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A Model of Greedflation

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Abstract

I present a model where firms' pricing power increases with the volatility of the general price level. Confronted with a change in the price of a good, consumers solve a signal extraction problem to infer the good's relative price. Yet general price volatility obscures price signals, and consumers attribute part of any price change to variation in the price level. Ultimately, imperfect information confers firms with greater market power, raises the profit share, and magnifies inflationary shocks. These predictions are in line with recent empirical evidence.

JEL Codes: E30, E31, E32, E52

Keywords: Price level, Inflation, Informational Frictions, Inflation Volatility, Corporate Profits, Markups.

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Introduction

Particularly in media circles, the topic of "greedflation" has garnered significant attention in recent years. Referring to the rise in firms' markups following an inflationary shock, the concept has nonetheless received little formal treatment in academic circles.[1] Addressing this issue, in this paper I examine the interplay between market power and inflation, and show how optimal markups increase with the degree of price level uncertainty. Central to the framework is the assumption that consumers have imperfect information about the price level (see e.g., Coibion and Gorodnichenko, 2015). By making it harder for consumers to discern relative prices, this complicates consumers' decision making and enhances firms' pricing power.[2] Ultimately, price uncertainty raises a firm's profit share and amplifies inflationary shocks.

Adopting a setting of monopolistic competition, the only departure from standard theory is consumer uncertainty about the price level. Faced with this, the consumer solves a signal extraction problem to determine a good's relative price. As such, the informational friction is similar to that in the classic model of Lucas (1972), where perfectly competitive *sellers* are uncertain about the relative price of their good. Most importantly, as price level volatility rises in my setting, the consumer attributes more of any good's price change to variation in the general price level. In turn, this reduces the elasticity of demand and confers firms with more market power. More generally, the lower elasticity exemplifies the sluggish adjustment inherent to many rational inattention models; e.g., it also arises in the setting of Maćkowiak and Wiederholt (2015) in the face of business cycle uncertainty.

I proceed as follows. Section 1 presents a stylized model conveying the main insight of the paper and discusses its implications. Section 2 draws on recent empirical

[1] Two prominent exceptions are Weber and Wasner (2023) who maintain that a rise in input costs acts as a coordination device for tacit collusion, and Glover et al. (2023) who argue that prospective inflation motivates firms to raise prices preemptively.

[2] This accords with the European Central Bank's characterization of recent inflation dynamics. In a monetary policy statement issued on May 4, 2023, it noted that "*in some sectors firms have been able to increase their profit margins on the back of . . . the uncertainty created by high and volatile inflation*" (Lagarde and de Guindos, 2023).

evidence to evaluate the model. Section 3 concludes.

1 Model of Price Level Uncertainty

The economy comprises a representative consumer and a continuum of monopolistically competitive firms.

1.1 The Consumer Problem

The consumer has a love of variety and a constant elasticity of substitution (CES) utility function over a continuum of goods $i \in [0, 1]$:

$$\mathbf{U} = \left(\int_0^1 Q(i)^{\frac{\theta-1}{\theta}} \, di \right)^{\frac{\theta}{\theta-1}},$$

where $Q(i)$ denotes the quantity of good i consumed and $\theta > 1$. The income constraint is

$$\int_0^1 P(i) Q(i) \, di = E,$$

where $P(i)$ denotes the price of good i and E aggregate consumption expenditure. Maximizing utility yields the demand for good i:

$$Q(i) = \left(\frac{P(i)}{P} \right)^{-\theta} \frac{E}{P} \,,$$

where P is the aggregate price level. Rewriting this in log form gives

$$q(i) = -\theta r(i) + e - p, \tag{1}$$

where small letters denote logs and $r(i) = p(i) - p$. Driven by such factors as informational frictions, processing costs, or rational inattention, at the time of purchasing good i, the (log) price level p is uncertain. Assuming that $r(i)$ and $p(i)$ are joint normally distributed, upon observing $p(i)$ the consumer solves a signal extraction problem:

$$p(i) = r(i) + p \Rightarrow \mathbb{E}\big(r(i)|p(i)\big) = \frac{\sigma^2_{r(i)}}{\sigma^2_{r(i)} + \sigma^2_p}\big(p(i) - \mathbb{E}p\big),$$

where $\sigma^2 > 0$ denotes variance. Under certainty equivalence, log demand for good i, Eq. (1), reduces to

$$q(i) = -\left(\frac{\theta\,\sigma^2_{r(i)}}{\sigma^2_{r(i)} + \sigma^2_p}\right)\, p(i) + \varphi_i, \tag{2}$$

where firms take φ_i as given and I assume that $\frac{\theta\,\sigma^2_{r(i)}}{\sigma^2_{r(i)} + \sigma^2_p} > 1$. As the variance of the price level, σ^2_p, rises, the consumer ascribes less of any firm's price change to a change in its relative price. As a result, demand is less sensitive to relative price changes, and the elasticity of demand falls.

Proposition 1 *Confronted with a good's price $p(i)$ and an uncertain price level p, the effective price elasticity of demand is $\frac{\theta\,\sigma^2_{r(i)}}{\sigma^2_{r(i)} + \sigma^2_p} < \theta$, where θ is the elasticity in a setting of perfect information.*

1.2 Firms' Optimal Markups under Price Uncertainty

Firms have a production function, $Y = L^\alpha$, where Y denotes output, L labor, and $0 < \alpha < 1$. Taking the real level of aggregate demand and the nominal wage as given, firm i chooses $P(i)$ to maximise profits and sets price as a markup over marginal cost, mc:

$$P(i) = \frac{\theta'}{\theta' - 1}\, mc, \qquad \text{where} \qquad \theta' = \frac{\theta\,\sigma^2_{r(i)}}{\sigma^2_{r(i)} + \sigma^2_p} < \theta,$$

Two points are worth noting. First, the lower elasticity of demand arising from consumer price uncertainty results in a higher markup and thus increases profit share. Second, it is easy to show that markup growth is increasing in its level—suggesting that markups rise more in concentrated industries. Denoting the markup by μ, we have:

Proposition 2 *A firm's markup, optimal price, and profit share, $1 - \frac{\alpha}{\mu}$, are increasing in the volatility of the price level, σ_p^2.*

1.3 Discussion of Model Implications

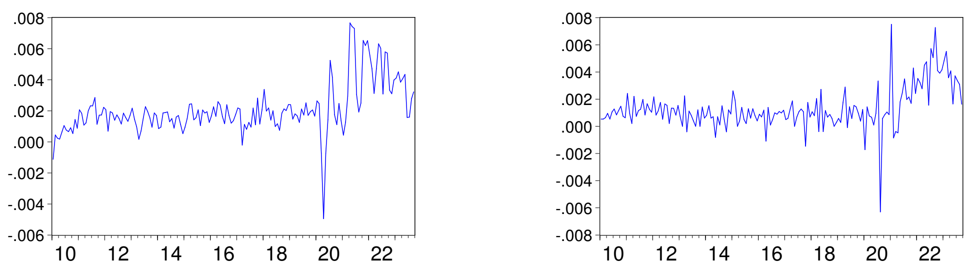
The model shows how desired markups rise in periods of greater price level uncertainty. For example, with an increasing prevalence of inflationary supply shocks, both price volatility and marginal costs rise. According to the model, a firm's price rises for two reasons: i) the rise in marginal costs; and ii) the rise in the desired markup. Because they assume perfect information, standard models discount the latter channel, and thus fail to capture the amplification of the price shock. Significantly, markups can rise here even in the absence of marginal cost changes. Furthermore, the model predicts asymmetry in price adjustment during periods of price volatility. Regardless of the state of the business cycle, the mechanism puts upward pressure on prices and is thus a source of downward nominal rigidity.[3]

A confluence of factors contributed to price level uncertainty between 2021-2022. Being accustomed to low and stable inflation, consumers were not attuned to a different inflationary environment. In addition, a number of well-publicized events provided justification for fluctuations in the price level—and thereby raised its perceived variance. For example, the war in Ukraine caused substantial dislocations in energy and food markets, leading to fluctuations in input costs. Labor supply shortages and disruptions to supply chains associated with the Covid-19 pandemic had a similar impact. Public pronouncements that inflation would be temporary, which ultimately proved inaccurate, underscored a sense of price uncertainty. Figure 1 highlights the volatility of U.S. and Eurozone core inflation after 2020. By excluding the more volatile food and energy components, this metric conveys the broad-based nature of the price

[3] The mechanism can potentially explain the absence of deflation or more pronounced disinflation during the Great Recession, namely the "missing deflation puzzle." The period 2008-2012 was characterized by relatively high price volatility.

volatility. Complementing this, Figure 2a) reveals the erratic nature of the monthly change in U.S. consumers' inflationary expectations over the same period. Figure 2b) displays an index of consumers' one-year ahead inflation uncertainty for the Eurozone. Commencing in April 2020, the index derives from consumer surveys eliciting the perceived likelihood of inflation occurring in specific ranges.

A natural setting for the model to operate is one where there are relatively inexpensive products. Here, consumers have little incentive to monitor and process pricing information, leading to information asymmetry. One such setting is the food and drink sector, which has been the focus of discussions on greedflation, and where there are a large number of disparate consumer products. Much of the empirical section below focusses on this sector in the United States and Eurozone.



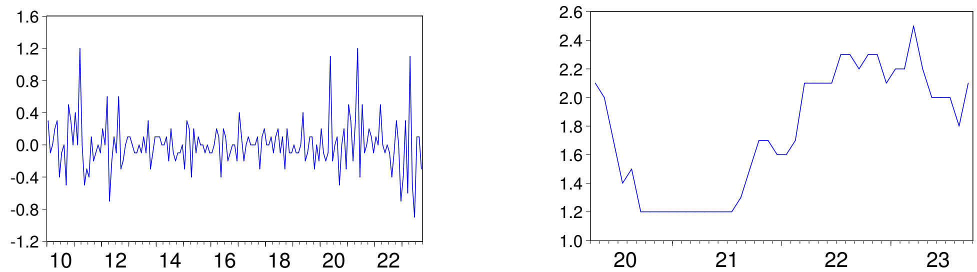
(a) United States Core Inflation (%). (b) Eurozone Core Inflation (%).

Figure 1: U.S. and Eurozone Core Inflation: 2010M1-2023M9. The figures present the monthly percentage change in the aggregate core price indices (the CPI and HICP), which exclude food and energy. *Source:* Bureau of Labor Statistics and the European Central Bank Data Portal.

2 Empirical Evidence on Mechanism

An integral part of the model is the scaling factor for the elasticity of demand, $\frac{\sigma^2_{r(i)}}{\sigma^2_{r(i)}+\sigma^2_p} \in (0,1]$, where a lower value signifies greater market power. To provide a sense of the quantitative importance of the price uncertainty channel, I estimate this over time for each region for frequently-purchased consumer products.[4] Throughout, volatility, σ^2,

[4]For the United States, I use product price data and the Consumer Price Index (CPI) from the Bureau of Labor Statistics. For the Eurozone, data on the aggregate price index, the Harmonised Index of



(a) U.S. Monthly Change in Consumers' Inflation Expectations.

(b) Eurozone Measure of Inflation Uncertainty.

Figure 2: Inflation Uncertainty. For the United States, inflation uncertainty is the monthly change in consumers' one-year ahead inflationary expectations. The Eurozone index is part of the Consumer Expectations Survey published by the European Central Bank. Commencing in April 2020, it derives from a probability distribution of consumers' one-year ahead inflationary expectations. *Source:* University of Michigan Survey of Consumer Expectations and the European Central Bank Data Portal.

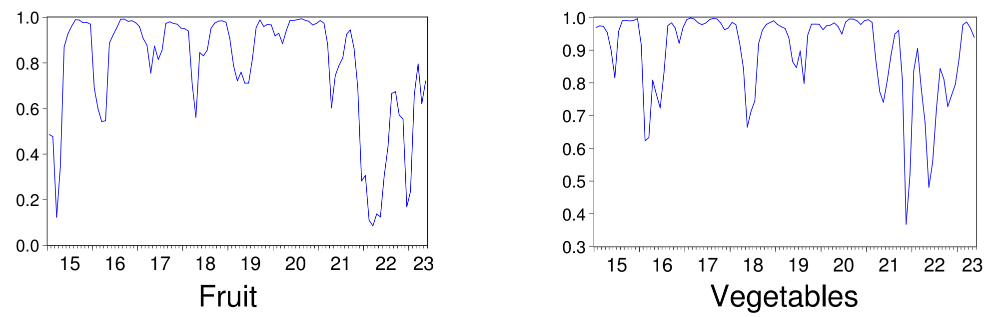


Figure 3: Eurozone, 2015M1-2023M5. This figure displays the scaling factor, $\frac{\sigma^2_{r(i)}}{\sigma^2_{r(i)}+\sigma^2_p}$, for each good's elasticity of demand. $\sigma^2_{r(i)}$ denotes the variance of the relative price of each good, while σ^2_p is the variance of the aggregate HICP index. Price terms are in logs and variance denotes a six-month rolling average. A lower value of the scaling factor indicates greater market power arising from price uncertainty. *Source:* Eurostat.

refers to a six-month rolling variance. Figure 3 displays the evolution of the scaling factor for two important food categories, fruit and vegetables, for the Eurozone between

Consumer Prices (HICP), and individual prices derive from Eurostat. Because consistent monthly data are only available for the Eurozone for individual products from 2014, I take January 2015 as a starting point. For profits, the U.S. data derives from the Bureau of Economic Analysis (BEA), and refers to the ratio of corporate profits to gross domestic product (GDP) for nonfinancial firms (adjusting for inventory valuation and capital consumption.) The profit series for the Eurozone comes from Hansen et al. (2023) and refers to the percentage point contribution of profits to the annual change in the Eurozone consumption deflator index.

Figure 4: United States, 2015M1-2023M5. This figure displays the scaling factor, $\frac{\sigma^2_{r(i)}}{\sigma^2_{r(i)}+\sigma^2_p}$, for each good's elasticity of demand. $\sigma^2_{r(i)}$ denotes the variance of the relative price of the good, while σ^2_p is the variance of the CPI index. Price terms are in logs and variance denotes a six-month rolling average. A lower value of the scaling factor indicates greater market power arising from price uncertainty. All indices refer to U.S. city average prices for urban consumers. Apart from milk, which is priced per gallon, prices refer to the cost per pound of the product. *Source*: U.S. Bureau of Labor Statistics.

2015M1-2023M5. Exploiting finer product classifications, Figure 4 traces the scaling factor for four common U.S. food products over the same period: chicken breast, pork chops, fresh milk, and cookies. Reflecting approximate price stability over the past decade, the scaling factor is on average close to one for all products prior to 2021. The U.S. indices exhibit an average decline to around .7 between 2021-2022, followed by a subsequent rise toward the end of 2022. Mirroring these movements, the model predicts a rise in markups over this period, and the evidence bears this out. Glover et al. (2023) document markup growth of 3.4 percent in the United States during 2021, accounting for approximately half of inflation that year. In line with Figure 4, they report that markup growth contributed little to inflation over the previous decade. There is also a decline in the scaling factor in the Eurozone, but commencing around six months later. Turning to evidence from profits, Figure 5 illustrates the evolution of profits and price volatility since 2015Q1 for the United States and Eurozone. Although many factors impact both variables, the comovement of both series for each region after 2020 is striking, and also in line with the markup evidence. Beginning in mid-2022, U.S. price volatility declines as shocks dissipate, and this is accompanied by declining profitability.

Focussing now on cross-sectional variation, I compare two sectors—retail and wholesale—with plausibly different degrees of information asymmetry between buyers and sellers. In the context of supply chains, both sectors are relatively close to consumers and sell finished products. Yet their respective market environments exhibit significant differences. Wholesalers operate in a business-to-business setting and fulfill bulk orders from profit-maximising retailers who frequently exert market power. By contrast, retailers deal with customers who purchase relatively small quantities of a multitude of products, and have less incentive to monitor price developments. Consistent with this, Link et al. (2023) examine survey data and report that firms have greater information about the economy than households. For comparison, Figure 6 traces the evolution of profit shares for the U.S. wholesale and retail sectors between 2001Q1 and 2023Q1. Comparing both series, they comove closely up until 2020, after which the profit share in the retail sector exhibits a more pronounced rise. While only suggestive, this provides some evidence for the model.

Finally, what is the quantitative importance of this channel? Here I derive a highly tentative estimate for the United States for the period 2021-22. Corresponding to a markup of 1.2, one common estimate of the average elasticity of demand for the U.S. economy is 6 (see e.g., Ball and Mankiw, 2022). With the scaling factor falling to an average of .7 in 2021 and 2022, the model predicts a decline in the aggregate elasticity from 6 to around 4 over this period. In turn, this implies a 9 percent increase of markups from 1.2 to 1.3. This suggests that profit growth contributed to around 60 percent of the 14 percent inflation over this period. This is in a similar ballpark to studies attributing approximately half of recent inflation to profit growth (Hansen et al., 2023; Glover et al., 2023). Meanwhile, the model predicts a 15 percent rise in the profit share from .34 to .39, which is similar to the approximate 14 percent rise in the profit share from 7 to 8 percent shown in Figure 5.[5] Together, these figures suggest that the quantitative importance of this channel is potentially large.

3 Conclusion

What distinguishes this theory of greedflation is its focus on imperfect information as a source of market power. Underlying the model is a standard textbook cost of inflation, namely, that volatility in the price level obscures price signals. Irrespective of firm size or the existing level of market power, this renders demand more inelastic and enhances firms' pricing power. Yet the mechanism outlined here is not a fundamental driver of inflation. Rather, it amplifies existing inflationary shocks and is a source of inflation persistence. More generally, the framework provides a microfoundation for variation in markups and contributes to a large literature emphasising the importance of markup shocks (see e.g., Ireland, 2004; Smets and Wouters, 2007). While the paper presents some suggestive evidence, more compelling identification requires microeconomic data.

[5]Because the stylized model omits many factors impacting profit shares, the model's predictions overstate level of the profit share. In the calibration, I choose α, the exponent on labor in the production function, to ensure a labor share of $\frac{2}{3}$.

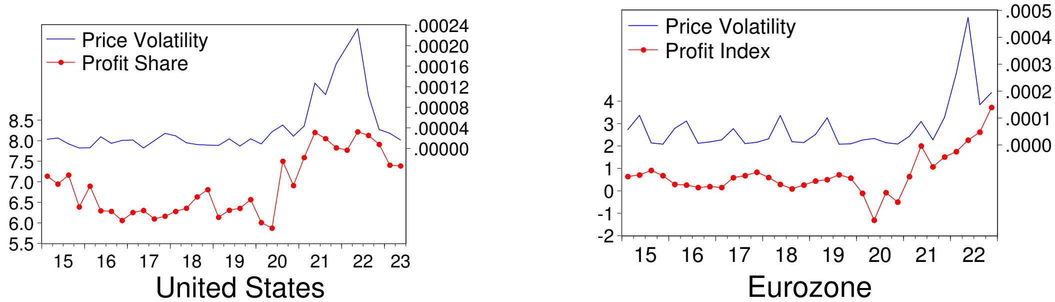


Figure 5: Profits and Price Volatility: 2015Q1-2023Q2. For the Eurozone, profits refer to the percentage point contribution of profits to the annual change in the consumption deflator index for the region. This series runs until 2022Q4. For the United States, the profit share denotes profits for nonfinancial corporate firms as a share of GDP (adjusting for inventory valuation and capital consumption adjustments). Volatility is a six-month rolling variance. *Source:* Bureau of Labor Statistics, Bureau of Economic Analysis, Eurostat, and Hansen et al. (2023)

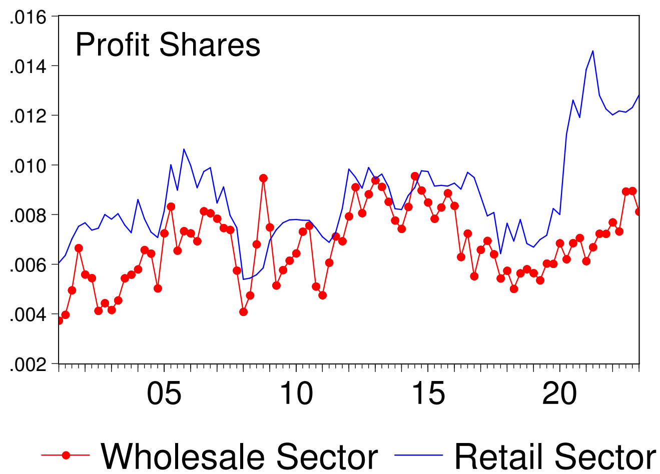


Figure 6: United States, 2001Q1-2023Q1. Profit shares refer to respective profits as a proportion of GDP (after inventory valuation and capital consumption adjustments). *Source:* Bureau of Economic Analysis.

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