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Large supply shocks often raise concerns that retailers exploit rising costs to increase markups. We study the oil-price shock following Russia's invasion of Ukraine using wholesale fuel prices, near-universe daily retail prices across Great Britain, and more than 200 million precisely geolocated searches from a major fuel-price comparison platform. Despite fuel prices rising by 37% over the preceding 21 months with essentially no change in search, the abrupt post-invasion increase triggered a more than twentyfold surge in daily search while retail margins contracted sharply. An event-study design shows that this shock-induced search increase causally reduced retail prices and margins, with 95th- versus 5th-percentile exposure implying an 8% margin reduction at the peak. The implied loss to retailer margins peaked at £5.2 million per week, around £650 per station. We rationalise these findings with a model in which large, rapid price increases raise consumer attention and price sensitivity, intensifying competition and compressing margins. More broadly, supply shocks can therefore change not only firms' costs but also the demand conditions governing how those costs are passed through. Consistent with the model's additional predictions, pass-through is approximately complete and symmetric before the invasion, but lower and temporarily exhibits a pronounced rockets-and-feathers pattern afterwards.

1 Introduction

Large supply shocks routinely generate accusations that retailers exploit rising input costs to increase markups, a concern that has become particularly prominent in recent public debate over so-called "greedflation" (Harford, 2026). These concerns are again prominent following the 2026 disruption to the Strait of Hormuz, which sharply restricted global oil supplies. In the UK, Chancellor Rachel Reeves asked the Competition and Markets Authority (CMA) to remain on "high alert" for unjustifiable increases in petrol, diesel and heating-oil prices (HM Treasury, 2026). The CMA subsequently brought forward formal requests for revenue, cost and sales data from firms responsible for thousands of fuel stations in order to scrutinise retailer margins (Competition and Markets Authority, 2026). Similar concerns have arisen in the US, where President Trump publicly called on gasoline retailers to reduce pump prices immediately (Singh, 2026). These episodes reflect a recurring concern that supply disruptions create opportunities for retailers to expand markups. Yet there is surprisingly little direct evidence on whether retailers actually do so, or on the mechanisms through which large cost shocks affect retail pricing and margins.

How retail markups respond to a cost shock is theoretically ambiguous. Under imperfect competition, the extent of cost pass-through, and hence whether markups rise or fall as costs increase, depends on the shape of demand (Weyl and Fabinger, 2013; Mrázová and Neary, 2017). The possibility that firms exploit inflationary episodes to increase markups has become prominent in public debate under the label "greedflation" (Harford, 2026; Inman, 2023). One possible mechanism is informational, with greater price volatility leading consumers to attribute more of a firm's price increase to general inflation, reducing perceived price sensitivity and allowing markups to rise (Scanlon, 2024). Large shocks could, however, produce the opposite response, since aggregate cost uncertainty can increase consumers' incentives to acquire information and intensify price competition (Bénabou and Gertner, 1993). Supply shocks may therefore weaken or strengthen competitive discipline, making their effect on retail markups theoretically ambiguous.

We study this question using the oil-price shock following Russia's invasion of Ukraine. We combine detailed wholesale fuel prices, a near-universe of daily retail fuel prices across Great Britain, and more than 200 million precisely geolocated searches from PetrolPrices.com. Descriptively, the shock is associated with a striking compression in retail margins alongside an extraordinary increase in consumer search. Estimated margins for both petrol and diesel temporarily fell below zero relative to prevailing wholesale benchmarks, while daily search increased more than twentyfold. This response was not simply driven by high fuel prices. Despite prices rising steadily by 37% in the 21 months before the invasion, search remained essentially flat. Moreover, search fell sharply when prices subsequently stabilised at a high level, before surging again when prices began rising rapidly for a second time. The descriptive evidence therefore suggests that consumer attention responds to large and abrupt price movements rather than to the level of prices itself.

To establish whether the descriptive relationship reflects a causal mechanism, we exploit predetermined spatial variation in the use of PetrolPrices.com before the invasion. We instrument post-invasion search using pre-invasion local platform use interacted with event-week indicators, since areas with more consumers already familiar with the platform and facing lower search costs were able to respond much more strongly when the invasion sharply increased the gains from comparing fuel prices. The resulting event study has a strong first stage and shows no evidence of differential pre-trends in search, retail prices or margins. Following the invasion, search and retail prices display a striking mirror-image pattern, with larger shock-induced increases in search generating larger reductions in prices and margins. At the peak of the effect, the difference in pre-invasion search exposure between stations at the 95th and 5th percentiles implies an approximately 0.6–0.8% reduction in retail prices and an 8% reduction in retail margins. The implied consumer savings (and loss to retailer margins) reach approximately £5.2 million per week. Price reductions are also concentrated among stations that were relatively expensive within their local markets before the invasion, consistent with greater search disciplining initially high-priced retailers. Together, the results trace a causal link from the supply shock, through increased consumer search, to intensified retail competition and margin compression.

We rationalise these findings using a simple model in which consumer attention responds endogenously to salient price movements. Sufficiently large and rapid price increases raise attention, increasing consumers' price sensitivity and compressing equilibrium retail margins. The central implication is that a supply shock can change not only firms' costs but also the demand conditions governing how those costs are passed through to consumers. The model rationalises the sharp increase in search and the causal reduction in margins, but also generates two additional predictions. First, pass-through should be lower following a salient cost shock while consumer attention remains elevated and margins are compressed. Second, as price increases subside, attention dissipates and margins recover; this recovery can temporarily offset falling wholesale costs and cause price decreases to pass through more slowly than increases. We test these predictions using an asymmetric error-correction model. Before the invasion, wholesale-cost changes pass through approximately completely and symmetrically. Following the invasion, pass-through is substantially lower and initially becomes strongly asymmetric. Wholesale-cost increases pass through more rapidly than decreases, before the two responses subsequently converge. These results support the broader mechanism linking supply shocks, consumer attention and retail competition. The mechanism is not specific to fuel. In consumer markets with transparent prices, large and rapid cost shocks may themselves increase consumer attention and strengthen competitive discipline. The effect of a supply shock on markups may therefore depend not only on its size, but also on whether it is sufficiently abrupt to change consumer behaviour and how easily consumers can compare prices across firms.

We contribute to four related literatures. First, we contribute to work on how firms adjust markups during large cost shocks and crises. Changes in markups can amplify or dampen the effect of input-cost shocks on consumer prices, with De Loecker et al. (2016), for example, showing that firms increased markups as input costs fell following Indian trade liberalisation. Evidence from large crisis episodes suggests that margins need not increase when costs rise. Firm margins fell following the 2022 UK energy shock (Manuel et al., 2024), retail fuel margins declined following hurricanes even as pump prices rose (Beatty et al., 2021; Neilson, 2009), and supermarket prices changed little following a major earthquake (Cavallo et al., 2014). We show that retail margins compress sharply during a large externally generated cost shock and, crucially, identify a mechanism behind this response. The shock induces consumers to search more intensively, strengthening competitive pressure precisely when retailers face rapidly rising input costs.

Second, we contribute to the literature on cost pass-through under imperfect competition. Pass-through depends fundamentally on the structure of demand (Weyl and Fabinger, 2013; Mrázová and Neary, 2017), and has been studied across settings including exchange-rate shocks, commodity inputs, environmental costs, regulated fees and fuel taxes (Auer et al., 2021; Nakamura and Zerom, 2010; Bonnet et al., 2013; Fabra and Reguant, 2014; Bakker and Datta, 2025; Genakos and Pagliero, 2022; Genakos et al., 2026; Alm et al., 2009; Montag et al., 2023; Alexeeva-Talebi, 2011; Borenstein et al., 1997). Existing work shows that pass-through can depend on demand curvature, price salience and the extent to which consumers are informed. In these settings, however, salience and consumer information are taken as features of the demand environment. Our results introduce a distinct mechanism in which consumer attention itself responds endogenously to the cost shock. When a price increase is sufficiently large and salient, attention rises, demand becomes more price-sensitive and margins compress. Large cost shocks can therefore change both firms' costs and the competitive environment in which those costs are passed through.

Third, we contribute to the literature on consumer search, price information and price-comparison technologies. Classical search models show how the fraction of informed consumers shapes price dispersion and market power (Stigler, 1961; Varian, 1980; Stahl, 1989; Sorensen, 2000), while a related literature studies how online search and price-comparison technologies affect consumer search and firm pricing (Brown and Goolsbee, 2002; Ellison and Ellison, 2009; Santos et al., 2012; Ronayne, 2021). In fuel markets, greater consumer information is associated with lower prices (Pennerstorfer et al., 2020), while direct measures of online search show that search responds to fuel prices and market conditions (Lewis and Marvel, 2011; Byrne and de Roos, 2017). Closely related, Byrne and de Roos (2022) show that a temporary shock to the incentives to search can generate a persistent increase in gasoline price search, while Montag et al. (2026) show that the effects of mandatory price disclosure depend on consumers' prior information. We advance this literature using more than 200 million precisely geolocated searches, which allow us to measure changes in attention around individual stations, together with an empirical design that uses pre-invasion local platform use to isolate the search response generated by the shock. This allows us to causally link a large supply shock, the resulting increase in consumer search, and the compression of retail prices and margins. Our setting also connects to the extensive use of fuel markets to study local and spatial competition (Eckert, 2013; Hosken et al., 2008; Houde, 2012; Pennerstorfer and Weiss, 2013; Davis et al., 2025; Genakos and Pagliero, 2022; Genakos and Kampouris, 2026).

Finally, we contribute to a long-running and contested literature on asymmetric cost pass-through. Whether retail fuel prices systematically respond faster to cost increases than to decreases remains unsettled. A large literature documents the familiar "rockets-and-feathers" pattern (Bacon, 1991; Borenstein et al., 1997; Peltzman, 2000; Alm et al., 2009; Byrne, 2015; Genakos et al., 2026), while other studies find much weaker or approximately symmetric adjustment (Bachmeier and Griffin, 2003; Douglas, 2010). We help reconcile these findings by characterising when asymmetry should emerge. Search frictions and consumer learning have long been proposed as potential explanations (Yang and Ye, 2008; Tappata, 2009; Cabral and Fishman, 2012; Lewis, 2011), with empirical evidence linking search behaviour to asymmetric adjustment provided by Lewis and Marvel (2011) and Heim (2021). Our model shows that pass-through can remain symmetric when consumer attention is stable, but become temporarily asymmetric following a sufficiently salient price shock, as elevated attention initially compresses margins and subsequent margin recovery slows the pass-through of falling costs. Consistent with this prediction, we find approximately symmetric pass-through in the year before the invasion, but pronounced rockets-and-feathers adjustment following the attention shock, with the asymmetry subsequently disappearing as the responses converge. Our results therefore provide a mechanism for why asymmetric pass-through appears in some periods but not others.

2 Setting and Data

Russia's full-scale invasion of Ukraine on 24 February 2022 generated a large, sudden and largely unexpected disruption to global oil markets. Brent crude prices rose from $99.08 per barrel on the day of the invasion to $127.98 by 8 March, while wholesale fuel prices adjusted almost immediately. The result was one of the largest input-cost shocks faced by UK fuel retailers in recent decades. Because the shock originated outside the UK retail fuel market and was both abrupt and economically substantial, it provides a particularly useful setting in which to study how retailers adjust prices and markups during supply disruptions.

We combine near-universe daily retail fuel prices from Experian, covering approximately 8,000 petrol stations across Great Britain, with daily wholesale prices provided by the RAC Foundation and constructed using S&P Global Platts data. Platts prices provide the principal benchmark for wholesale fuel procurement in the UK, with retailers typically purchasing fuel at a station- or contract-specific premium over the prevailing benchmark. Although this premium may differ across stations, it is plausibly fixed over the relatively short period surrounding the shock. Changes in the gap between a station's retail price and the relevant wholesale benchmark therefore identify changes in its retail markup, allowing us to trace the evolution of station-level margins throughout the supply shock. For the empirical analysis, we focus on retail diesel prices, which provide more complete coverage across stations over time.

To measure consumer attention, we use novel search data from PetrolPrices.com, the UK's largest fuel-price comparison platform. The data contain more than 200 million searches conducted between 2020 and 2024. Each search records the user's location and chosen search radius, allowing us to reconstruct the set of petrol stations that appeared in the search results and therefore formed the consumer's feasible choice set. We aggregate these searches to the station-day level and measure attention by the number of searches in which each station appeared.[1] To account for differences in local market size, we link station locations to 2021 Census Output Areas and use the population living within five miles of each station—the platform's default search radius—to construct per-capita measures of consumer search.

3 Descriptive Evidence

3.1 Retail Margins During Supply Shocks

Figure 1 plots crude oil prices alongside estimated retail margins for diesel and unleaded petrol around Russia's invasion of Ukraine. We measure the retail margin as the difference between the pump price and a one-week rolling average of the wholesale benchmark price, in pence per litre. This smoothing is motivated by the structure of wholesale fuel procurement in the UK. Retailers typically purchase fuel through contracts indexed to Platts benchmark prices, and the Competition and Markets Authority documents that the prices paid by retailers may depend on weekly averages of benchmark prices with negotiated lags (Competition and Markets Authority, 2023). We therefore use the one-week moving average as a parsimonious proxy for prevailing wholesale acquisition costs. The resulting measure should be interpreted as an estimated retail margin relative to wholesale costs rather than as a direct measure of individual stations' realised accounting margins.

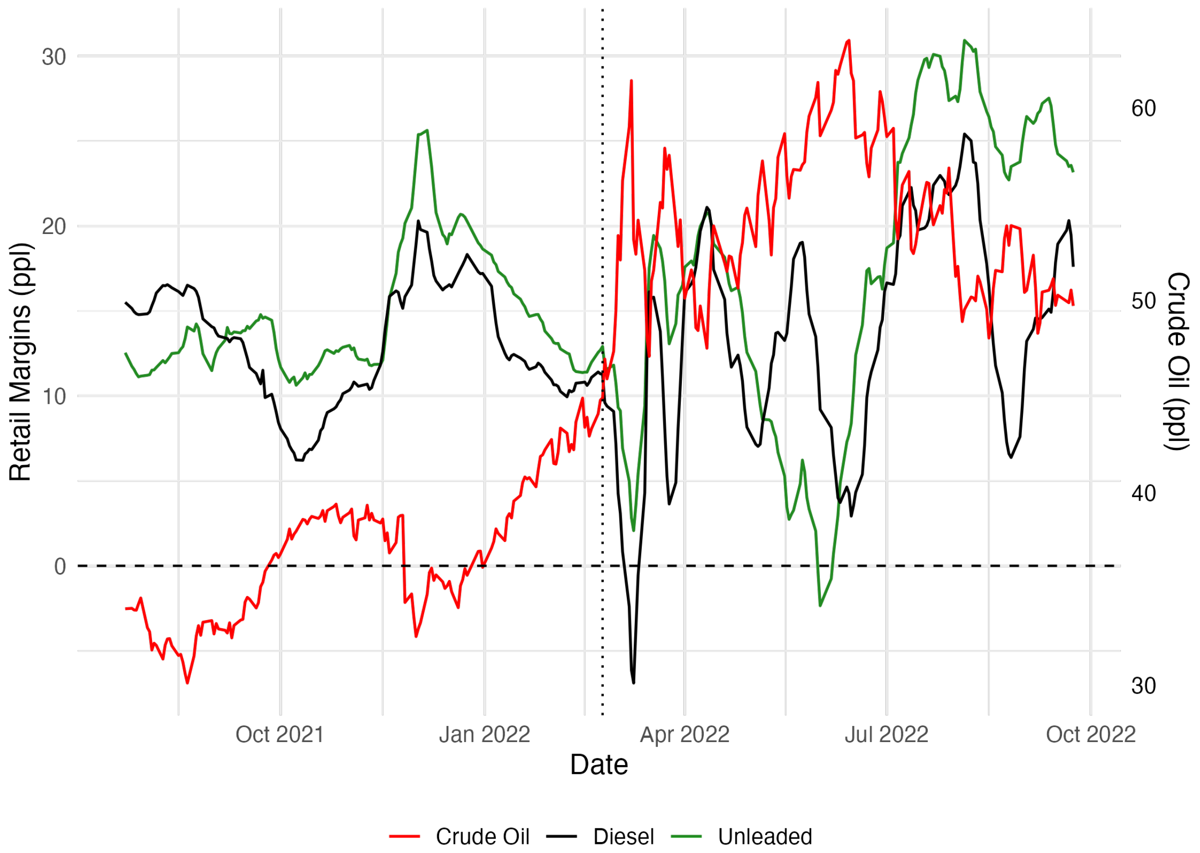
Even before the invasion, the series display a broadly negative relationship: increases in crude oil prices

[1] See Figure 5 in the appendix for a visual of the app.

tend to coincide with lower retail margins, while margins recover when crude prices stabilise or fall. This pattern becomes especially pronounced following the invasion. As crude oil and wholesale prices rose sharply, estimated margins for both diesel and unleaded petrol compressed almost immediately. Diesel margins briefly became strongly negative, while unleaded margins also fell below zero.[2] Given that the wholesale series is a market benchmark rather than the exact contracted purchase price faced by each retailer, these negative values should not be interpreted literally as evidence that all stations were selling fuel at a loss. They nevertheless indicate that pump prices initially rose substantially less than prevailing wholesale costs.

Margins subsequently recovered as the initial surge in crude and wholesale prices moderated, although they remained volatile throughout the following months. The central pattern is therefore inconsistent with retailers using the supply shock to expand markups (for the broader debate, see Weber and Wasner, 2023). Instead, retailers appear to have absorbed part of the sudden increase in input costs, at least temporarily, causing estimated margins to contract most sharply precisely when oil prices were rising fastest. Similar margin compression during large supply disruptions has been documented following hurricanes in US fuel markets and during the 2022 UK energy shock (Neilson, 2009; Beatty et al., 2021; Manuel et al., 2024).

Figure 1: Retailer Margins and Oil Prices

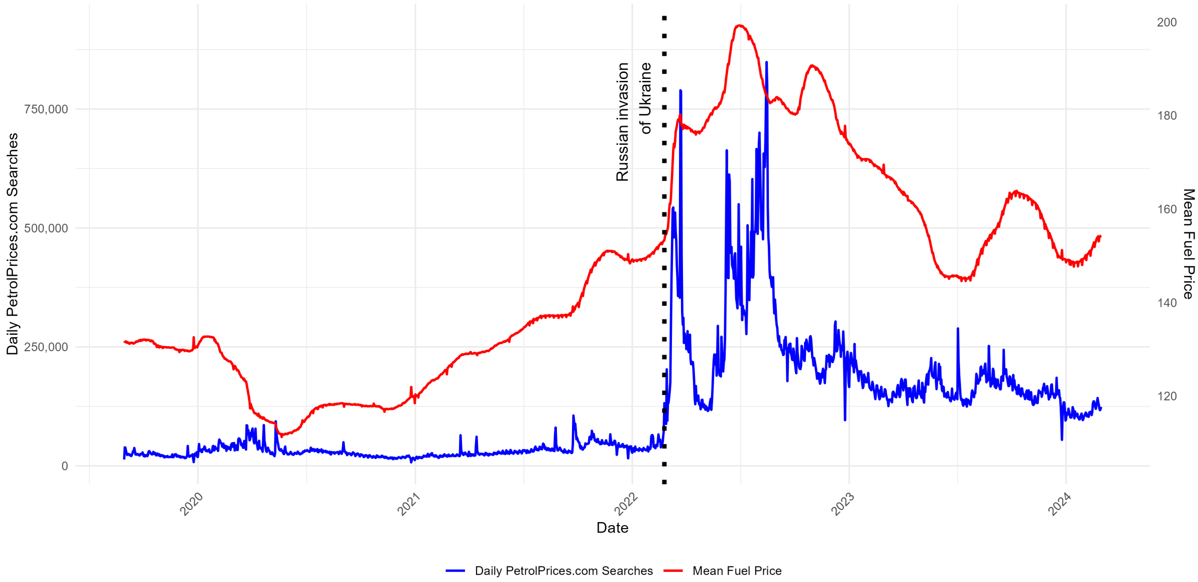


Notes: The figure presents estimates of average retail margins for UK fuel stations, broken down by diesel and unleaded petrol fuel, and crude oil prices converted into pence per litre. Retail margins are calculated from average retail prices on a given day, from which we subtract estimated wholesale prices for the respective fuel blend, smoothed over a trading week. Prices for blended fuels contain wholesale prices for fossil and renewable fuel components, additional costs imposed by the Renewable Transport Fuel Obligation, fuel duty, and VAT.

[2] The CMA's independent analysis similarly finds negative estimated retail spreads for both petrol and diesel in February–March 2022 around Russia's invasion of Ukraine.

3.2 Consumer Attention During Supply Shocks

Figure 2: Fuel prices and search activity for fuel prices in the UK



Notes: The figure shows the total of daily searches on PetrolPrices.com and daily average diesel retail prices.

Figure 2 shows the evolution of average UK fuel prices alongside daily searches on PetrolPrices.com. In the 21 months preceding Russia's invasion of Ukraine, nominal fuel prices increased steadily by 37% (41p per litre) while CPI inflation over that period was only 6.3%. Despite this substantial increase in real retail prices, consumer search remained remarkably stable, averaging 31,000 searches per day. The gradual rise in fuel prices therefore generated little additional consumer attention.

Following Russia's invasion of Ukraine, however, consumer behaviour changed dramatically. As fuel prices surged in response to the oil shock, daily search activity increased almost immediately, peaking at more than 750,000 searches per day—over twenty times its pre-invasion level. The timing of this response closely mirrors the rapid increase in fuel prices, with search intensity remaining elevated while prices continued to rise before declining as prices stabilised and began to fall.

The contrast between the gradual pre-invasion increase in fuel prices and the post-invasion surge suggests that consumer attention responds primarily to large, salient price shocks rather than to the level of prices itself. Supply shocks are especially likely to generate such attention because they produce abrupt price increases while the underlying disruption itself—here, Russia's invasion of Ukraine—also attracts extensive public and media scrutiny. This combination makes both the movement in prices and its cause unusually visible, inducing consumers to devote greater attention to comparing prices across retailers. Supply shocks therefore generate substantial endogenous changes in consumers' information-acquisition behaviour.

The subsequent evolution of search activity reinforces this distinction between price levels and large price movements. When fuel prices temporarily stabilised just below 180 pence per litre, daily searches fell sharply to around 125,000, despite prices remaining historically high. When prices then began rising rapidly again and approached 200 pence per litre, search activity surged for a second time, again reaching roughly 750,000 searches per day. Consumer attention therefore appears to respond to large and abrupt changes in prices, rather than moving mechanically with the prevailing price level.

As fuel prices subsequently declined gradually towards their pre-shock level, search activity fell much more rapidly. It did not, however, return to its pre-invasion baseline. Instead, searches stabilised for the following two years at around five times their earlier level. This persistence suggests that the shock produced a lasting change in search behaviour: although the exceptional attention generated by sharp price increases dissipated, many consumers continued to compare fuel prices more actively than they had before the invasion.

4 Causal Evidence

4.1 Consumer Attention and Retail Pricing

4.1.1 Empirical Strategy

Our objective is to estimate the causal effect of consumer search on retail prices and margins. A direct regression of prices on search would not identify this effect because search is endogenous to prices: consumers may search more precisely when a station raises its price, while local shocks may simultaneously affect both search and pricing. We therefore use Russia's invasion of Ukraine to construct an instrument for station-level search activity.

The instrument combines predetermined spatial variation in the use of PetrolPrices.com with the aggregate increase in search generated by the invasion. Let

$$s_j^0 = \overline{Search}_{j,\text{Jan. 2022}}$$

denote average daily searches in which station j appeared during January 2022, expressed per 100 residents living within five miles of the station. This variable captures the pre-existing propensity of consumers around station j to use PetrolPrices.com. There is substantial spatial variation in this propensity: search intensity at the 95th percentile is approximately seven times that at the 5th percentile.

Russia's invasion generated a large national increase in the returns to comparing fuel prices. The mechanism behind our instrument is that consumers differ in their costs of acquiring and comparing price information (Stahl, 1996). They must know that PetrolPrices.com exists, be willing to use it, and be familiar with how to compare nearby stations. These costs were already lower in areas with greater pre-invasion use of the platform. When the invasion sharply increased the potential savings from finding a cheaper station, consumers in these areas could therefore increase their search activity more readily and on a larger scale. Pre-invasion search intensity captures the size of this pre-existing pool of platform-aware, low-search-cost consumers. Its interaction with the aggregate post-invasion incentive to search consequently predicts the local increase in search generated by the shock.

The design is analogous to a shift-share or differential-exposure design. The predetermined exposure is s_j^0, while the aggregate shock is represented flexibly by event-week indicators following the invasion. Their interaction captures whether the common shock produced larger changes around stations with greater pre-existing platform use.

We implement this design using the following event-study specification:

$$Y_{jt} = \sum_{k \in K} \beta_k \left(s_j^0 \cdot \mathbb{1}\{t = k\} \right) + \lambda_j + \gamma_t + \varepsilon_{jt}, \tag{1}$$

where Y_{jt} is the outcome for station j in year-week t, s_j^0 is the station's average daily per-capita search intensity in January 2022, λ_j denotes station fixed effects, and γ_t denotes week-year fixed effects. We omit the fifth week before the invasion, $k = -5$, so all coefficients are measured relative to that week.

We first estimate Equation 1 using contemporaneous daily search appearances per 100 residents as the dependent variable. This provides the first stage: whether the invasion generated larger increases in search around stations with greater pre-invasion use of PetrolPrices.com. The coefficient β_k gives the additional change in contemporaneous search at event week k generated by one additional daily January 2022 search appearance per 100 residents. The identifying prediction is that these coefficients are close to zero before the invasion and positive afterwards.

We then estimate the same specification with the logarithm of the station's weekly retail price as the dependent variable. These reduced-form estimates show whether stations more exposed to the invasion-induced increase in search experienced different pricing outcomes. If greater consumer search intensified local price competition, stations with higher pre-invasion search intensity should exhibit lower retail prices and thus narrower margins following the invasion. We additionally estimate the specification using the station's retail margin, measured in pence per litre as the retail price minus the corresponding wholesale price. This allows us to test directly whether the invasion-induced increase in consumer search compressed retailer margins.

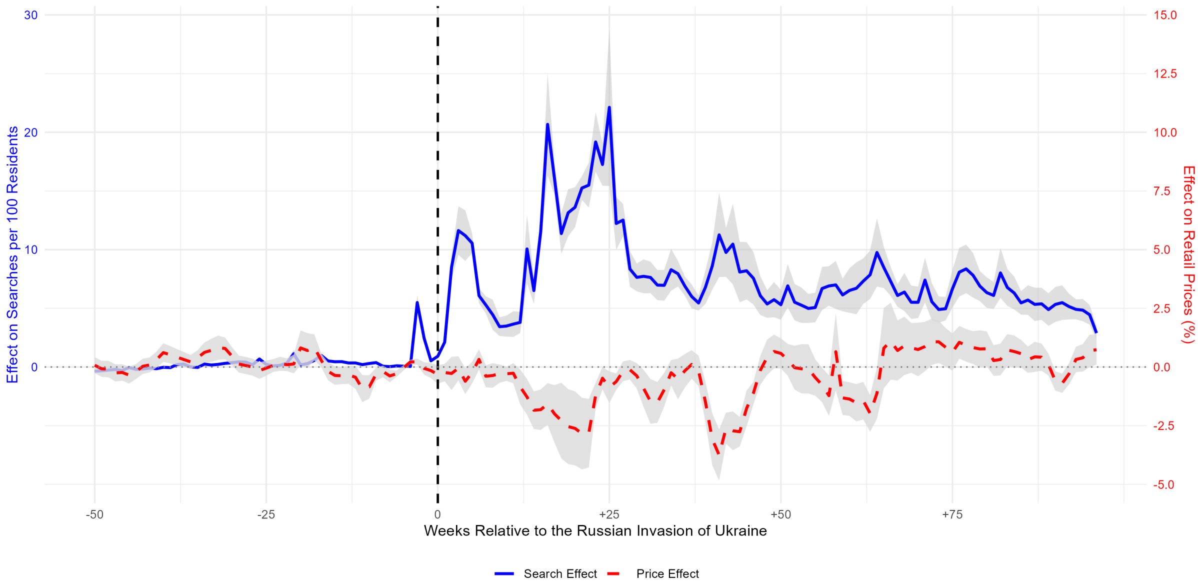
Identification requires that, absent the differential increase in search generated by the invasion, stations with different levels of pre-invasion platform use would have followed parallel trends in retail prices and margins. Station fixed effects absorb permanent differences across stations, while year-week fixed effects absorb changes in crude oil prices, wholesale fuel costs, and other aggregate shocks common to all stations. The absence of differential pre-trends in search, retail prices and margins provides support for this identifying assumption, while the first-stage estimates establish that the invasion generated substantially larger increases in search around stations with greater pre-existing platform use.

4.1.2 Results

Figure 3 presents the event-study estimates. Before the invasion, both the search and price coefficients fluctuate around zero, with no evidence of differential pre-trends across stations with different levels of pre-invasion search intensity. This supports the identifying assumption that, absent the shock, search activity and prices around these stations would have evolved similarly.

The invasion generates a large and persistent first stage. Search increases disproportionately around stations with greater pre-existing use of PetrolPrices.com. At its peak, one additional daily January 2022 search appearance per 100 residents predicts the invasion-induced increase in contemporaneous search activity to be approximately 20 additional daily search appearances per 100 residents, relative to the omitted fifth week before the invasion. The difference in baseline search intensity between stations at the 5th and 95th percentiles, equivalent to approximately 2 standard deviations, therefore implies an increase of approximately four additional daily search appearances per 100 residents at the 95th-percentile station. This represents a sizeable increase in search activity, particularly because the population denom-

Figure 3: Consumer Search and Retail Prices



Notes: The figure presents event-study estimates from estimating equation 1. The blue line denotes the first stage with contemporaneous daily search appearances per 100 residents as the dependent variable, while the red line shows the reduced form with the logarithm of a station's average weekly diesel retail price as the dependent variable. Coefficients are measured relative to 5 weeks before the full-scale invasion. Shaded areas indicate 95% confidence levels. Standard errors are clustered at the station level.

inator includes many residents who do not purchase fuel, and because consumers need not search every day: a single search may be sufficient to update their beliefs about relative prices at nearby stations for the following week or two. Although the effect subsequently declines, it remains positive throughout the post-invasion period.

Retail prices move in the opposite direction. As the differential increase in search emerges, stations more exposed to the search shock begin to charge lower prices. At its largest, the coefficient of 3–4 per cent implies a reduction in retail prices of approximately 0.6–0.8 per cent for the 95th-to-5th percentile difference described above, or 0.3–0.4 per cent for a one-standard-deviation increase. Because wholesale costs and other aggregate shocks are absorbed by the week fixed effects, these lower retail prices also imply narrower retail margins. The corresponding estimates in Figure 6 imply reductions in margins of approximately 8 per cent for the 95th-to-5th percentile difference and 4 per cent for a one-standard-deviation increase, given the average diesel margin of 13 ppl over the period. The estimates therefore show that the invasion-induced increase in consumer search intensified local competition and compressed markups. The direction of this effect is consistent with Lewis and Marvel (2011), who use aggregate traffic to a fuel-price comparison website to document a negative relationship between consumer search and retail margins; our station-level design isolates the causal effect of the shock-induced increase in search.

The event-study estimates reveal a clear negative causal relationship between the invasion-induced increase in consumer search and retail prices. The two series display broadly mirrored responses over much of the post-invasion period; stronger increases in search generally lead to larger reductions in retail prices. The relationship is not, however, proportional throughout the event window. The initial surge in search produces little immediate price response, whereas the subsequent sustained period of elevated search generates a pronounced decline in prices. Around week 40, the first-stage estimate is approximately 10 additional daily search appearances per 100 residents and the reduced-form retail-price effect is approximately 2.5–3 per cent. Combining these estimates implies that one additional daily search appearance per 100 residents reduces retail prices by approximately 0.25–0.30 per cent (and reduces diesel margins by 4 per cent of the average margin). As the instrument-induced search response declines during the final year of the sample, the retail-price effect returns towards zero. The results therefore suggest that the effect of search on prices is nonlinear: large and sustained increases in consumer attention temporarily intensify competitive pressure, whereas smaller or short-lived increases appear insufficient to generate an immediate or proportionate price response.

Figure 7 in the appendix estimates the baseline specification in equation (1) separately by whether a station priced above the median within its local market in the omitted pre-invasion week, where the local market comprises all stations within five miles, the platform's default search radius. The decline in retail prices is concentrated mostly among stations that were relatively expensive before the invasion. This pattern is consistent with greater consumer search primarily disciplining stations with initially higher prices rather than generating a uniform market-wide reduction.

4.1.3 Aggregate Effects

Finally, we quantify the aggregate effect of the search response on consumer savings, and thus retailer profit losses assuming the elasticity of demand for fuel is zero in the short run. We calculate

$$\widehat{S} = \sum_{k=0}^{52} \frac{Q}{53}\, \bar{P}_k \sum_j \omega_j \left[\exp\!\left(-\widehat{\beta}_k s_j^0 \right) - 1 \right]. \tag{2}$$

where Q is annual petrol and diesel consumption,[3] $\bar{P}_k$ is the weekly average fuel price, weighted 60 per cent towards diesel and 40 per cent towards unleaded,[4] s_j^0 is station j's pre-invasion search intensity, and ω_j is its share of total fuel volume (available in the Experian data). This integrates the estimated price effect over weeks 0–52 and over the full volume-weighted distribution of exposure, relative to a counterfactual in which search intensity is zero. The resulting estimate implies approximately £77 million ($95.2 million) in consumer savings, or alternatively lost profits to retailers, during the first year after the invasion. The weekly effects are economically substantial: estimated savings exceed £4 million ($4.9 million) in several weeks and peak at approximately £5.2 million ($6.4 million) in week 41 alone. As a robustness exercise, applying the weekly IV estimate of the effect of search on prices to each station's contemporaneous weekly search intensity suggests a similar, though slightly smaller, saving of approximately £64 million ($79.2 million).[5]

These estimates establish that increases in consumer search intensify retail competition and compress margins. We next develop a simple model of endogenous attention that rationalises this result and derives additional predictions for the aggregate adjustment of retail prices to wholesale costs.

5 Interpreting the Evidence

The descriptive and causal evidence points to a common mechanism. Large and salient increases in prices generate sharp increases in consumer search, while the spatial design shows that greater search

[3]We set $Q = 42.2$ billion litres, based on the Department for Transport's estimate of UK road-transport consumption of motor fuel in 2022 (Department for Transport, 2025).

[4]The 60:40 weighting approximates the relative volumes of diesel and petrol sold in the UK. The CMA reports diesel sales of approximately 26 billion litres in 2021, compared with approximately 17 billion litres of petrol (Competition and Markets Authority, 2023).

[5]Specifically, we calculate $\widehat{S}^{IV} = \sum_{k=0}^{52} \frac{Q}{53} \bar{P}_k \sum_j \omega_j \left[\exp\!\left(-\widehat{\theta}_k s_{jk} \right) - 1 \right]$, where $\widehat{\theta}_k = \widehat{\beta}_k / \widehat{\pi}_k$ is the weekly IV estimate, $\widehat{\pi}_k$ is the corresponding first-stage estimate, and s_{jk} is station j's contemporaneous search intensity in week k.

intensifies competitive pressure and reduces retail prices and margins. As prices subsequently stabilise or fall, search declines and margins recover. We use a simple model of endogenous consumer attention to rationalise these patterns and derive additional predictions for the aggregate pass-through of wholesale costs into retail prices.

Consider a market with differentiated petrol stations indexed by $j = 1, \ldots, J$. There is a mass of consumers indexed by i, each of whom purchases one unit of fuel in each time period t. Consumer i's indirect utility from purchasing from station j at time t is

$$u_{ijt} = \xi_j - \alpha_t p_{jt} + \varepsilon_{ijt} \tag{3}$$

where ξ_j captures time-invariant station characteristics, p_{jt} is the retail price charged by station j, and ε_{ijt} is an i.i.d. Type-I extreme-value consumer–station taste shock. Consumer price sensitivity depends on aggregate attention,

$$\alpha_t = \alpha + \gamma A_t, \qquad \gamma > 0 \tag{4}$$

Greater attention therefore makes consumers more responsive to price differences across stations.

Stations compete in prices under differentiated product competition. The standard logit pricing condition implies that the retail margin of station j is

$$\mu_{jt} \equiv p_{jt} - w_t = \frac{1}{(\alpha + \gamma A_t)(1 - s_j)}, \tag{5}$$

where w_t is the common wholesale price of fuel and s_j is station j's market share.[6] Greater attention therefore increases consumers' price sensitivity and places downward pressure on retail margins.

Attention is persistent and responds to salient increases in the aggregate retail price. Let $\bar{p}_t$ denote the aggregate retail price and $\bar{A}$ the baseline level of attention. We assume

$$A_t - \bar{A} = \rho(A_{t-1} - \bar{A}) + \kappa[\Delta\bar{p}_{t-1} - \tau]_+, \qquad 0 \leq \rho < 1, \quad \kappa > 0, \tag{6}$$

where $\tau \geq 0$ is a salience threshold and $[x]_+ \equiv \max\{x, 0\}$. Small or gradual price increases that remain below the salience threshold therefore generate no additional attention. Large and rapid price increases instead produce a sharp increase in attention. Once such increases cease, attention gradually returns towards its baseline level. Because each individual station is small relative to the aggregate market, its own price has a negligible effect on the aggregate retail price index and hence on the evolution of aggregate attention. Stations therefore take A_t and its law of motion as given when setting prices.

5.1 Model Implications

The model generates four predictions that map directly into the empirical patterns documented above and provide additional predictions for aggregate pass-through.

[6] In this environment, equilibrium station market shares are invariant to both aggregate wholesale costs and aggregate attention. Because the wholesale-cost shock is common across stations and consumers have no outside option, an equal additive increase in all retail prices leaves relative prices and hence market shares unchanged. Similarly, a common increase in attention raises price sensitivity at all stations and compresses equilibrium margins proportionally, leaving utility differences across stations, and hence market shares, unchanged. This differs from other price-salience pass-through environments such as that in Bakker and Datta (2025), where the cost shock is firm-specific.

Implication 1: Salient price increases raise consumer attention.

The attention process implies that price increases affect attention only when they are sufficiently large to cross the salience threshold:

$$A_t - \bar{A} - \rho(A_{t-1} - \bar{A}) = \kappa[\Delta\bar{p}_{t-1} - \tau]_+ = \begin{cases} 0, & \Delta\bar{p}_{t-1} \leq \tau, \\ \kappa(\Delta\bar{p}_{t-1} - \tau) > 0, & \Delta\bar{p}_{t-1} > \tau. \end{cases} \tag{7}$$

This maps directly into Figure 2. The long, gradual increase in fuel prices before the invasion generates little to no change in search, and even the relatively rapid increase in late 2021 does not produce the discrete increase in search observed subsequently. By contrast, the sharp price increase following Russia's invasion generates an immediate surge in search, as does the second rapid increase in prices later in 2022. In the language of the model, the former price movements remain below the salience threshold, while the two large post-invasion increases cross τ and generate substantial additional consumer attention.

The magnitude of the response is also informative about the shape of the attention process. The threshold τ governs whether a price increase attracts additional attention, while κ governs the strength of the response once that threshold is crossed. The twenty-fold increase in search following the post-invasion price movements suggests that this intensive-margin response is substantial.

Implication 2: Greater consumer attention compresses retail margins.

A sufficiently large wholesale-price increase raises retail prices enough to trigger additional attention. Greater attention increases price sensitivity and, from the station pricing condition, reduces the retail margin.

$$\begin{gathered} \Delta w_t \text{ sufficiently large} \Longrightarrow \Delta\bar{p}_t > \tau \Longrightarrow A_{t+1} \uparrow, \\ \frac{d\mu_{j,t+1}}{dA_{t+1}} = -\frac{\gamma}{(\alpha + \gamma A_{t+1})^2(1 - s_j)} < 0. \end{gathered} \tag{8}$$

Since $p_{jt} = w_t + \mu_{jt}$, greater attention also reduces the retail price conditional on wholesale cost. This is the model counterpart of the central causal results in Figures 3 and 6 that greater consumer search reduces retail prices and compresses retail margins. The model therefore rationalises the main empirical finding that a large wholesale-cost shock can raise consumer attention sufficiently to intensify competition and compress, rather than expand, retailer margins.

Implication 3: Salient wholesale-price increases reduce pass-through.

The model implies that pass-through depends on whether a wholesale-price increase generates additional consumer attention. Let t denote the period in which the wholesale price increases. Because attention responds to lagged retail-price changes, a salient increase affects margins from period $t + 1$. Retail-price adjustment relative to the pre-shock period can therefore be decomposed as

$$p_{j,t+1} - p_{j,t-1} = \underbrace{w_{t+1} - w_{t-1}}_{\text{wholesale-cost increase}} - \underbrace{(\mu_{j,t-1} - \mu_{j,t+1})}_{\text{margin compression from increased attention}}. \tag{9}$$

For gradual wholesale-price movements that do not generate additional attention, retail margins remain unchanged and the aggregate wholesale-cost increase passes through one-for-one into retail prices. Following a sufficiently large and salient increase, by contrast, attention rises and margins compress. Retail prices therefore increase by less than wholesale costs. The model thus predicts lower pass-through following salient wholesale-price increases than following gradual increases that do not attract additional consumer attention. The mechanism also provides a channel through which the demand conditions governing cost pass-through (Weyl and Fabinger, 2013; Mrázová and Neary, 2017) can themselves change endogenously in response to the cost shock.

Implication 4: Salient price increases can generate temporary asymmetry in pass-through dynamics.

Consider a salient wholesale-price increase followed by a subsequent decrease in wholesale prices back towards their original level. Once gradual price adjustment is introduced, the realised margin $p_{jt} - w_t$ need not equal the frictionless margin $\mu_j(A_t)$. Let

$$p^*_{jt} \equiv w_t + \mu_j(A_t) \tag{10}$$

denote the frictionless target price. Suppose observed retail prices adjust gradually and symmetrically towards this target,

$$p_{jt} - p_{j,t-1} = \lambda \left[p^*_{jt} - p_{j,t-1}\right], \qquad 0 < \lambda \leq 1. \tag{11}$$

When attention remains at its baseline level, the frictionless margin is constant and this adjustment process generates identical pass-through dynamics for wholesale-price increases and decreases of the same magnitude. Following a salient increase, however, attention becomes elevated and the frictionless margin compresses. When wholesale prices subsequently fall and retail-price increases no longer cross the salience threshold, no new attention is generated. For $A_{t-1} > \bar{A}$ and $\Delta\bar{p}_{t-1} \leq \tau$,

$$\Delta A_t = -(1-\rho)(A_{t-1} - \bar{A}) < 0. \tag{12}$$

so attention dissipates and frictionless margins recover,

$$\Delta A_t < 0 \quad \Longrightarrow \quad \underbrace{\Delta\mu_j(A_t) > 0}_{\text{frictionless margin recovery}} \quad . \tag{13}$$

Recovery in the frictionless margin offsets part of the contemporaneous decline in wholesale costs in the frictionless target price towards which retailers are adjusting,

$$\Delta p^*_{jt} = \underbrace{\Delta w_t}_{<0} + \underbrace{\left[\mu_j(A_t) - \mu_j(A_{t-1})\right]}_{>0}. \tag{14}$$

The resulting pass-through dynamics depend on the interaction between λ, which governs the speed of retail-price adjustment, and ρ, which governs the persistence of attention and hence margin recovery. When the frictionless margin recovers sufficiently quickly while retail prices are still adjusting, wholesale-price decreases can pass through more slowly than preceding increases. This asymmetry is temporary. As attention returns to baseline, frictionless-margin recovery disappears, and if wholesale prices also return to their original level, retail prices converge back to their original level. Thus, following a sufficiently strong attention shock, the model can generate faster pass-through of wholesale-price increases than subsequent decreases without implying different eventual pass-through. This mechanism is closely related to the search-based explanation for rockets-and-feathers pricing in Lewis (2011), but here the change in consumer search is generated endogenously by a salient aggregate supply shock.

The first two predictions rationalise the descriptive and causal evidence already documented in Figures 2, 3, and 6. The final two predictions provide additional implications that we can take to the data. We therefore next compare aggregate wholesale-to-retail pass-through before and after Russia's invasion of Ukraine, testing whether pass-through changes from approximately complete and symmetric in the pre-invasion period to incomplete and asymmetric following the salient post-invasion shock.

5.2 Testing Implications 3 and 4

Following the canonical asymmetric distributed-lag error-correction approach of Borenstein et al. (1997), we estimate

$$\begin{aligned}\Delta P_{jt} = &\sum_{l=0}^{L} \beta_l^I \left(W_{t-l} - W_{t-l-1}\right) \mathbb{1}\left(W_{t-l} > W_{t-l-1}\right) \\ &+ \sum_{l=0}^{L} \beta_l^D \left(W_{t-l} - W_{t-l-1}\right) \mathbb{1}\left(W_{t-l} \leq W_{t-l-1}\right) \\ &+ \eta P_{j,t-1} + \varphi W_{t-1} + \theta_j + \varepsilon_{jt}\end{aligned} \tag{15}$$

for one year pre (24 February 2021 to 23 February 2022) and one year post (24 February 2022 to 23 February 2023) the full-scale Russian invasion of Ukraine. Here, ΔP_{jt} is the change in the retail fuel price at station j on trading day t relative to the previous trading day, and W_t is the wholesale price. The coefficients β_l^I and β_l^D capture the effect on the current retail-price change of a wholesale-price increase or decrease occurring l trading days previously. The distributed-lag structure therefore allows both the magnitude and timing of pass-through to differ between wholesale-price increases and decreases.

The terms $P_{j,t-1}$ and W_{t-1} introduce an error-correction mechanism, allowing retail prices to respond not only to current and lagged wholesale-price changes but also to deviations from their long-run relationship with wholesale prices. For a stable error-correction process, $\eta < 0$, and the implied long-run wholesale-to-retail pass-through is $-\varphi/\eta$. Station fixed effects, θ_j, absorb persistent station-specific differences in retail-price levels, including differences in average retail margins.[7] The pass-through coefficients are therefore identified from within-station changes in retail prices over time.

We exclude weekends because wholesale benchmark prices are not observed on Saturdays and Sundays. The sequence of observations is consequently defined in trading days, with Monday treated as the trading day immediately following Friday. A Monday retail-price change is therefore measured relative to the preceding Friday, and the lag index l throughout refers to trading days rather than calendar days.

Equation (15) allows us to examine both implications of the model at the aggregate level. Implication 3 predicts lower pass-through following the salient post-invasion wholesale-price shock, while Implication 4 predicts that the subsequent adjustment can become dynamically asymmetric, with wholesale-price decreases passing through more slowly than increases. Importantly, the error-correction term allows such differences in short-run adjustment to be distinguished from gradual convergence towards the long-run relationship between retail and wholesale prices.

[7] This is particularly useful because the panel is unbalanced, so the composition of observed stations can change over time.

To characterise the dynamic response, we construct cumulative pass-through coefficients. For a one-unit wholesale-price increase at trading day zero, let δ_k^I denote the cumulative retail-price response after k trading days. The response is given recursively by

$$\delta_k^I = \begin{cases} \beta_0^I, & k = 0, \\ (1+\eta)\delta_{k-1}^I + \beta_k^I + \varphi, & k > 0, \end{cases} \tag{16}$$

where $\beta_k^I = 0$ for $k > L$. We construct δ_k^D analogously for a one-unit wholesale-price decrease. The sequences $\{\delta_k^I\}$ and $\{\delta_k^D\}$ therefore trace the cumulative pass-through of wholesale-price increases and decreases, respectively, while incorporating both the direct distributed-lag response and subsequent error correction.

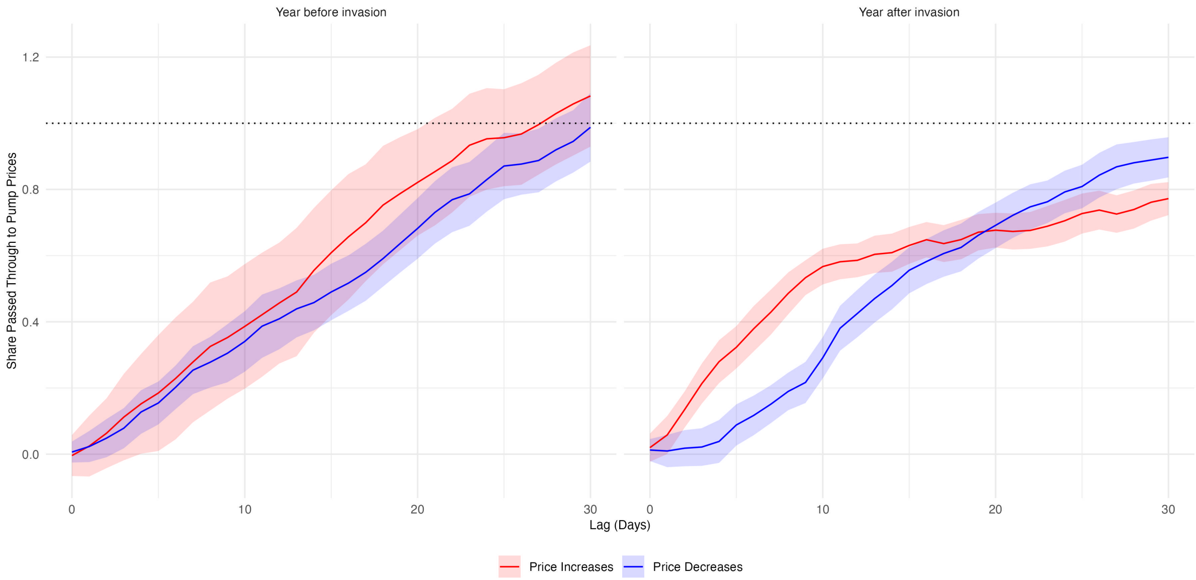
Figure 4 shows a marked change in pass-through following the invasion. In the pre-invasion period, wholesale-price increases and decreases generate very similar retail-price responses. Both adjust gradually, their confidence intervals overlap throughout most of the horizon, and cumulative pass-through approaches one after around 30 trading days. There is therefore little evidence of systematic asymmetric pass-through in the year preceding the invasion. This absence of asymmetry is notable given the extensive evidence of "rockets-and-feathers" pricing in motor-fuel markets (Bacon, 1991; Borenstein et al., 1997; Byrne, 2015; Genakos et al., 2026).

The post-invasion period looks very different. First, cumulative pass-through is lower: even after 30 trading days both responses remain below the near-complete pass-through observed before the invasion. This is consistent with Implication 3 of the model, under which the increase in consumer attention following a salient wholesale-price shock compresses retail margins and reduces the share of the wholesale-cost movement passed through to pump prices.

Second, the dynamics become sharply asymmetric. Following wholesale-price increases, pass-through rises rapidly, reaching around one-half within the first ten trading days. Wholesale-price decreases initially pass through much more slowly, with the two response paths clearly separated over the early part of the adjustment horizon. The gap subsequently closes, with the responses converging at around 18–20 trading days before the estimated pass-through of decreases catches up with that of increases. The asymmetry therefore lies primarily in the speed and path of adjustment rather than in a permanently lower response to wholesale-price decreases. This pattern is consistent with Implication 4. Following the large attention shock, declining attention and recovering retail margins can temporarily offset wholesale-price decreases and slow their pass-through to pump prices.

Taken together, the results provide a consistent aggregate counterpart to the station-level evidence above. Before the invasion, when consumer attention is comparatively stable, wholesale-cost changes pass through gradually but approximately symmetrically. Following the salient post-invasion shock, overall pass-through falls and a pronounced, but temporary, rockets-and-feathers pattern emerges.

Figure 4: Wholesale-to-retail price pass-through before and after Russia's invasion of Ukraine.



Notes: The figure presents estimates of cumulative pass-through, δ_k^I and δ_k^D, constructed according to Equation (16). The left panel reports estimates using the year preceding Russia's invasion of Ukraine, while the right panel reports estimates using the year following the invasion. Shaded areas indicate 95% confidence intervals. Standard errors are clustered at the day level.

6 Conclusion

Large supply shocks often generate concerns that retailers exploit rising input costs to expand markups. We find the opposite in the UK fuel market following Russia's invasion of Ukraine. Retail margins compressed sharply as prices rose, while consumer search increased more than twentyfold. Using predetermined spatial variation in platform use, we show that this increase in search causally intensified competition and reduced retail prices and margins, with the 95th-to-5th percentile difference in exposure implying an approximately 8% reduction in margins at the peak of the effect. Our model rationalises these findings through an endogenous-attention mechanism in which large and rapid price increases induce consumers to search more and become more price sensitive. Consistent with its additional implications, wholesale-cost pass-through is lower following the shock and changes from approximately symmetric before the invasion to temporarily asymmetric afterwards.

The broader implication is that supply shocks can change not only firms' costs but also the competitive environment in which those costs are passed through. The speed of the shock matters. Fuel prices increased substantially but gradually before the invasion with little response in consumer search, whereas large and rapid price movements generated dramatic increases in attention. This mechanism is unlikely to be specific to fuel. In markets with transparent and readily comparable prices, abrupt cost shocks may themselves strengthen competitive discipline by inducing consumers to acquire information and compare firms more actively. The effect of a supply shock on markups may therefore depend not only on its magnitude, but also on how rapidly it arrives and how easily consumers can respond by comparing prices across firms.

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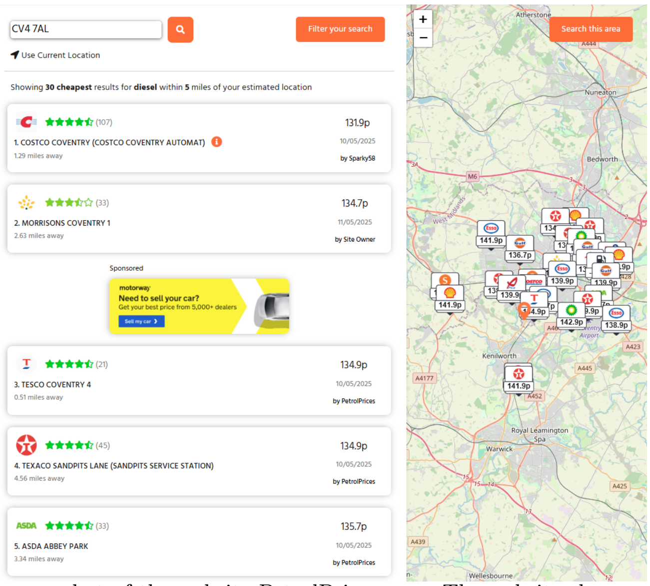
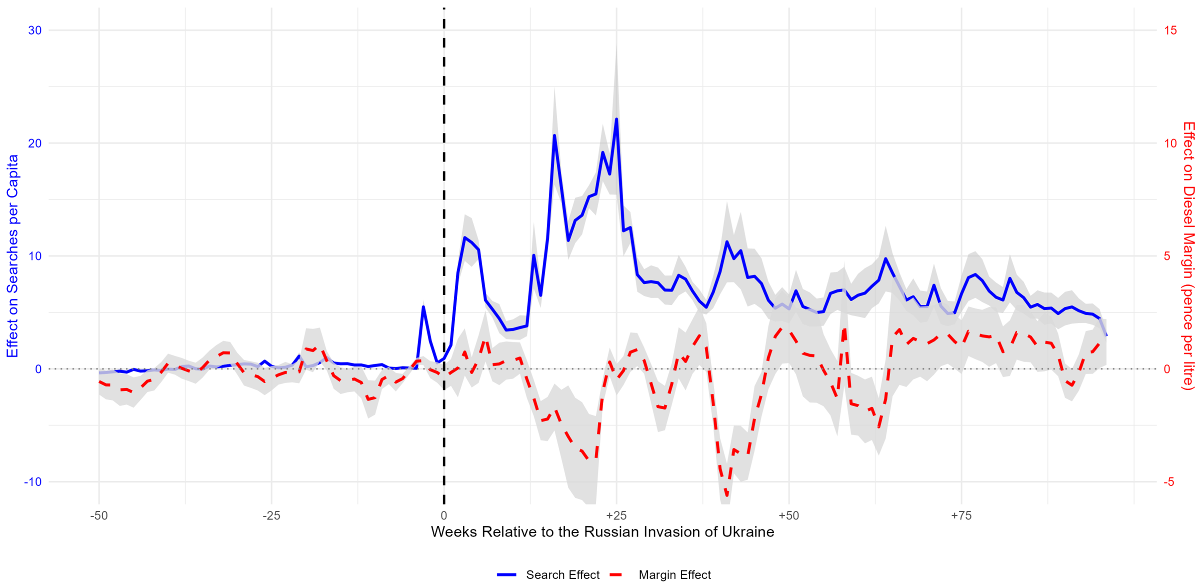
A Additional Figures

Figure 5: PetrolPrices.com Price Comparison



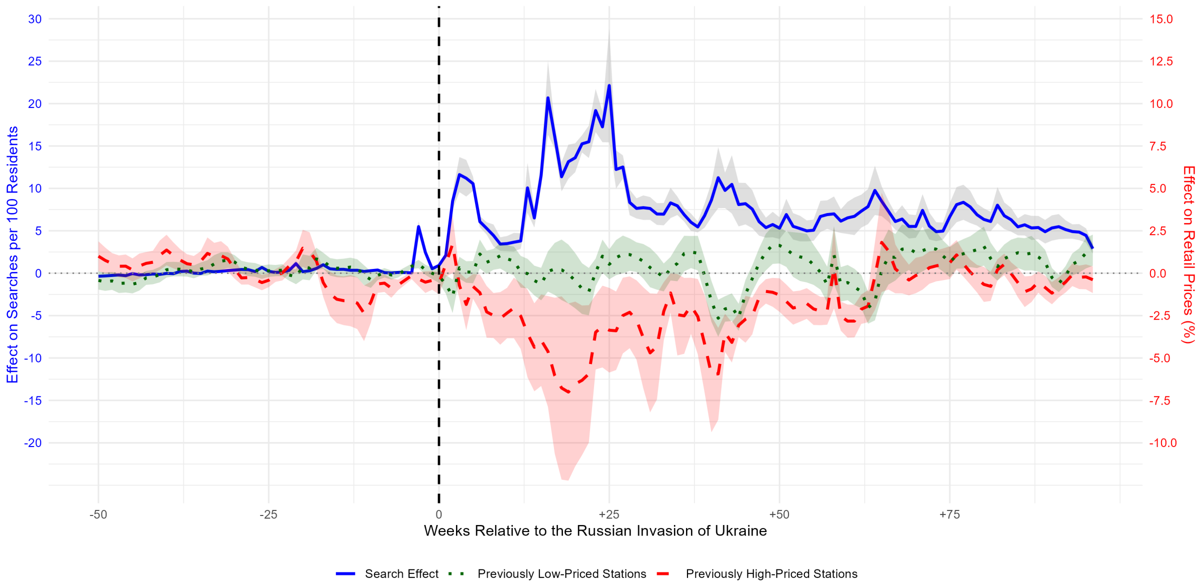
Notes: The figure shows a screenshot of the website PetrolPrices.com. The website shows a map with stations around the University of Warwick and orders them in a list by their retail prices.

Figure 6: Consumer Search and Retailer Margins



Notes: The figure presents event-study estimates from estimating equation 1. The blue line denotes the first stage with contemporaneous daily search appearances per 100 residents as the dependent variable, while the red line shows the reduced form with stations' average weekly margin in pence per litre for diesel fuel as the dependent variable. Coefficients are measured relative to 5 weeks before the full-scale invasion. Shaded areas indicate 95% confidence levels. Standard errors are clustered at the station level.

Figure 7: Consumer Search and Heterogeneous Price Effects



Notes: The figure presents event-study estimates from estimating equation 1. The blue line denotes the first stage with contemporaneous daily search appearances per 100 residents as the dependent variable. The green and red lines show the reduced form with the logarithm of a station's average weekly diesel retail price as the dependent variable, broken up by stations which posted, during the week 5 weeks before the invasion, prices lower than the median price in their local market (green line) and those stations that posted prices above the median (red line). Coefficients are measured relative to 5 weeks before the full-scale invasion. Shaded areas indicate 95% confidence levels. Standard errors are clustered at the station level.

B Model Derivations

This appendix provides the derivations underlying the model and the four implications discussed in Section 5. We first derive the static pricing equilibrium and the relationship between consumer attention, retail margins, and wholesale-cost pass-through. We then append a simple symmetric process of gradual price adjustment in order to characterise the dynamic asymmetry considered in Implication 4. The adjustment process does not alter the frictionless pricing condition or the qualitative implications derived from it.

B.1 Demand and Static Pricing

There is a unit mass of consumers indexed by i and J differentiated petrol stations indexed by j. Each consumer purchases one unit of fuel in each period and chooses among the J stations, so there is no outside option. Consumer i's indirect utility from purchasing from station j in period t is

$$u_{ijt} = \xi_j - \alpha_t p_{jt} + \varepsilon_{ijt}, \tag{17}$$

where ξ_j denotes time-invariant station characteristics, p_{jt} is the retail price, and ε_{ijt} is an i.i.d. Type-I extreme-value taste shock. Price sensitivity depends on aggregate consumer attention,

$$\alpha_t = \alpha + \gamma A_t, \qquad \gamma > 0, \tag{18}$$

where $\alpha + \gamma A_t > 0$. The corresponding logit market share of station j is

$$s_{jt} = \frac{\exp(\xi_j - \alpha_t p_{jt})}{\sum_{k=1}^{J} \exp(\xi_k - \alpha_t p_{kt})}. \tag{19}$$

We normalise the mass of consumers to one. Station j therefore chooses its price to maximise

$$\pi_{jt} = (p_{jt} - w_t)s_{jt}, \tag{20}$$

where w_t is the common per-unit wholesale cost of fuel.[8]
For logit demand,

$$\frac{\partial s_{jt}}{\partial p_{jt}} = -\alpha_t s_{jt}(1 - s_{jt}). \tag{21}$$

The first-order condition for an interior optimum is therefore

$$\begin{aligned} 0 &= s_{jt} + (p_{jt} - w_t)\frac{\partial s_{jt}}{\partial p_{jt}} \\ &= s_{jt}\left[1 - \alpha_t(p_{jt} - w_t)(1 - s_{jt})\right]. \end{aligned} \tag{22}$$

Hence the frictionless retail margin is

$$\mu_{jt} \equiv p_{jt} - w_t = \frac{1}{\alpha_t(1 - s_{jt})} = \frac{1}{(\alpha + \gamma A_t)(1 - s_{jt})}. \tag{23}$$

B.1.1 Equilibrium market shares

Although the pricing condition in Equation (23) contains the station's market share, equilibrium shares are invariant to common changes in wholesale costs and aggregate attention in this environment. Multiplying Equation (23) by α_t gives

$$\alpha_t(p_{jt} - w_t) = \frac{1}{1 - s_{jt}}. \tag{24}$$

The deterministic component of consumer utility can therefore be written as

$$\begin{aligned} \xi_j - \alpha_t p_{jt} &= \xi_j - \alpha_t w_t - \alpha_t(p_{jt} - w_t) \\ &= \xi_j - \alpha_t w_t - \frac{1}{1 - s_{jt}}. \end{aligned} \tag{25}$$

Substituting this expression into the logit choice probabilities yields

$$s_{jt} = \frac{\exp\left(\xi_j - \frac{1}{1-s_{jt}}\right)}{\sum_{k=1}^{J}\exp\left(\xi_k - \frac{1}{1-s_{kt}}\right)}. \tag{26}$$

The common term $-\alpha_t w_t$ cancels from all choice probabilities. Equation (26) therefore contains neither w_t nor α_t. Equilibrium market shares are consequently determined by the time-invariant station characteristics $\{\xi_j\}_{j=1}^{J}$ and may be written

$$s_{jt} = s_j. \tag{27}$$

Stations may therefore have different equilibrium market shares, but common changes in wholesale costs and aggregate attention do not change those shares in this parsimonious environment. Substituting Equation (27) into the pricing condition gives

[8] In the model, w_t represents the relevant common wholesale input cost faced by stations. Empirically, we proxy this object using the observed wholesale benchmark.

$$\mu_j(A_t) = \frac{1}{(\alpha + \gamma A_t)(1 - s_j)}. \tag{28}$$

Two comparative statics follow immediately. Holding attention fixed,

$$\frac{\partial p_{jt}}{\partial w_t} = 1, \tag{29}$$

so a common wholesale-cost change passes through one-for-one into frictionless retail prices. By contrast,

$$\frac{d\mu_j(A_t)}{dA_t} = -\frac{\gamma}{(\alpha + \gamma A_t)^2(1 - s_j)} < 0, \tag{30}$$

so greater consumer attention compresses retail margins.

B.2 Endogenous Consumer Attention

Let $\bar{p}_t$ denote the realised aggregate retail price and $\bar{A}$ the baseline level of consumer attention. Attention evolves according to

$$A_t - \bar{A} = \rho(A_{t-1} - \bar{A}) + \kappa[\Delta\bar{p}_{t-1} - \tau]_+, \qquad 0 \leq \rho < 1, \quad \kappa > 0, \tag{31}$$

where $[x]_+ \equiv \max\{x, 0\}$ and $\tau \geq 0$ is the salience threshold. The aggregate price may be understood as any fixed-weight index of station prices,

$$\bar{p}_t = \sum_{j=1}^{J} \omega_j p_{jt}, \qquad \omega_j \geq 0, \qquad \sum_{j=1}^{J} \omega_j = 1. \tag{32}$$

Because each individual station is small relative to the aggregate market, it takes A_t and its law of motion as given when setting its price. The timing is

$$\bar{p}_{t-1} \longrightarrow A_t \longrightarrow p_{jt} \longrightarrow \bar{p}_t \longrightarrow A_{t+1}, \tag{33}$$

so current attention is predetermined when stations set period-t prices.

B.2.1 Implication 1: salient price increases raise consumer attention

Equation (31) can be written in terms of the innovation to attention as

$$A_t - \bar{A} - \rho(A_{t-1} - \bar{A}) = \kappa[\Delta\bar{p}_{t-1} - \tau]_+ = \begin{cases} 0, & \Delta\bar{p}_{t-1} \leq \tau, \\ \kappa(\Delta\bar{p}_{t-1} - \tau) > 0, & \Delta\bar{p}_{t-1} > \tau. \end{cases} \tag{34}$$

Price increases below the threshold therefore generate no additional attention, whereas increases above the threshold generate a positive attention innovation.
In particular, if attention is initially at its baseline level and the retail price increase in period t crosses the threshold, then

$$A_t = \bar{A}, \qquad \Delta\bar{p}_t > \tau \quad \Longrightarrow \quad A_{t+1} - \bar{A} = \kappa(\Delta\bar{p}_t - \tau) > 0. \tag{35}$$

Because a common wholesale-cost increase shifts frictionless retail prices one-for-one when attention is held fixed, a sufficiently large wholesale-cost increase can therefore generate the salient retail-price increase required to raise attention.

B.2.2 Implication 2: greater attention compresses retail margins

Suppose a salient price increase raises attention from $\bar{A}$ to $A^H > \bar{A}$. From Equation (30),

$$\mu_j(A^H) < \mu_j(\bar{A}). \tag{36}$$

The amount of margin compression is

$$\begin{aligned} c_j(A^H) &\equiv \mu_j(\bar{A}) - \mu_j(A^H) \\ &= \frac{1}{(1-s_j)(\alpha+\gamma\bar{A})} - \frac{1}{(1-s_j)(\alpha+\gamma A^H)} \\ &= \frac{\gamma(A^H-\bar{A})}{(1-s_j)(\alpha+\gamma\bar{A})(\alpha+\gamma A^H)} > 0. \end{aligned} \tag{37}$$

Since the frictionless retail price satisfies

$$p_{jt} = w_t + \mu_j(A_t), \tag{38}$$

the same increase in attention also reduces the retail price conditional on the wholesale cost.

B.2.3 Implication 3: salient wholesale-price increases reduce pass-through

Consider first a low-attention state in which wholesale cost is w^L and attention is at its baseline level. The frictionless retail price is

$$p_j^L = w^L + \mu_j(\bar{A}). \tag{39}$$

Now suppose wholesale costs rise by $\Delta w > 0$ and the resulting salient retail-price increase raises attention to $A^H > \bar{A}$. At the elevated wholesale cost and attention level,

$$p_j^H = w^L + \Delta w + \mu_j(A^H). \tag{40}$$

The total retail-price change between the low- and high-attention states is therefore

$$\begin{aligned} p_j^H - p_j^L &= \Delta w + \mu_j(A^H) - \mu_j(\bar{A}) \\ &= \underbrace{\Delta w}_{\text{wholesale-cost increase}} - \underbrace{c_j(A^H)}_{\text{margin compression}} \\ &< \Delta w. \end{aligned} \tag{41}$$

Normalising by the wholesale-cost increase gives

$$PT_j^H \equiv \frac{p_j^H - p_j^L}{\Delta w} = 1 - \frac{c_j(A^H)}{\Delta w} < 1. \tag{42}$$

By contrast, if the wholesale-cost increase does not generate additional attention, $A^H = \bar{A}$ and hence $c_j(A^H) = 0$. In that case,

$$PT_j = 1. \tag{43}$$

The model therefore predicts lower pass-through when a wholesale-cost increase raises consumer attention and compresses retail margins.
This is a transitional implication associated with elevated attention. If a permanent wholesale-cost increase is followed eventually by a complete return of attention to $\bar{A}$, the frictionless margin also returns to $\mu_j(\bar{A})$ and long-run frictionless pass-through of the common wholesale cost returns to one.

B.3 Gradual Price Adjustment and Dynamic Asymmetry

The previous results describe the frictionless price implied by the station pricing problem. Implication 4 concerns the path by which observed retail prices respond to changes in that frictionless price. Once gradual price adjustment is introduced, the realised margin $p_{jt} - w_t$ need not equal the frictionless margin $\mu_j(A_t)$. Going forward, we denote the frictionless target price by p^*_{jt} and the observed retail price by p_{jt}

$$p^*_{jt} \equiv w_t + \mu_j(A_t) \tag{44}$$

and suppose that the observed retail price p_{jt} adjusts symmetrically towards this target according to

$$p_{jt} - p_{j,t-1} = \lambda \left(p^*_{jt} - p_{j,t-1}\right), \qquad 0 < \lambda \leq 1. \tag{45}$$

Equivalently,

$$p_{jt} = (1 - \lambda)p_{j,t-1} + \lambda p^*_{jt}. \tag{46}$$

This reduced-form adjustment process does not alter the frictionless pricing condition derived above. It simply allows the observed retail price to converge gradually towards the price implied by the static model.

Because attention responds to the realised aggregate price change, gradual adjustment damps the movement that triggers salience. Following a wholesale-cost increase Δw at date t, with attention predetermined at its baseline level $A_t = \bar{A}$ and observed prices initially equal to their frictionless targets, $p_{j,t-1} = p^*_{j,t-1}$, the frictionless target rises by Δw but the aggregate realised price rises by only

$$\Delta \bar{p}_t = \lambda \Delta w \tag{47}$$

so $A_{t+1} - \bar{A} = \kappa[\lambda \Delta w - \tau]_+$ and the increase is salient iff $\lambda \Delta w > \tau$. A wholesale-cost increase that would generate a salient price movement under frictionless adjustment ($\Delta w > \tau$) therefore does not necessarily do so once adjustment is gradual ($\lambda \Delta w < \tau$).

B.3.1 Symmetric adjustment when attention is constant

Consider a permanent wholesale-cost change of magnitude $d > 0$ occurring at $t = 0$, and suppose the retail price is initially at its frictionless level. Suppose the resulting retail-price adjustment is not salient—automatically the case for a wholesale-cost decrease, while for a wholesale-cost increase this requires $\lambda d \leq \tau$—so that attention remains at $\bar{A}$ and the frictionless margin satisfies $\mu_j(A_t) = \mu_j(\bar{A})$ in every period.

For a wholesale-cost increase,

$$w_t = w_{-1} + d, \qquad t \geq 0, \tag{48}$$

the frictionless target price rises by exactly d. Iterating Equation (46) gives

$$p_{j,t} - p_{j,-1} = \left[1 - (1-\lambda)^{t+1}\right] d, \qquad t = 0, 1, 2, \ldots. \tag{49}$$

For an otherwise identical wholesale-cost decrease,

$$w_t = w_{-1} - d, \qquad t \geq 0, \tag{50}$$

the response is

$$p_{j,t} - p_{j,-1} = -\left[1 - (1-\lambda)^{t+1}\right] d. \tag{51}$$

Let $p^I_{j,t}$ and $p^D_{j,t}$ denote the price paths under the wholesale-costs increase and decrease. Hence

$$\left|p^I_{j,t} - p_{j,-1}\right| = \left|p^D_{j,t} - p_{j,-1}\right| \tag{52}$$

at every horizon. The adjustment process therefore produces gradual but symmetric pass-through when attention, and hence the frictionless margin, remains constant.

B.3.2 The earlier pass-through result is preserved

It is useful to verify that gradual adjustment does not overturn Implication 3. Consider two price paths facing the same wholesale-cost sequence and the same value of λ. In the first, attention remains at baseline; in the second, attention becomes elevated after the salient shock.
Let p^0_{jt} denote the observed price under baseline attention and p^A_{jt} the observed price when attention is elevated. Their respective frictionless targets are

$$p^{*,0}_{jt} = w_t + \mu_j(\bar{A}) \tag{53}$$

and

$$p^{*,A}_{jt} = w_t + \mu_j(A_t). \tag{54}$$

Whenever $A_t \geq \bar{A}$,

$$p^{*,A}_{jt} \leq p^{*,0}_{jt}. \tag{55}$$

Subtracting the two adjustment equations yields

$$p^A_{jt} - p^0_{jt} = (1-\lambda)\left(p^A_{j,t-1} - p^0_{j,t-1}\right) + \lambda\left[\mu_j(A_t) - \mu_j(\bar{A})\right]. \tag{56}$$

The two paths share the same pre-shock price, and once attention is elevated it remains weakly above baseline, $A_t \geq \bar{A}$, at every subsequent horizon. Hence the margin term in Equation (56) is weakly negative throughout. It follows recursively that

$$p^A_{jt} \leq p^0_{jt}. \tag{57}$$

Thus adding gradual adjustment preserves the earlier result that the attention response lowers retail-price pass-through of the cost increase relative to the low-attention counterfactual.

B.3.3 Implication 4: temporary asymmetric pass-through

Now consider the period following a salient price increase. Suppose attention is elevated at the end of period $t-1$,

$$A_{t-1} > \bar{A}, \tag{58}$$

and that retail-price increases no longer cross the salience threshold,

$$\Delta \bar{p}_{t-1} \leq \tau. \tag{59}$$

There is therefore no new attention innovation, and Equation (31) becomes

$$A_t - \bar{A} = \rho(A_{t-1} - \bar{A}). \tag{60}$$

Hence

$$\Delta A_t = A_t - A_{t-1} = -(1-\rho)(A_{t-1} - \bar{A}) < 0. \tag{61}$$

Since the frictionless margin is decreasing in attention, this decline in attention causes the frictionless margin to recover. Define the period-t recovery in the frictionless margin as

$$r_{jt} \equiv \mu_j(A_t) - \mu_j(A_{t-1}). \tag{62}$$

Using Equation (28),

$$\begin{aligned} r_{jt} &= \frac{1}{(1-s_j)(\alpha+\gamma A_t)} - \frac{1}{(1-s_j)(\alpha+\gamma A_{t-1})} \\ &= \frac{\gamma(A_{t-1} - A_t)}{(1-s_j)(\alpha+\gamma A_t)(\alpha+\gamma A_{t-1})} \\ &= \frac{\gamma(1-\rho)(A_{t-1} - \bar{A})}{(1-s_j)(\alpha+\gamma A_t)(\alpha+\gamma A_{t-1})} > 0. \end{aligned} \tag{63}$$

Suppose wholesale costs fall in period t by $d_t > 0$, so that

$$\Delta w_t = -d_t. \tag{64}$$

The change in the frictionless target retail price is then

$$\begin{aligned} \Delta p^*_{jt} &= \Delta w_t + [\mu_j(A_t) - \mu_j(A_{t-1})] \\ &= -d_t + r_{jt}. \end{aligned} \tag{65}$$

Provided $r_{jt} < d_t$, the target price continues to fall, but by less than the wholesale cost itself. Recovery in the frictionless margin therefore acts against the decline in wholesale costs.

To see how this affects observed price adjustment, define the gap between the frictionless target and the observed retail price immediately before the wholesale-price decline as

$$g_{j,t-1} \equiv p^*_{j,t-1} - p_{j,t-1}. \tag{66}$$

Using Equation (45), the observed retail-price change during the downturn is

$$\begin{aligned}\Delta p_{jt} &= \lambda \left[p^*_{jt} - p_{j,t-1}\right] \\ &= \lambda \left[g_{j,t-1} - d_t + r_{jt}\right]. \end{aligned} \tag{67}$$

Holding the inherited adjustment gap $g_{j,t-1}$ fixed, in the counterfactual in which the frictionless margin remains compressed and does not recover $r_{jt} = 0$, giving

$$\Delta p^0_{jt} = \lambda \left[g_{j,t-1} - d_t\right]. \tag{68}$$

The difference between the two price changes is therefore

$$\Delta p_{jt} - \Delta p^0_{jt} = \lambda r_{jt} > 0. \tag{69}$$

Whenever both price changes are negative, Equation (69) implies that the absolute decline in the observed retail price is smaller when the frictionless margin is recovering. Thus recovery in the frictionless margin slows the realised pass-through of a wholesale-price decrease even though the primitive adjustment process λ is itself symmetric.

A simple matched-shock comparison illustrates the resulting adjustment asymmetry. Suppose first that a wholesale-cost increase of magnitude d occurs from a low-attention equilibrium in which the observed price is initially equal to its frictionless target. Because attention responds with a lag, the impact retail price increase is

$$\Delta p^I_{j,0} = \lambda d. \tag{70}$$

Because the wholesale-cost increase is common across stations, the aggregate retail-price increase on impact is also λd. For this increase to generate the elevated attention considered here, we require $\lambda d > \tau$.

Now consider a subsequent wholesale-cost decrease of the same magnitude while attention remains elevated but is dissipating. From Equation (67),

$$\Delta p^D_{jt} = \lambda \left[g_{j,t-1} - d + r_{jt}\right]. \tag{71}$$

If the observed price has not overshot its frictionless target, $g_{j,t-1} \geq 0$, and the wholesale-cost decline is sufficiently large that

$$d > g_{j,t-1} + r_{jt}, \tag{72}$$

then the retail price falls and

$$\begin{aligned}\left|\Delta p^D_{jt}\right| &= \lambda \left[d - g_{j,t-1} - r_{jt}\right] \\ &< \lambda d = \Delta p^I_{j,0}. \end{aligned} \tag{73}$$

Thus, following a sufficiently strong attention shock, the model can generate slower pass-through of a subsequent wholesale-price decrease than of the preceding wholesale-price increase. The exact magnitude and duration of this asymmetry depend on the joint dynamics of price adjustment and attention: λ governs the speed at which observed prices approach their frictionless targets, while ρ governs the persistence of elevated attention and hence the path of margin recovery.

B.3.4 The asymmetry is temporary

Finally, suppose there are no further salient price increases. Iterating the attention process gives

$$A_{t+h} - \bar{A} = \rho^h (A_t - \bar{A}), \qquad h = 0, 1, 2, \ldots, \tag{74}$$

and hence, because $0 \leq \rho < 1$,

$$A_{t+h} \longrightarrow \bar{A}. \tag{75}$$

It follows that

$$\mu_j(A_{t+h}) \longrightarrow \mu_j(\bar{A}), \tag{76}$$

so the margin-recovery term eventually disappears.

If wholesale costs also return to their original level w^L, the frictionless target converges to its original value,

$$p^*_{j,t+h} \longrightarrow w^L + \mu_j(\bar{A}) = p^L_j. \tag{77}$$

From Equation (46), with $0 < \lambda \leq 1$, the observed retail price then also converges to p^L_j. Thus the attention mechanism can generate different adjustment paths for wholesale-price increases and decreases without generating different eventual price levels. The asymmetry concerns the dynamics of pass-through rather than its eventual endpoint.