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Edgeworth Price Cycles and intertemporal price discrimination

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ABSTRACT

In a retail gasoline market exhibiting Edgeworth Price Cycles, prices change asymmetrically with many small decreases interrupted by occasional large increases. The result is a *de facto* menu of prices from which consumers can choose based on exactly *when* they buy. This article introduces four classes of purchase timing strategies designed to systematically shift consumer purchases towards the cycle troughs. It shows in the study market of Toronto, Canada, the monetary gains to consumers from optimized timing strategies are as high as 3.9%. Markups earned from these consumers fall up to 82%. In spite of the gains from timing strategies, surprisingly few consumers use them. Evidence is presented that a main reason is that consumers are not well informed about the cycles. Policy implications are discussed.

1. Introduction

> "*If drivers can pump gas at a lower price and they get that advanced notice, believe me they're going appreciate that so they can at least co-ordinate their consumer spending habits*"—*MPP Joe Tascona, 2007, when introducing a bill in the Canadian House of Commons that would require gasoline companies to give consumers 72 hour advance notice of gasoline price increases.*

In retail gasoline markets that exhibit a pricing phenomenon known as Edgeworth Price Cycles, consumers have the option to buy at a relatively high price or a relatively low one depending on exactly *when* they buy. Edgeworth Price Cycles are a competitive pricing phenomenon in which prices cycle asymmetrically at a high frequency. They were formalized theoretically by Maskin and Tirole (1988) and studied empirically in retail gasoline markets by many authors (Noel, 2007a, Noel, 2007b, Noel, 2009, Eckert, 2002, Eckert, 2003, Eckert and West, 2004, and Atkinson, 2009 in Canada, Lewis, 2009, Lewis and Noel, 2011 and Doyle et al., 2008 in the U.S., Wang, 2009a and Wang, 2009b in Australia, Foros and Steen, 2008 in Norway, and others). The bulk of the literature supports the argument that the price process is that of Edgeworth Price Cycles. The view is further supported by various government reports and by recent direct testimony from gasoline company executives (Conference Board of Canada, 2001, Australian Competition and Consumer Commission, 2007).

Fig. 1 shows the retail price series for the twenty-two gasoline stations in the city of Toronto, Canada used in this study. The twelve-hourly data, spanning four months in 2001, shows the asymmetric pattern clearly. A cycle begins when firms repeatedly undercut one another's price to steal market share back and forth. For goods like gasoline that are close to homogeneous with high cross price elasticities, it pays to do this. Gradually price falls toward marginal cost and margins approach zero. In the study market, the process usually lasts about a week. Then with prices at or near cost, one of the firms relieves the price pressure by increasing price at its stations by a significant amount, as much as 15% here. Others follow quickly with similar price increases and then, from the top of the cycle, a new wave of price undercutting begins. The result is an asymmetric price cycle with many small price decreases interrupted by occasional, large price restorations, and it repeats over and over.

The figure suggests that intertemporal changes in retail gasoline prices can be large and even predictable when there are Edgeworth Price Cycles. Although not an effort by firms to intertemporally price discriminate, the net effect of the cycles is that consumers have the ability to systematically purchase at a relatively high or a low price

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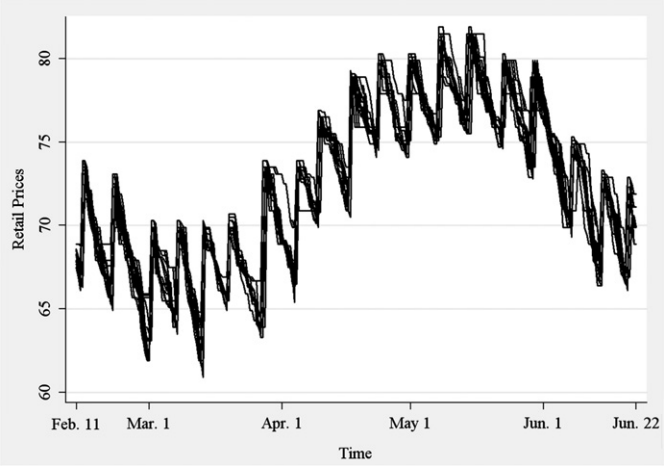

Fig. 1. Retail gasoline prices in Toronto, 2001.

depending on *when* they buy.[1] Price elastic consumers can in principle use the predictability to their advantage and increase their surplus.

It would seem a desirable strategy for many. High gasoline prices have long proven to be a contentious issue in the study market and in many others. In Toronto, claims of "collusive" pricing and "price-gouging" voiced by consumers and even some politicians are popular topics in the press. Consumer complaints in several countries have spawned large scale investigations to test such claims.[2] Complaints in some markets have led to the passage of price regulation in the form of divorcement, below-cost-selling, or anti-price-gouging laws. Although these investigations routinely find no evidence of widespread illegal practices and in spite of the fact that regulatory responses are often of dubious merit, the source of political pressure is clear. Many consumers feel they pay too much for gasoline and want to pay less. And if that is true, predicting when the troughs will occur in Edgeworth Price Cycles markets presents one way to pay less. But surprisingly, the evidence shows that few consumers in the study market used any kind of purchase timing strategy at all that would predict when low prices would occur.

How large are the potential gains from timing purchases? The primary goal of this article is to promote the use of purchase timing strategies designed to move purchases systematically closer to the troughs and reduce the average price paid by strategy followers. I show the gains can be significant for interested consumers.

I proceed in several stages. First, I estimate a series of regressions to identify a set of four triggers that can potentially predict when the large price increases are coming. Then I introduce and design four general classes of purchase timing strategies based on these triggers. The strategies must not only be effective but simple to follow as well. Third, I generate a consumer purchase profile for a number of possible timing strategies within each class by using variants of the purchase trigger rule for that class. For each purchase profile, I calculate the average price paid by consumers and the average markup received by firms from consumers using that strategy. Then I select from each class of strategies the single optimized strategy that maximizes the gain from the class. Finally, I compare the optimized purchase timing strategies across classes and to no timing strategy at all, to arrive at the best techniques for predicting cycle troughs and lowering the average price paid. I show that monetary gains of up to about 4% were readily available in the study market from using purchase timing strategies relative to purchasing myopically. Gains of 2.3% were available with arguably very little effort. The reduction in firm markups from such consumers are very large: 82% and 45% respectively.

The magnitude of the monetary gains is especially significant in light of the maximum possible gains from traditional contemporaneous search. They are at least *twice* as great and as much as *four times* as great as those obtainable from searching and buying at the cheapest of a handful of local stations in the area. They are even greater than the gains that could be had from checking prices at all twenty-two stations in the sample spread out across a seventeen mile distance and buying from the cheapest of those. I argue the relative search advantage of time versus space comes from the fact that Edgeworth Price Cycles create significant (and predictable) variation in prices over time while simultaneously compressing the price distribution across stations at a given point in time. Consumers are well known to be price elastic in the study market in a contemporaneous sense (which contributes to cycle generation in the first place), making the available potential gains from intertemporal switching all the more significant.[3]

I conclude that Edgeworth Cycles provide a mechanism by which price elastic consumers can pay significantly and systematically below the market average price using optimized timing strategies.

There are three caveats to this result to keep in mind. First, the gains are calculated at the margin. If timing strategies were to come into extensive use, then firms can be expected to adapt in response to the demand changes, and it is conceivable the existence of the cycle itself might be affected. I appeal to the Australian experience, however, to argue that even with extensive use, the cycle is likely to continue. Of course, the timing strategies introduced here would likely need to be reoptimized as demand patterns change.

The second caveat is that the timing strategies here were optimized specifically for the study market of Toronto for 2001. The general classes of timing strategies are portable across markets, but each strategy class must be optimized for each market separately and then reoptimized time to time as conditions change. Certain ones may work best in one market, others in a different one, noting that even small departures from the optimized setting can evaporate monetary gains quickly.

The third caveat is that there are non-monetary costs associated with using purchase timing strategies, often in the form of time and effort spent. These costs can be significant and overwhelm the monetary gains from using a timing strategy. Indeed, few consumers in the study market appear to use a timing strategy at all and non-monetary costs are a likely cause.

It is worth exploring whether the non-monetary costs of implementing timing strategies or a basic lack of awareness of the cycle is responsible for the absence of timing strategy use. I report evidence from several sources suggesting that cycle awareness in the study market was very weak. Back of the envelope calculations suggest that the non-monetary costs under certain timing strategies are unlikely to be high for a marginal consumer. The implication is that, at the margin, sizeable welfare gains were being left on the table by at least some consumers poorly informed about the cycles and how to time them, rather than by the magnitude of non-monetary costs alone.

There are policy implications. In an environment where consumers are highly price elastic and openly wary about high gas prices, welfare gains can be achieved by making consumers more aware of the cycle. This should be done. Especially given the sometimes hostile tone of

[1] Models of intertemporal search can themselves generate an asymmetric cycle similar to these (e.g. Conlisk et al., 1984, Fershtman and Fishman, 1992), as discussed later. These models rely on complete information and foresight by consumers.

[2] While there have been isolated cases of price fixing by individual station dealers in local markets (e.g. Ballarat, Australia Wang, 2008) or four nearby towns in Quebec, Canada (Clark and Houde, 2009), comprehensive investigations in various countries have found no evidence in support of collusion or price fixing amongst the large gasoline companies.

[3] Noel (2008) shows high firm level elasticities are needed for cycle generation.