reservation utility $\widehat{x} = \overline{\varepsilon} - \sqrt{2c(\overline{\varepsilon} - \underline{\varepsilon})}$, to provide expressions for the levels of the two costs (scaled by the extent of product differentiation, $(\overline{\varepsilon} - \underline{\varepsilon})$). These are labelled as $\widehat{c}$ and $\widehat{s}$ in (13).[19]

$$\frac{\widehat{c}}{(\overline{\varepsilon} - \underline{\varepsilon})} = \frac{1}{2}(\frac{b}{1-a})^2 \text{ and } \frac{\widehat{s}}{(\overline{\varepsilon} - \underline{\varepsilon})} = a - (\frac{b}{1-a}) \tag{13}$$

By then using the expressions in (13) with aggregate data on the levels of a and b from an actual market, one can calculate numerical values for the two cost measures. As an example and to further illustrate their intuition, the measures are now calculated for eight different markets from the UK using responses from a survey of 2027 consumers.[20] Values for a and b are obtained from questions that asked i) whether consumers had searched for an alternative supplier in the past three years and ii) how many suppliers a consumer had searched beforehand, conditional on that consumer having switched suppliers in the past three years. The values for a and b and the estimated results are displayed in the first four columns of Table 1.

[19] Alternative predictions can also be used, such as the total proportion of consumers choosing to switch. This may be easier to measure empirically than the chosen proportions, a and b, but such a restriction is less general as it is dependent upon n and the market coverage assumption.

[20] The details and findings of the survey are provided in Chang and Waddams (2008).

Table 1: Survey Responses and Estimated Measures of Search and Switching Costs

Market	a	b	$\widehat{c}/(\overline{\varepsilon}-\underline{\varepsilon})$	$\widehat{s}/(\overline{\varepsilon}-\underline{\varepsilon})$	$\widehat{c}_{single}/(\overline{\varepsilon}-\underline{\varepsilon})$
Electricity	0.69	0.02	0.001	0.641	0.241
Mobile Phone	0.66	0.01	0.000	0.627	0.216
Fixed Phone Line Rental	0.78	0.02	0.003	0.706	0.307
National + Overseas Calls	0.76	0.02	0.002	0.681	0.279
Broadband	0.51	0.02	0.001	0.476	0.129
Car Insurance	0.51	0.01	0.000	0.495	0.129
Mortgage	0.56	0.01	0.000	0.546	0.159
Current Bank Account	0.78	0.01	0.001	0.731	0.304

The estimates suggest that switching costs are larger than search costs. This follows for two reasons. First, note that the proportion of consumers who switched after only one search, b, is very low. This suggests that once consumers start to search alternative suppliers, they are likely to search more than one non-local firm. This indicates that marginal search costs are relatively low. Second, note that the proportion of consumers who choose not to search any alternative suppliers, a, is very high. If search costs are low, then consumers must be deterred from starting to search due to the existence of high switching costs.

Finally, to assess how the measures would differ if one were to ignore the role of one of the forms of friction under a single-cost approach, let us impose the restriction $s = 0$. The model would then suggest that the proportion of consumers who choose not to search beyond their local firm in equilibrium, a, equals $1 - G(\widehat{x})$. This would offer a single-cost measure for the level of search costs, $\widehat{c}_{single}/(\overline{\varepsilon}-\underline{\varepsilon}) = a^2/2$. By attributing all the observed inertia to search costs alone, this method can generate estimates of search costs that exhibit an upward bias. Indeed, from (14), it is easy to see that whenever switching costs are larger than zero, such a single-cost approach suffers from an upward bias, $(\widehat{c}_{single} - \widehat{c}) > 0$, which becomes larger as the level of switching costs increases. This bias is illustrated by the final column of Table 1 where the single-cost measure is calculated for comparison. The bias appears substantial in this context. Consequently, studies that fail to integrate both forms of friction may offer misleading estimates and further attempts to estimate both costs simultaneously would appear desirable for future research.

$$\frac{(\widehat{c}_{single} - \widehat{c})}{(\overline{\varepsilon} - \underline{\varepsilon})} = \frac{1}{2}[[1 - G(\widehat{x} - s)]^2 - [1 - G(\widehat{x})]^2] \tag{14}$$

9 Conclusions

To help better understand and measure frictions in product markets, this paper has offered a unified analysis of search costs and switching costs. In its main contribution, the paper has identified the theoretical mechanisms by which the two costs can generate different effects on competition and welfare. First, a unit increase in either cost discourages consumers from initiating any search activity beyond their existing supplier, but the effect is larger for search costs rather than switching costs. This arises because, unlike switching costs, the decision to incur search costs must be made at a time when a consumer is relatively uniformed and because the decision to search does not commit the consumer to switch suppliers. Second, a unit increase in search costs prompts searching consumers to search fewer firms. No such effect is generated by switching costs because they cannot be incurred across multiple suppliers. Third, a unit increase in switching costs encourages fully informed consumers to remain loyal to their existing supplier. No such effect exists for search costs because a fully informed consumer cannot incur search costs. Far from having equivalent effects, the paper has shown that these mechanisms are so different that an increase in either cost can have the relatively larger marginal effect on market power. However, in many cases, it is search costs that are the more anti-competitive and welfare-damaging. Therefore, in response to the concerns about market frictions in markets such as those for banking in Europe, the paper suggests that policymakers may prefer to focus their resources on reducing search costs rather than switching costs.

As a secondary contribution, the paper has also presented a simple 'back of the envelope' method for separately identifying measures of the two costs empirically. By using some restrictions from the consumers' optimal search to switch strategy, it has shown how measures for the two costs can be estimated simultaneously with the use of aggregate consumer survey data. The method's speed and reliance on easily accessible data may make it especially useful to competition authorities or other organisations.

Overall, it is hoped that the paper may prompt researchers to think further about search costs and switching costs. Empirically, we hope that future work will continue to develop more sophisticated estimation methodologies that account for the existence of both costs. This is highlighted by the paper's demonstration that a focus on only one cost may lead to upwardly-biased estimates. Theoretically, the finding that search costs are often particularly anti-competitive and welfare-damaging underlines the importance of consumer search as an increasingly active field of study. Finally, it is hoped that our results could also be extended to help explore the role of search costs and switching costs in labour markets.

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Appendix:

Appendix A - Derivation of Return Demand

A consumer who is local to firm i will form part of firm i's local return demand, (5), if she i) starts to search from firm i, ii) chooses to search the entire market without optimally stopping, but then prefers to buy from firm i rather than iii) buying from any other firm or iv) taking the outside option. This occurs with the probability that i) $\varepsilon_i \leq \widehat{x} - s + p_i - p^*$, ii) $\varepsilon_j \leq \widehat{x}\ \forall j \neq i$, iii) $\varepsilon_i - p_i \geq \varepsilon_j - p^* - s\ \forall j \neq i$ and iv) $\varepsilon_i \geq p_i$. As ii) is non-binding, this probability can be expressed by $\int_{\max\{\underline{\varepsilon}, p_i\}}^{\widehat{x}-s+p_i-p^*} G(\varepsilon - p_i + p^* + s)^{n-1} g(\varepsilon) d\varepsilon$. With simplification, the use of the uniform assumption, and multiplying over firm i's $(1/n)$ local consumers, the firm's local return demand can then be expressed by $(1/n(\overline{\varepsilon} - \underline{\varepsilon})) \int_{\max\{\underline{\varepsilon}, p_i\}+p^*-p_i+s}^{\widehat{x}} G(\varepsilon)^{n-1} d\varepsilon$.

A consumer who is local to some firm $j \neq i$ will form part of firm i's non-local return demand, (6), if she i) starts to search from firm j, and continues to search without stopping at ii) firm i or iii) any other firm $k \neq j, i$, but then prefers to buy from firm i rather than

iv) buying from firm j, v) buying from any firm k or vi) taking the outside option. This occurs with the probability that i) $\varepsilon_j \leq \widehat{x} - s$, ii) $\varepsilon_i \leq \widehat{x} + p_i - p^*$, iii) $\varepsilon_k \leq \widehat{x}\ \forall k \neq i, j$, iv) $\varepsilon_i - p_i - s \geq \varepsilon_j - p^*$, v) $\varepsilon_i - p_i - s \geq \varepsilon_k - p^* - s\ \forall k \neq i, j$ and vi) $\varepsilon_i \geq p_i + s$. Conditions i) and iii) are non-binding. Further, by rewriting iv) as $\varepsilon_j \leq \varepsilon_i - p_i + p^* - s$, observe that the probability that condition iv) is met is zero unless $\varepsilon_i \geq \underline{\varepsilon} + p_i - p^* + s$ and so with this further condition, the total probability can then be expressed by $\int_{\max\{p_i+s, \underline{\varepsilon}+p_i-p^*+s\}}^{\widehat{x}+p_i-p^*} G(\varepsilon - p_i + p^* - s)G(\varepsilon - p_i + p^*)^{n-2}g(\varepsilon)d\varepsilon$. With simplification, the use of the uniform assumption and multiplying over the $((n-1)/n)$ consumers that are not local to firm i, firm i's non-local return demand can be expressed by $[(n-1)/n][1/(\overline{\varepsilon} - \underline{\varepsilon})] \int_{\max\{\underline{\varepsilon}, p^*\}+s}^{\widehat{x}} G(\varepsilon)^{n-2}G(\varepsilon - s)d\varepsilon$.

Appendix B - Equilibrium Existence

The existence of equilibrium is difficult to fully demonstrate in models such as these. See Christou and Vettas (2008) for a technical discussion within a related model of informative advertising. The difficulties arise due to potential kinks in demand which can prevent profit functions from being globally concave. Indeed, in our context, the expressions for the components of residual demand, presented in (3)-(6), are only valid if $|p_i - p^*|$ is not too large. In particular, equations (3)-(6) are only valid for $p_i \in [p_B = p^* + \underline{\varepsilon} - (\widehat{x} - s), p_T = p^* + \overline{\varepsilon} - \widehat{x}]$. If $p_i < p_B$, none of firm i's local consumers will wish to make a non-local search and so firm i's local fresh demand becomes equal to $(1/n)$ and its local return demand must equal zero. If $p_i > p_T$, any non-local consumer who visits firm i will never wish to stop, such that firm i's non-local fresh demand becomes equal to zero and its non-local return demand must be re-expressed. Further kinks will also be present at the more extreme prices, $\hat{p_B} = p^* + \underline{\varepsilon} - \widehat{x}$ and $\hat{p_T} = p^* + \overline{\varepsilon} - (\widehat{x} - s)$. Consequently, a general proof of existence appears intractable in this model but existence can be demonstrated within the special case where $s \to 0$. Here, the model collapses to some standard search models and so we can apply previous results. When $p^* < \underline{\varepsilon}$ existence is demonstrated by Anderson and Renault (1999). When $p^* > \underline{\varepsilon}$, although Wolinsky (1986) did not consider such kinks, Armstrong et al (2009) prove existence in the special case of a standard uniform match distribution.

Appendix C - Proofs of Propositions

Proof of Proposition 1:

When a symmetric equilibrium exists, the equilibrium price must form a solution to the necessary first order condition, $p^* = -D_i(p^*, p^*)/D_i'(p^*, p^*)$. To see that the price in Proposition 1 follows directly from this condition, first note $\sum_{k=0}^{n-2} G(\widehat{x})^k = (1-G(\widehat{x})^{n-1})/(1-G(\widehat{x}))$. Using this and (3)-(6), then note that when evaluated at $p_i = p^*$, i) $D_i(p_i, p^*)$ in (2), implies $D_i(p^*, p^*) = (1/n)[1 - G(\max\{\underline{\varepsilon}, p^*\})G(\max\{\underline{\varepsilon}, p^*\} + s)^{n-1}]$ and ii) $D_i'(p_i, p^*)$ implies $D_i'(p^*, p^*) = -(1/(n(\overline{\varepsilon}-\underline{\varepsilon}))\cdot[1+G(\widehat{x}-s)\sum_{k=0}^{n-2} G(\widehat{x})^k - I(p^* \leq \underline{\varepsilon})G(\underline{\varepsilon}+s)^{n-1}]$. Further, for any symmetric equilibrium to exist, a solution to the first order condition must lie within $p^* \in [0, \widehat{x} - s)$ as Condition 1 implies $p^* < \widehat{x} - s$. Conditional on the existence of such a solution, the equilibrium price is unique. This is most easily observed if one rearranges the FOC as $(p^*/D_i(p^*, p^*)) = -D_i'(p^*, p^*)$ and notes that the left-hand side is independent of $\widehat{x}$ while the right-side is strictly increasing in $\widehat{x}$ for all $\widehat{x} - s \in (\underline{\varepsilon}, \overline{\varepsilon})$, which is ensured via Condition 1 so long as either $c > 0$ or $s > 0$.

Proof of Proposition 2:

To show that the price under market coverage, (8), is increasing in c, note that $\partial(1/p_C^*)/\partial c = (\overline{\varepsilon} - \underline{\varepsilon})^{-2}(\partial\widehat{x}/\partial c)[\sum_{k=0}^{n-2} G(\widehat{x})^k + G(\widehat{x} - s)\sum_{k=0}^{n-2} kG(\widehat{x})^{k-1}]$. This is negative for all $n \geq 2$ because i) $\partial\widehat{x}/\partial c = -(\overline{\varepsilon} - \underline{\varepsilon})/(\overline{\varepsilon} - \widehat{x}) < 0$ for all $c \geq 0$ ($\widehat{x} \leq \overline{\varepsilon}$), and ii) $\widehat{x} - s > \underline{\varepsilon}$ via Condition 1. To show that the price is also increasing in s, note that $\partial(1/p_C^*)/\partial s = (\overline{\varepsilon} - \underline{\varepsilon})^{-2}[(\partial(\widehat{x} - s)/\partial s) \cdot \sum_{k=0}^{n-2} G(\widehat{x})^k - (n-1)G(\underline{\varepsilon} + s)^{n-2}]$. This is negative for all $n \geq 2$ because i) $\partial(\widehat{x} - s)/\partial s = -1$ and ii) $\widehat{x} > \underline{\varepsilon}$.

Proof of Proposition 3:

Expanding (10) and multiplying by $(\overline{\varepsilon} - \underline{\varepsilon})$ yields

$$\begin{aligned} A \cdot (\overline{\varepsilon} - \underline{\varepsilon})^2 \quad &= \quad (n-1)G(\overline{\varepsilon} + s)^{n-2} \\ &\quad - G(\widehat{x} - s)\sum_{k=0}^{n-2} kG(\widehat{x})^k \cdot \left(\frac{\overline{\varepsilon} - \underline{\varepsilon}}{\overline{\varepsilon} - \widehat{x}}\right) \\ &\quad - \sum_{k=0}^{n-2} G(\widehat{x})^k \cdot \left(\frac{\widehat{x} - \underline{\varepsilon}}{\overline{\varepsilon} - \widehat{x}}\right) \end{aligned}$$

To prove the first claim, first note that $A < 0$ such that $dp_C^*/dc > dp_C^*/ds$ when $s \to 0$, for all $\widehat{x} - s > \underline{\varepsilon}$ which is ensured via Condition 1. We then need only show that there exists a range of parameters with low n where $A > 0$ such that $dp_C^*/dc < dp_C^*/ds$. As A is increasing in s, set s as large as possible under Condition 1, such that $A_{s \simeq \widehat{x} - \underline{\varepsilon}} =$

$(\overline{\varepsilon}-\underline{\varepsilon})^{-2}[(n-1)G(\widehat{x})^{n-2}-((\widehat{x}-\underline{\varepsilon})/(\overline{\varepsilon}-\widehat{x}))\sum_{k=0}^{n-2}G(\widehat{x})^k]$. It then follows that $A_{s\simeq\widehat{x}-\underline{\varepsilon},n=2}>0$ when $\widehat{x}$ belongs to the non-empty interval, $[\underline{\varepsilon},(\overline{\varepsilon}+\underline{\varepsilon})/2)$.

To prove the second claim, we show that for all relevant parameters, i) $\partial A_{s\simeq\widehat{x}-\underline{\varepsilon}}/\partial n<0$ and ii) $A_{s\simeq\widehat{x}-\underline{\varepsilon}}<0$ when $n\to\infty$. For i) note that $\partial A_{s\simeq\widehat{x}-\underline{\varepsilon}}/\partial n$ can be expressed as $(\overline{\varepsilon}-\underline{\varepsilon})^{-2}[G(\widehat{x})^{n-2}[1+(n-1)\ln G(\widehat{x})]+[(\widehat{x}-\underline{\varepsilon})/(\overline{\varepsilon}-\widehat{x})]\cdot[(G(\widehat{x})^{n-1})/(1-G(\widehat{x}))]\cdot\ln(G(\widehat{x}))]$. This is increasing in $\widehat{x}$, yet negative for all $n\geq 2$, even when $\widehat{x}$ is set equal to its maximum possible value, $\widehat{x}=\overline{\varepsilon}$, as consistent with $c=0$. Finally, for ii) note that $A_{s\simeq\widehat{x}-\underline{\varepsilon}}<0$ when $n\to\infty$ for all $\widehat{x}\in(\underline{\varepsilon},\overline{\varepsilon}]$.

Proof of Proposition 4:

Using (9), define $H=p^*_{NC}(\overline{\varepsilon}-\underline{\varepsilon})^{-1}[1+G(\widehat{x}-s)\sum_{k=0}^{n-2}G(\widehat{x})^k)]-1+G(p^*_{NC})G(p^*_{NC}+s)=0$. From the implicit function theorem, it then follows that $dp^*_{NC}/dc>dp^*_{NC}/ds$ if i) $dH/dp^*_{NC}>0$ and ii) $dH/dc<dH/ds$. Using our assumptions, $\widehat{x}-s>p^*_{NC}>\underline{\varepsilon}$, both can be shown to be true as $[\partial(\widehat{x}-s)/\partial c-\partial(\widehat{x}-s)/\partial s]=-(\widehat{x}-\underline{\varepsilon})/(\overline{\varepsilon}-\widehat{x})<0$.

Proof of Proposition 5:

As in the text, define aggregate consumer surplus as $CS=[E(\varepsilon|Buy)-p^*]D(p^*,p^*)-\gamma c-\varphi s$. With the application of an envelope-style argument[21], one can then claim i) $\partial CS/\partial c\approx -D(p^*,p^*)[\partial p^*/\partial c]-\gamma$ and ii) $\partial CS/\partial s\approx -D(p^*,p^*)[\partial p^*/\partial s]-\varphi$. A small increase in either of the two costs, $\eta=c,s$, can create many indirect effects. Through the increase itself or the resulting rise in equilibrium price, the proportion of consumers who purchase in equilibrium, $D(p^*,p^*)$, may fall, the proportion of consumers who switch, φ, may reduce, the number of non-local searches, γ, conducted may fall and consumers' expected match value, $E(\varepsilon|Buy)$, may change. However, in each of these cases, the consumers who experience a change in their equilibrium surplus will be on the decision margin and they will be approximately indifferent between their initial status and the status induced by the increase in η. As such, these effects will have no first order magnitude. This leaves only the following direct effects. Any increase in $\eta=s,c$ will reduce consumer surplus by a) raising the price faced by existing buyers, $-D(p^*,p^*)\cdot\partial p^*/\partial\eta$, and b) increasing the total cost of existing search and switching activity, $\partial(\gamma c-\varphi s)/\partial\eta$, if $\eta>0$.

To then show that $\partial CS/\partial c<\partial CS/\partial s$ whenever $\partial p^*/\partial c>\partial p^*/\partial s\geq 0$, we need only demonstrate that the number of non-local searches, γ, exceeds the number of switches, φ. For $n<\infty$, we know that the proportion of consumers who search in equilibrium, $G(\widehat{x}-s)$,

[21]See Armstrong et al (2009) for a similar argument within a search model.

must be larger than the proportion of consumers who switch in equilibrium because i) all switchers conduct at least one non-local search and ii) a positive proportion of consumers search beyond their local firm but then decide not to switch (via Distinctions 2 and 3), (this proportion equals the market level of local return demand, $nR_{Li}(p^*, p^*) > 0$). For $n = \infty$, all searching consumers eventually find an attractive offer and switch such that the proportion of consumers who search equals the proportion of consumers who switch. However, we know that each searching consumer expects to conduct more than one search in equilibrium, via Distinction 4, such that $\gamma > \varphi$. Indeed, each searching consumer expects to conduct the following number of searches, $(1 - G(\widehat{x}))[1 + 2G(\widehat{x}) + 3G(\widehat{x})^2 ... + (n-1)G(\widehat{x})^{n-2}] + (n-1)G(\widehat{x})^{n-1}$ or equivalently, $\sum\limits_{k=0}^{n-2} G(\widehat{x})^k$, which is greater than one when $n = \infty$ if $\widehat{x} > \underline{\varepsilon}$, which is ensured via Condition 1.

The proof for total welfare, $W = [E(\varepsilon|Buy)]D(p^*, p^*) - \gamma c - \varphi s$, then follows from our previous arguments as $\partial W/\partial c \approx -\gamma$ and $\partial W/\partial s \approx -\varphi$.

Finally, consider industry profits, $\Pi = p^* D(p^*, p^*)$. To show $\partial \Pi/\partial c > \partial \Pi/\partial s$ whenever $\partial p^*/\partial c > \partial p^*/\partial s \geq 0$, we need to consider two cases. First, under market coverage, the proof is trivial as $D(p^*_C, p^*_C) = 1$. Second, under non-market coverage, $D(p^*_{NC}, p^*_{NC}) = 1 - G(p^*_{NC})G(p^*_{NC} + s)^{n-1}$ and $\partial \Pi/\partial \eta = [p^*_{NC}(\partial D(.)/\partial \eta) + D(.)(\partial p^*_{NC}/\partial \eta)]$. The result then follows as $\partial D(.)/\partial c = 0 > \partial D(.)/\partial s$.

Proof of Proposition 6:

Given $n \to \infty$, there is no return demand. Therefore, as all consumers are local to Firm 1, its demand derives solely from the consumers that are unwilling to start a non-local search. Given a price at Firm 1, p_1, and the expectation of a non-local price, p^*_2, it then follows that $D_1(p_1, p^*_2) = 1 - G(\widehat{x} - s + p_1 - p^*_2)$. Now consider the $(n-1)$ entrants who have no local consumers. Their demand can only result from the $G(\widehat{x} - s + p_1 - p^*_2)$ consumers who start a search from Firm 1. Such consumers will visit any given entrant firm, say Firm 2, with probability, $(1/(n-1)) \sum_{k=0}^{n-2} G(\widehat{x})^k$, and find it optimal to stop at Firm 2 with probability, $1 - G(\widehat{x} + p_2 - p^*_2)$, such that $D_2(p_2; p^*_1, p^*_2) = G(\widehat{x} - s + p_1 - p^*_2) \cdot [1/(n-1)] \cdot [\sum_{k=0}^{n-2} G(\widehat{x})^k] \cdot [1 - G(\widehat{x} + p_2 - p^*_2)]$. After stating the incumbent and entrant profit maximisation problems and simultaneously solving the two first order conditions, it follows that $p^*_1 = \overline{\varepsilon} - \widehat{x} + (s/2)$ and $p^*_2 = \overline{\varepsilon} - \widehat{x}$. Clearly, $\partial p^*_\alpha/\partial c > \partial p^*_\alpha/\partial s$ is true for $\alpha = 1, 2$ given $\widehat{x} > \underline{\varepsilon}$. By noting that industry profits, Π, equal $p^*_1 D_1(p^*_1, p^*_2) + p^*_2[1 - D_1(p^*_1, p^*_2)]$, one can further show $\partial \Pi/\partial c > \partial \Pi/\partial s$ given $\widehat{x} > \underline{\varepsilon}$. Finally, using similar arguments to that used in Proposition 5, one can show that the results for total welfare and consumer surplus follow for $c > 0$ if the total number of searches, γ, exceeds the total number of switches, φ. Here, this is ensured as the number of switches equals $1 - D_1(p_1^*, p_2^*)$ and the average switcher conducts $[1/(1 - G(\widehat{x}))] > 1$ searches.

Proof of Proposition 7:

Given $n \to \infty$, there is no return demand. Consider any firm i. Its a_i local consumers can buy at its local price, p_{iL}. However, such consumers will only buy if they do not initiate a non-local search. Given that the consumers expect to pay a non-local price, p_{NL}^*, firm i's local demand will then equal $D_{iL}(p_{iL}, p_{NL}^*) = a_i[1-G(\widehat{x}-s+p_{iL}-p_{NL}^*)]$. Now consider firm i's non-local demand. Any of the $(1-a_i)$ consumers that are not local to Firm i can buy from firm i at the price, p_{iNL}. Such consumers will start to search beyond their own local firm with probability, $G(\widehat{x}-s+p_L^*-p_{NL}^*)$, visit firm i with probability, $\sum_{k=0}^{n-2} G(\widehat{x})^k$, and find it optimal to stop at firm i with probability, $1 - G(\widehat{x} + p_{iNL} - p_{NL}^*)$, such that $D_{iNL}(p_{iNL}; p_{NL}^*, p_L^*) = (1 - a_i) \cdot G(\widehat{x} - s + p_L^* - p_{NL}^*) \cdot [\sum_{k=0}^{n-2} G(\widehat{x})^k] \cdot [1 - G(\widehat{x} + p_{iNL} - p_{NL}^*)]$. Firm i's profits are then equal to $p_{iL}D_{iL}(.) + p_{iNL}D_{iNL}(.)$. After stating the associated maximisation problem and simultaneously solving the two first order conditions, it follows that $p_L^* = \overline{\varepsilon} - \widehat{x} + (s/2)$ and $p_{NL}^* = \overline{\varepsilon} - \widehat{x}$. Clearly, $\partial p_\alpha^*/\partial c > \partial p_\alpha^*/\partial s$ is true for $\alpha = L, NL$ given $\widehat{x} > \underline{\varepsilon}$. By noting that industry profits, Π, equal $p_L^* \cdot \sum_{i=1}^n a_i D_{iL}(p_L^*, p_{NL}^*) + p_{NL}^* \cdot (1 - \sum_{i=1}^n a_i D_{iL}(p_L^*, p_{NL}^*))$, one can further show $\partial \Pi/\partial c > \partial \Pi/\partial s$ given $\widehat{x} > \underline{\varepsilon}$. Finally, using similar arguments to that used in Proposition 5, one can show that the results for total welfare and consumer surplus follow for $c > 0$ if the total number of searches, γ, exceeds the total number of switches, φ. Here, this is ensured as the number of switches equals $1 - \sum_{i=1}^n a_i D_{iL}(p_L^*, p_{NL}^*)$ and the average switcher conducts $[1/(1 - G(\widehat{x}))] > 1$ searches.