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Sellers' inflation, price dispersion and substitutability: Schumpeter meets Lerner

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Abstract

The relationship between firm markups and inflation remains a topic of contention. Empirical findings suggest that many firms were able to maintain or increase their markups and profits amidst the recent wide-ranging cost shocks. This phenomenon, often referred to as sellers' inflation, raises two questions: i) why do firms change their price-setting strategies from previously competing for market shares via lower prices to raising prices in proportion or even excess of a price shock, and ii) why can they do so without impeding their market share and profitability? We argue that current supply-side explanations exhibit several theoretical and empirical shortcomings and instead propose a demand-based alternative based on the textbook argument of distorted price signals. We argue that higher price dispersion during periods of price shocks reflect informational costs for consumers and reduce consumers' price elasticity of demand by deranging the system of relative prices they oversee. Based on an agent-based model, we demonstrate that the combination of boundedly rational consumers and informational costs due to price dispersion enables firms to increase their markups and profits in response to wide-ranging cost-push shocks. As consumers increasingly struggle to monitor price changes, they become less able to adequately punish (or reward) firms for raising (or maintaining) prices. This straightforward mechanism offers a promising explanation for the emergence of sellers' inflation.

Keywords: Inflation, Markups, Agent-based modeling, Consumer behavior, Price dispersion

JEL-Codes: E31, E71, D83, C63

Declarations of interest: none

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1. Introduction

The relationship between firm markups and inflation remains contested (Gwin & van Hoose, 2011), and the potentially outsized role of corporate profits and markups during the latest inflationary episode has added fuel to a fiery debate among both academics and policymakers alike (Lagarde, 2024; Weber et al., 2025). While recent empirical studies on markup and profit dynamics reveal large heterogeneities among industries, regions, and periods under investigation, many suggest that a substantial share of firms maintained or increased markups in response to wide-ranging cost shocks (Nikiforos et al., 2024). This begs the question whether firms do so despite risking a loss of market share and absolute profits – or whether they are in fact able to preserve or increase their markups without impeding their market share and profitability. While much of the empirical evidence points to the latter, existing explanations for this phenomenon – often referred to as a profit-led or sellers' inflation – are either limited in their applicability or fall short in explaining *why* firms that previously competed for market share via prices i) now raise prices in proportion or even excess of the initial cost shocks and ii) do so without impeding their market share and profitability.

To address this shortcoming, we suggest a demand-based mechanism that builds on a textbook inflation cost: price dispersion reduces the quality of price signals. We build a model of heterogeneous firms and consumers, in which the ability of consumers to oversee and assess a system of relative prices depends on the level of overall price dispersion. Prices are set by firms by applying a variable markup over constant unit raw costs and firm-specific variable costs which evolve according to changes in firms' productivity. Firms adjust their markup in proportion to changes in their sales. The underlying rationale is that if demand increases for a given firm, there must exist a price differential to competitors for otherwise homogeneous goods and thus an unrealized profit opportunity. Firms try to realize this opportunity by increasing markups until demand shrinks again. Unprofitable firms exit the market and are replaced by new entrants. Previously constant and homogeneous unit raw costs of firms are then subjected to firm-specific stochastic shocks, reflecting a situation of increased but heterogeneous input prices.

If consumers are not constrained by informational cost in times of increased price dispersion, no sellers' inflation dynamic emerges following these wide-ranging cost shocks. Contrastingly, if consumers are sensitive to informational costs and their system of relative prices is impeded by increasing price dispersion, firms pass through more than the initial cost shocks while increasing both their markups and profits. Thus, the textbook inflation cost of distorted price signals in combination with boundedly rational consumers is enough to generate a sellers' inflation dynamic by endogenously shifting the price elasticities of consumers. Notably, this mechanism works without relying on supply-side factors such as capacity constraints, implicit collusion or exogenous changes in firm behavior, nor on demand-side factors such as excess demand, consumers accepting price increases that they deem "justified" or limited substitution possibilities. While we do not rule out the existence and relevance of these channels for inflationary pressures, our proposed demand-side mechanism provides a generalized explanation for the conundrum why firms that previously competed for market share through prices *can and choose* to completely or even in excess pass-through cost increases to their customers and do so without impeding their market share or profitability. As such, it presents a simpler, more broadly applicable mechanism for explaining empirical observations of profit-led inflationary pressures than previous supply-based explanations. Our results highlight the overall potential of search and informational costs in explaining industry-level markup dynamics during periods of inflation.

The remainder of this paper is organized as follows: Section 2 summarizes the related literature, discusses the general background and extant empirical evidence of sellers' inflation, shortcomings of previous explanatory attempts and finally the theoretical and empirical basis of our approach. Section 3 provides our model setup while Section 4 presents our simulation results. We conclude our findings and discuss avenues for future research in Section 5.

2. Related Literature

2.1 Background and Empirical Evidence

Our work relates to several different strands of literature. Most prominently, it adds to an ongoing contention about the relationship of firms' markups and inflation (see Gwin and van Hoose (2011) for an overview of earlier contributions). Building on the foundational work of Weber and Wasner (2023), firms' markups and profits have come under scrutiny once again for potentially driving inflationary pressures. Indeed, several empirical studies suggest firms to have maintained or even increased markups in the latest inflationary episode (See Bräuning et al. (2023), Colonna et al. (2023), Davis (2024), Glover et al. (2023b), Konczal and Lusiani (2022), Nikiforos et al. (2024), Storm (2023) for the U.S., Acharya et al. (2023) for the Euro area, Guschanski and Onaran (2025) for the UK, Arquié and Thie (2023) for France and Uxó et al. (2025) for Spain), while enjoying robust or increasing profits (Glover et al., 2023a; Guschanski and Onaran, 2025; Konczal and Lusiani, 2022; Storm, 2023).[1] The table in Appendix A summarizes these studies.

This phenomenon is often referred to as a profit-led or sellers' inflation. The latter term was initially coined by Lerner (1958) to describe inflationary pressures resulting from firms' or workers' attempts to increase their shares of income through price and wage setting, rather than by excess demand. Unlike buyers' inflation, which occurs when prices rise due to consumers bidding for scarce goods, sellers' inflation results from autonomous price hikes by sellers and wage pressures, even in the absence of demand pressures. The recent debate on the existence and relevance of such a sellers' inflation saw some contention about the definition and

[1] Mixed results on the relationship of markups and inflation can be found in Alvarez et al. (2024) and Matamoros (2024) while Bijnens et al. (2023), Bilyk et al. (2023), Conlon et al. (2023) and Koppenberg et al. (2025) find markups to have little, none or negatively contributed to recent inflationary pressures.

application of this concept.[2] At the core of the discussion is the role and relationship of firms' markups versus profits and the question whether a profit-led or sellers' inflation requires (non-cyclical) increases in markups and/or profits following a cost shock, or, if constant markups and (non-cyclical) increases in profits already warrant such a classification. In this paper, we take the term sellers' inflation to describe an inflationary pressure arising from increasing markups paired with a substantial increase in profits. It is often overlooked that such an increase presupposes that demand has become sufficiently inelastic. Otherwise, consumers would punish the cost pass-through by substituting away from the now more expensive good, and, in doing so, mitigate increases in profits or the overall price level. Under this standard view of price competition, firms would instead shoulder a part of the burden by decreasing their markups following a cost shock. With this theoretical rationale in mind, we contend that the focus on firms' markups has obscured the fact that firms' price-setting is constrained by the substitution behavior of customers. From this perspective, the question is not so much why firms increase markups in the wake of a cost shock, but rather why demand for their products has apparently become sufficiently inelastic to allow them to do so. This does not mean, however, that the initial question of why firms decide to pass-through cost increases in proportion or even excess of cost increases is a trivial one. As Weber and Wasner (2023) point out, this at first seems to go against established insights on firms' pricing strategies, which suggest firms to refrain from raising prices to protect their market share.

A satisfactory explanation for the phenomenon of sellers' inflation must thus answer the two central questions of why firms that previously competed for market share through prices i) now decide to raise prices in proportion or even excess of an initial shock and ii) are able to do so without impeding their market share and profitability. Notably, many of the studies affirming an outsized role to markups and corporate profits in driving the recent inflationary pressures

[2] See Nikiforos et al. (2024) for an overview.

remain rather vague in their answers to these questions. Usually, these studies revert to some notion of market power, implicit collusion or consumers' perceived legitimacy for price hikes but fail to map out a detailed and congruent mechanisms to answer the questions raised above.

2.2 Existing Explanations for Sellers' Inflation

One of the most comprehensive explanatory attempts can be found in the foundational study of Weber and Wasner (2023). The authors propose a three-stage inflation process comprising an impulse, propagation and conflict stage. Here, we will focus on the former two as these aim to explain an outsized role for profits and markups in driving inflationary pressures, while the conflict stage sees workers trying to regain real wage losses. At the impulse stage, rising prices in important upstream sectors due to bottlenecks or commodity market dynamics create windfall profits. As pointed out by Weber et al. (2025) these profit dynamics of individual firms or sectors may or may not be substantial enough to move measures of aggregate markups. In a second stage, the price increases propagate downstream to other firms via intermediate input costs. Weber and Wasner (2023) reason that these shocks constitute an implicit coordination mechanism for firms – which otherwise refrain to increase prices to gain or protect market share – to jointly raise prices as they expect competitors to do the same. Still, the question remains why firms which previously favored market share over increasing prices now completely or even in excess pass through increases rather than picking up market share through lower pass-through than their competitors. To this end, the authors provide a further qualification of their initial argument: In times of industry-wide supply constraints, firms are unable to gain market share from competitors. This argument appears convincing for situations of physical shortages as well as capacity or inventory constraints, which have been witnessed e.g. in shipping freights or semi-conductors and indeed, empirical evidence suggests the relevance of this channel (Acharya et al., 2023, Weber et al., 2025). If, however, supply constraints lead to rising input costs *without* bringing along quantity constraints – as was predominantly the case for the energy price shock – the question of i), why firms that previously competed for market share via prices now raise prices in proportion or even excess of the initial cost shocks, remains: Given that competitors are not physically constrained in production, this behavior, ceteris paribus, still risks a loss of market share and/or profits and thus challenges established insights on firms' pricing strategies (Weber and Wasner, 2023). Here, one might assume that even absent physical supply constraints, firms that maintained or increased their markups by raising prices felt not at risk of impeding their market share or profitability in the first place. As a potential explanation for this, previous studies suspect some wielding of market power, but – except for the case of physical supply constraints – remain wavy in the underlying mechanism. This constitutes a serious shortcoming since the well-documented surge in markups and other measures of market power before the prevalence of cost-push shocks has not led to a similar increase in the aggregate price level (De Loecker et al., 2020). Moreover, while some studies do suggest that higher pre-pandemic markups correlate with markup growth in the recent inflationary spell (e.g. Acharya et al., 2023), Davis (2024) documents growth both in the highest and lowest markup percentiles for publicly listed U.S. firms and Guschanski and Onaran (2025) even find large but low-markup firms to be the driver of markup growth in the UK since 2019. Adding to these issues, an explanation of rising markups by market power risks becoming tautological if – as is often the case – market power is measured by firms' markups.

Further attempts at explaining sellers' inflation suggest implicit collusion among firms as a potential mechanism (Weber and Wasner, 2023; Weber et al., 2025). Naturally, the applicability and scope of this mechanism is hard to assess. While both studies find some suggestive evidence for this channel by analyzing corporate earnings calls, many of their results point more broadly to a positive sentiment of executives towards industry-wide cost shocks and price volatility, leaving open the possibility of different explanatory attempts. Given the ample empirical evidence across a diverse set of industries and countries for remarkably robust or increasing markups, both physical supply constraints as well as implicit collusion appear too limited in scope to explain the extent of this dynamic. At this point, the previous, purely supply-oriented explanations – while not to be ruled out – appear insufficient to answer the questions raised above.

It is again Weber and Wasner (2023) who suggest another, this time demand-based mechanism of amplification for profit-fueled inflationary pressures: consumers' perceived legitimacy for price hikes in times of inflation reducing their elasticity of demand. However, this moral economy consideration is difficult to validate and has thus been both empirically and theoretically neglected in subsequent investigations of profit-led inflation. With the notable exceptions of Caruso Bloeck (2024) and Scanlon (2024), explorations into demand-based explanations of sellers' inflation remain missing.

2.3 A Novel Explanation

In this paper, we aim to address this gap and provide a candidate explanation to the questionswhy firms that previously competed for market share via prices i) now raise prices in proportion or even excess of an initial shock and ii) do so without impeding their market share and profitability. We propose that increased price dispersion during times of heterogeneous costs-shocks represent informational costs for consumers, impairing their ability to effectively evaluate relative prices across competitors. This resembles recent research incorporating scarce attention of consumers into market models (Caruso Bloeck, 2024; Eliaz & Spiegler, 2011; Kaplin et al., 2019; Scanlon, 2024).

We build on a two-step consumption model. In the first stage, consumers form so-called consideration sets (Kaplin et al., 2019), which represent restricted subsets of all available market options. In the second stage, consumers evaluate only those options, that are part of their consideration set. In our model, increasing price dispersion presents an informational cost that, in turn, reduces the size of consumers' consideration sets. This assumption is supported by recent findings of Binetti et al. (2024). Drawing on a large online survey of U.S. households, the authors find that among the various anticipated negative effects of inflation, respondents most frequently highlight the increased complexity and difficulty of household decision-making as its most critical consequence. As the authors point out, existing economic literature overlooks the importance of this inflation cost – a gap that this paper addresses.

Further, a longstanding strand of literature discusses the role of search costs in modulating the relationship between inflation and firms' markups (Benabou, 1992; Benabou & Gertner, 1993; Diamond, 1993; Gwin & Taylor, 2004; Gwin & Van Hoose, 2011). Of particular interest is the work of Gwin and Taylor (2004), who investigate the effect of search costs on profit margins in times of inflation in the US. Their results suggest markups to increase during inflation if search costs become sufficiently high, while for industries characterized by relatively low search costs on the consumer side, inflation is estimated to lower markups. While we do not model search costs explicitly, our mechanism is closely related: in our framework, price dispersion impairs consumers' ability to compare prices, reducing the effectiveness of price signals. We refer to this more broadly as an increase in the sensitivity to informational costs, encompassing both the cognitive and practical frictions associated with navigating a volatile and dispersed price environment.

Remarkably, the role of search and informational costs has gone unnoticed in the recent debate on the nexus of markup dynamics and inflation with two notable exceptions: First, Caruso Bloeck (2024) develops a search model in which inflation uncertainty reduces the informativeness of prices about relative costs. This negatively affects consumers' search behavior, rendering them less responsive to individual price signals. As a response, firms raise their markups. Ultimately, the increased informational costs of inflation uncertainty result in significant welfare losses through reduced allocative efficiency. Second, Scanlon (2024) presents a model comprising a representative consumer and a continuum of monopolistically competitive firms. Here, price volatility obscures price signals for consumers, complicating their decision making. This results in a reduced elasticity of demand on the consumer side which in turn increases firms pricing power.

The dynamics of our model of heterogeneous, strategically interacting firms and consumers suggest a positive relationship between informational cost, firms' markups and profits as well as an inverse effect on allocative efficiency. As such, our model replicates core results of Caruso Bloeck (2024), Gwin and Taylor (2004), as well as Scanlon (2024). The underlying mechanism of increased informational cost in times of inflation provides a promising explanation for recent profit and markup dynamics. More general, our results substantiate the crucial role of search and informational costs mediating the relationship between inflation and markups.

Methodologically, we opt for an agent-based model in our analysis, which is presumedly the most appropriate framework for explicating our theoretical mechanism for three reasons: First, we are interested in the potentially out-of-equilibrium response and adjustment of economic agents to a massive cost-push shock in time, which would be obscured by a mere comparative statics exercise comparing equilibria before and after the cost shock. Second, modelling the individual information set available to each agent in each period is crucial for our proposed mechanism, which might prove difficult to achieve with a purely analytical model. Third, agent-based models have proven to be a suitable tool for studying the dynamics and outcomes of heterogeneous, strategically interacting agents, such as firms and households (Steinbacher et al., 2021). While sellers' inflation is understood as precisely such a phenomenon, formal simulation models that focus specifically on that strategic interaction between firms and households in inflation scenarios are rare. Closest comes the work of Ciambezi et al. (2025), who develop a large-scale macroeconomic agent-based model to investigate the interplay of demand and supply factors in driving inflationary dynamics under imperfect information. As in our model, firms set prices according to a markup rule. However, in their setup, consumer demand depends negatively on the price and positively on firm size, without incorporating informational frictions on the demand side. As market concentration increases, inflationary pressures become increasingly driven by rising markups, potentially giving rise to sellers' inflation. In contrast, in our much simpler model sellers' inflation emerges through rising informational frictions on the consumer side in periods of elevated price dispersion, which hinder the efficient matching of supply and demand.

Our model setup builds upon a simplified version of the goods market of the canonical, agent-based *Schumpeter meets Keynes* model (Dosi et al., 2010) as well as the bare-bones variant of a replicator dynamics framework with stochastic productivity improvements as in Dosi et al. (2017). Advancing on their work, we introduce micro-founded consumer-firm interactions which replaces the replicator dynamics as a market selection mechanism. The model setup is discussed in detail in the following section.

3. Model Setup

The model consists of two sectors: (i) a goods market with i firms producing a homogeneous consumption good and (ii) a household sector with k consumers. Consumer choice is based on a logit-choice model, as in the Eurace@unibi Model (Dawid et al., 2019). Consumers make purchasing decisions based on the prices of goods they perceive, where the cheapest good has the highest likelihood to be chosen. In the baseline setup, there are no informational frictions and consumers perceive all goods in the market. In an extension, consumers face informational costs and perceive only a subset of all goods – called the consideration set. The size of the consideration set depends on the dispersion of prices. On the supply-side, we stick to the baseline model in Dosi et al. (2017) but introduce raw material costs into the pricing mechanisms of firms.

3.1 Sequence of Events

Figure 1 illustrates the sequence of events for one simulation run up to period 100 where firms experience a lasting input cost shock.

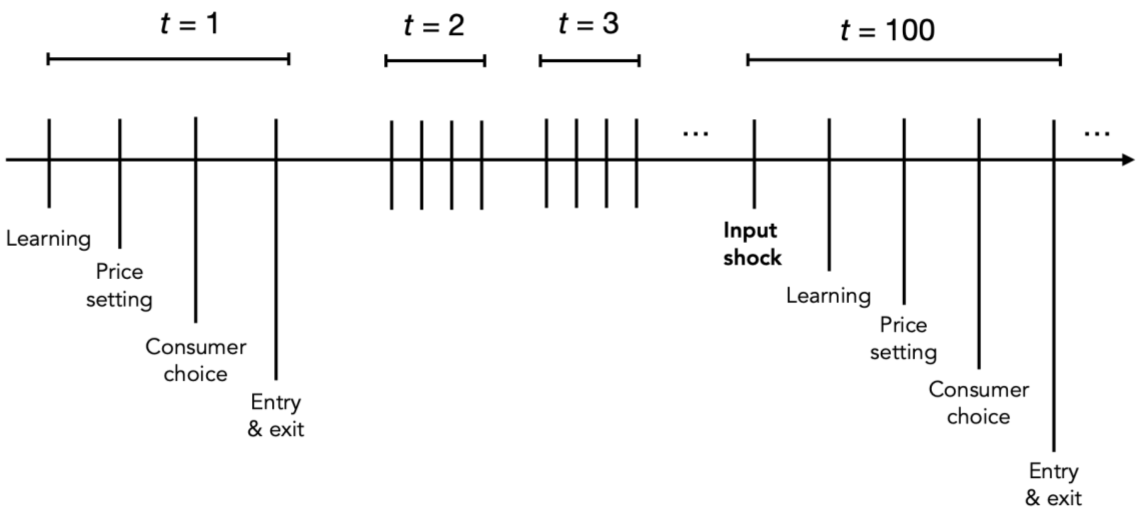

Figure 1: Sequence of events for one simulation run.

Learning: Firms learn based on idiosyncratic productivity shocks.

Price setting: Production costs are determined by the firm's productivity. Based on the production costs and a desired markup, firms set the price of their good.

Consumer choice: Affected by informational frictions, consumers update their consideration sets. Afterwards, consumers choose a firm out of their individual consideration set and spend all their predetermined expenditure on the (single) firm's good.

Entry and exit: Firms update their profits and market shares. Firms with zero profits leave the market and entrants replace them. Surviving firms update their markups for the next period based on their performance.

Input-shock: Starting at the beginning of period 100 heterogeneous price shocks affect all firms currently in the market as well as all new entrants.

3.1.1 Learning

Firms produce a homogeneous consumption good. Firms are endowed with capabilities that can evolve through learning (Dosi et al., 2000; Teece et al., 1997).[3] These capabilities, in turn, determine their productive efficiency. Learning at the firm level includes innovations in product design, efficiency of production, supply-chain management, as well as marketing (Schulz & Mayerhoffer, 2021). We adopt the firm-specific learning mechanism from Dosi et al. (2017), which has been first proposed in Dosi et al. (1995). For this multiplicative stochastic process, each firm *i* determines its productivity $A_{i,t}$ as follows:

$$A_{i,t} = A_{i,t-1} \cdot (1 + \lambda_{i,t}) \tag{1}$$

Where $\lambda_{i,t}$ describes a firm's learning parameter for that period and is drawn from a symmetric Laplace distribution with α = -0.04, β = 0.037. The symmetric distribution implies that productivity growth at the firm level can be either positive or negative. The notion of negative average productivity growth at the firm level ensures that the aggregate productivity stays approximately constant over time given the selection process of more productive firms. This is to ensure that we do not have a time trend in productivity (or the CPI) and can isolate the effect of a cost-push shock, not necessarily because we believe this productivity distribution is most appropriate empirically. In this sense, this parameter constellation is equivalent to assuming that there is no aggregate technological progress within our simulation which helps us isolate the sellers' inflation as our empirical target phenomenon. Yet, average negative productivity growth at the firm level is also consistent with recent empirical findings (Decker et al., 2017). In our framework, learning does not depend on the size of the firm, nor can successful firms

[3] See Aistleitner, Gräbner and Hornykewycz (2021) for a review about modeling learning and capability accumulation.

amplify the learning process. In the model, all firms start with an equal level of capabilities: $A_{i,0} = 1$.

3.1.2 Price Setting

Firms set prices ($P_{i,t}$) applying a variable markup ($\mu_{i,t}$) over units costs, following empirical evidence that markup pricing is the dominant strategy in practice (Alvarez et al., 2006; Fabiani et al., 2006). Unit costs consist of unit raw material costs ($R_{i,t}$), which are homogeneous until the price shock and firm-specific variable unit costs ($V_{i,t}$):

$$P_{i,t} = \left(1 + \mu_{i,t}\right) \cdot (V_{i,t} + R_{i,t}) \tag{2}$$

Variable costs are affected by firms' capabilities:

$$V_{i,t} = V_{i,t-1} \cdot (1 - \lambda_{i,t}) \tag{3}$$

where more productive firms have lower variable unit costs. Note that firms in our model are not capacity-constrained and are able to meet whatever demand they are facing.

3.1.3 Consumer Choice

Consumption expenditures are initialized by draws from a log-normal distribution, which has proven to be an empirically sensible approximation for actual expenditures (cf. Schulz and Mayerhoffer, 2023, for a review). All consumers have the same expenditure level for all periods. Thus, nominal aggregate demand is constant, which rules out the possibility that inflation emerges from excess demand. Our model is therefore demand-based, not in the sense that inflation is caused by changing the level of aggregate demand, but insofar as the price elasticity of demand for consumers varies. Consequently, all effects in the model are driven by the composition of demand rather than its level.

To model consumption allocation, we follow Benabou and Gertner (1993) and Caruso Bloeck (2024) in assuming that price dispersion affects the costs to acquire price information. If dispersion in prices is high, acquiring information about them is costly and consumers will thus rationally decide to be inattentive to some price movements (Caplin et al., 2019). In our model, each consumer k surveys the market and considers buying from a set of firms. These consideration sets at time t are denoted by $J_{k,t}$. When price dispersion – measured as the Coefficient of Variation of prices in t – is low, it is less costly for consumers to survey a larger fraction of the market, resulting in larger $J_{k,t}$. Likewise, when the price dispersion increases, the informational costs for consumers rise and in turn reduce the size of their consideration sets. Hence, the size of the consideration set $J_{k,t}$ develops according to:

$$|J_{k,t}| = S_{Max} - (S_{Max} - S_{Min}) \cdot \frac{SD(P_{i,t})/Mean(P_{i,t})}{SD(P_{i,t})/Mean(P_{i,t}) + \rho} \tag{4}$$

where S_{Max} denotes the maximum possible size of the consideration set (all firms). S_{Min} denotes the minimum size which we set to 5 firms to ensure consumers always have a sufficient number of options for substitution. The parameter ρ describes the sensitivity of consumers towards price dispersion. Larger values for ρ reduces consumers‘ sensitivity towards changes in the price dispersion. Changes in the composition of the consideration sets result either from changes in price dispersion or firms exiting the market: In either case, randomly chosen firms are added or removed to bring the consideration set back to the desired size.

The decision from which firm to buy is modelled using a logit-choice model adopted from the Eurace@unibi Model[4] (Dawid et al., 2019). Previous research in the marketing literature has shown that this model fits consumer choice well (Kamakura & Russell, 1989). Consumers select a firm out of their consideration set $i \in J_{k,t}$ with a logit probability:

$$Prob_{i,k,t} = \frac{\exp(-\gamma \cdot P_{i,t})}{\sum_{i \in J_{k,t}} \exp(-\gamma \cdot P_{i,t})} \tag{5}$$

where γ describes the price sensitivity of consumers. This parameter also affects the level of competition between the firms. High values of γ result in consumers always buying from the firm with the lowest price. Under lower values of γ consumers are unable to discriminate along the price dimension. Based on the probabilities of the logit-choice model consumers choose one firm for their expenditures. We assume consumer goods to be infinitely divisible and assume that firms are not capacity-constrained, i.e., they can satisfy any consumer demand they are confronted with. Hence, desired demand always materializes in sales.

3.1.4 Entry and Exit

Based on their performance in each time step, firms update their markup or exit the market. As in the markup equation in Dosi et al. (2010)[5], firms update their markups for the next period $\mu_{i,t+1}$ according to:

$$\mu_{i,t+1} = \mu_{i,t} \cdot \left(1 + \zeta \cdot \frac{(Q_{i,t} - Q_{i,t-1})}{Q_{i,t-1}}\right) \tag{6}$$

[4] The major difference is that we do not consider logarithmized prices in the logit equation, leading to a generally stronger price reaction of consumers in the model. We opt for this specification to show that sellers' inflation can emerge even for comparatively strong substitutability.
[5] The only difference is that firms update their markups based on sales rather than market shares.

where $Q_{i,t}$ is the quantity of products sold by firm i in period t and ζ is an elasticity parameter describing the effect of demand changes on the markup. Firms' profits are given by

$$\Pi_{i,t} = (P_{i,t} - (V_{i,t} + R_{i,t})) \cdot Q_{i,t}. \tag{7}$$

Firms with zero or negative profits leave the market and are deleted from consumers' consideration sets $J_{k,t}$. Each firm that exits the market is immediately replaced by a new entrant, in line with the empirical stylized fact that the number of firms in an economy is approximately constant in time (Dosi et al., 2017). New entrants start with a capability of $A_{i,t} = 1$, meaning they do not inherit innovations from incumbents. Under this assumption, aggregate productivity remains approximately stable over time, ensuring price stability rather than continuous deflation reflecting productivity increases with fixed nominal demand. Entrants draw their initial markup from the same distribution used at initialization.

Substituting and simplifying Equation (7), it becomes clear why firms' profits increase if a cost shock is met by constant markups and demand

$$\Pi = \mu \cdot Q \cdot (V + R). \tag{8}$$

For any increase in $(V + R)$, Π also increases, as long as all other variables stay constant, i.e., the price increase is not punished by consumers by decreasing demand.

3.1.5 Shock

Raw material costs $R_{i,t}$ remain homogeneous and constant at the initial level $R_{i,0}$ until period 100, at which point each firm experiences an additive cost shock ϵ_i:

$$R_{i,t} = \begin{cases} R_{i,0} & \text{if } t < 100 \\ R_{i,0} + \epsilon_i & \text{if } t \geq 100 \end{cases} \tag{9}$$

where ϵ_i is drawn from a beta distribution with α = 0.4, β = 3. This constitutes a one-time shock that persistently increases firms' production costs. Each firm as well as each new entrant after period 100 is subjected to a shock from this distribution. The shape of the beta distribution reflects heterogeneous cost shocks, with many firms facing small cost increases while a few experience substantial cost spikes. We assume that this cost-push shock is orthogonal to the initial cost structure before the shock, which implies that the dispersion of costs between firms unanimously increases after the shock. One might object that a common shock like global supply chain pressures should rather lead to a homogenization of costs between firms. Yet, firms' import intensity and integration into global production networks likely differs, leading to differential exposure to supply chain shocks (Cavallo and Kryvstov, 2023). Alvarez-Blaser et al. (2025) document that this differential sensitivity is usually a relatively unimportant driver of inflation but that this channel massively gained importance for the post-2020 inflation surge. The shock specification as a beta distribution aims to capture the direct effects of cost shocks by direct suppliers but also implicitly accounts for the indirect propagation of larger shocks within the production network. These propagation effects can play a sizeable role in moving the aggregate price level, as first shown by Weber et al. (2024) for the U.S. and later by Ipsen et al. (2025) for the EU, in line with our reduced-form assumption.

3.2 Initialization and Parameter Benchmark

The initialization of our agent-based model involves the following steps:

- All firms start with capabilities $A_{i,0}$ = 1 and draw their markup from a uniform distribution with values between 0.01 and 0.1. Both unit raw material costs ($R_{i,t}$) and unit costs ($V_{i,t}$) are set at 6, reflecting a situation in which 50% of the costs are due to raw inputs (Eurostat, 2025).

- The expenditures for k consumers are drawn from a lognormal distribution with $\mu = 4.5$ and $\sigma = 0.2$

Description	Symbol	Value
Number of consumers	k	1000
Number of consumer good firms	i	50
Markup sensitivity	ζ	0.05
Intensity of price competition	γ	12
Informational cost sensitivity – Baseline Scenario	ρ_B	1000
Informational cost sensitivity – Boundedly rational scenario	ρ_C	0.01

4. Results

In this section, we first present results of the baseline model, in which consumers are not constrained by informational cost, before introducing a model specification where consumers are sensitive to informational cost. Finally, we provide a sensitivity analysis of the model's parameters. All results show the average model output over 100 Monte-Carlo-simulations. Recall, for the interpretation, that we defined a sellers' inflation as excess inflation arising from increasing firm markups accompanied by a substantial increase in profits.

The upper half of Figure 2 shows the evolving producer costs (red) and a synthetic Consumer Price Index (CPI, green) calculated as the sales-weighted goods prices of our baseline model. Both graphs display persistent fluctuations without any discernible time trend. Due to the markup pricing scheme, the CPI is consistently above the actual producer costs. Notably, as the relative price changes plotted in the bottom part of Figure 2 show, both dynamics appear highly but not perfectly correlated. This is because consumers can substitute away from firms with high costs or markups, leading them to either decrease prices or even exit the market. As soon as firms are exposed to an external price shock at $t = 100$, both producer costs and the CPI become markedly elevated. The relative price change of both series, as displayed in the lower half of Figure 2, indicates that the pass-through of producer costs to the CPI is proportional but not in excess of the cost increases. The 1:1 pass-through in this specification is not so much indicative of an underlying sellers' inflation, as will become clear when looking at firms' profits and markups below, but the result of a general increase in producer costs for all firms in the market. While the magnitude of shocks varies across firms, the systematic nature limits consumers' ability to substitute away from the price increases entirely. Simply put: Everything got more expensive.

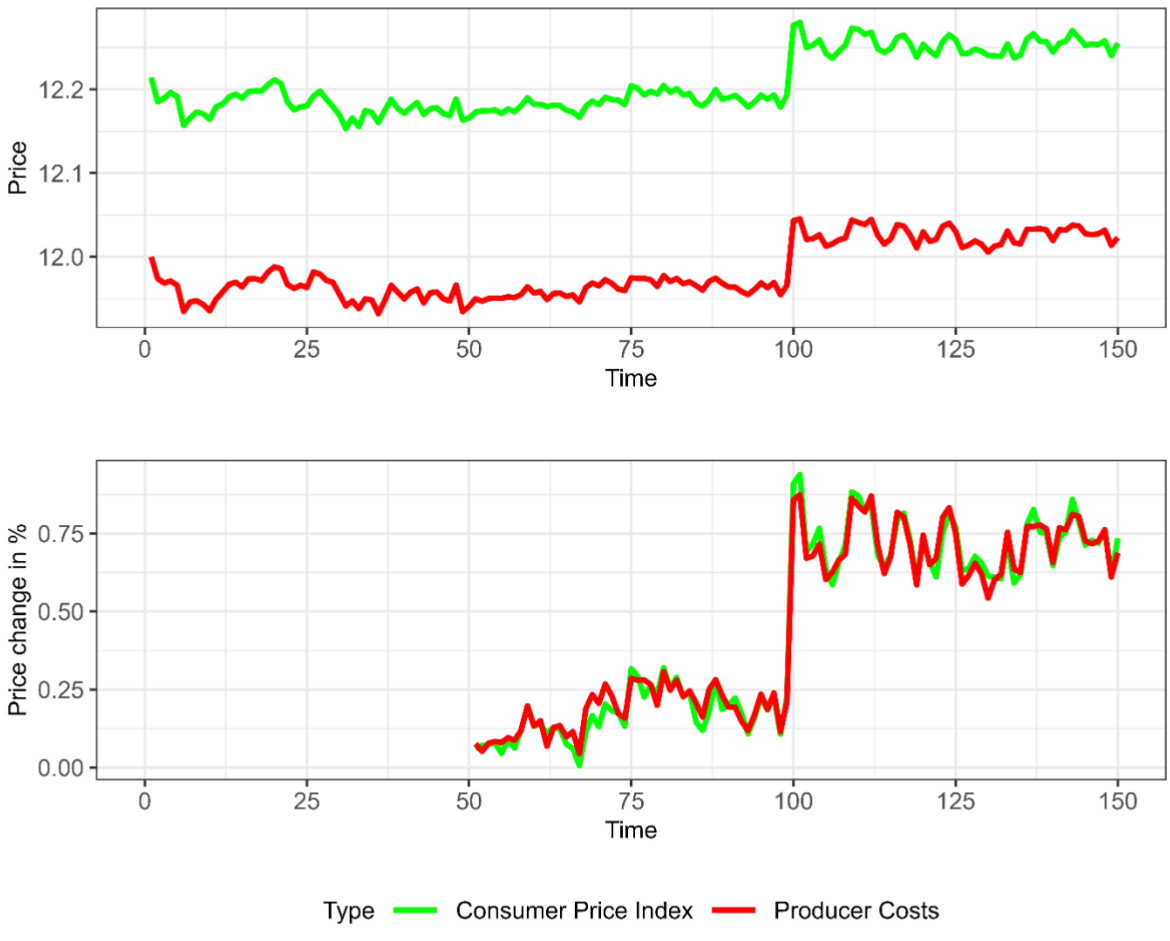

Figure 2: Producer costs (red) and synthetic Consumer Price Index (green) of the baseline model specification with no role for informational cost. Absolute price changes at the top and relative price changes with the baseline in period 50 at the bottom.

Firms' average profits (Figure 3) display an erratic behavior both prior and following the firms' exposure to the cost shock. Meanwhile, the sales-weighted markup (Figure 4, red) fluctuates closely around the mean of the overall price level, indicating that the system is in a statistical equilibrium before the cost shock. The unweighted markup (Figure 4, green) is constantly higher than the sales-weighted markup. Following the Olley-Pakes (1996) decomposition[6], the difference between the weighted and unweighted markup represents the covariance between firm size and markup. Since the results in Figure 4 reveal a negative covariance term, firms with higher markups have lower market shares in our model. This finding is in line with Díez et al. (2021), who use the same decomposition on a firm-level data set for 19 advanced economies for the period 2000-2015 and document a negative covariance between size and the markup. After the cost-push shock in period 100, both the profits and the weighted markup show no visible change in their overall dynamic. It is noteworthy that the unweighted markup in period 101 increases because some firms with small cost shocks saw an increase in their demand in the previous period and tried to capitalize on that by increasing their markups for the next period. However, consumers remain price sensitive and face no information costs, leading them to substitute away from high-markup firms in period 101. This substitution effect explains why firms' attempts to increase markups fail to translate into higher sales-weighted markups and can be quantified in the increase in negative covariance in period 101. Taken together, Figures 2 - 4 suggest that in the baseline model specification, sellers' inflation does not emerge following a cost shock because consumer substitution prevents firms from increasing their markups.

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[6] The decomposition is formally expressed as: $\mu_t = \bar{\mu}_t + \sum_i (s_{i,t} - \bar{s}_t)\left(\mu_{i,t} - \bar{\mu}_t\right)$, where μ_t is the firm-revenue-weighted average markup, s_{it} is the share of firm i's revenue in total revenue, $\bar{\mu}_t$ is the unweighted markup.

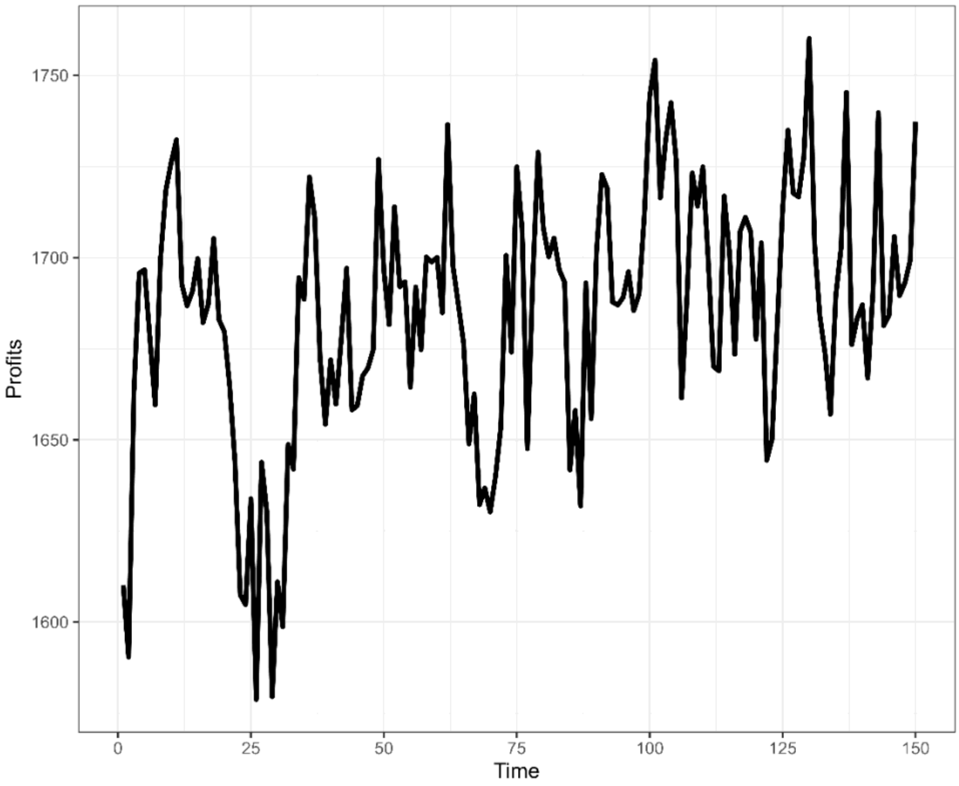

Figure 3: Aggregate profits in the baseline model specification.

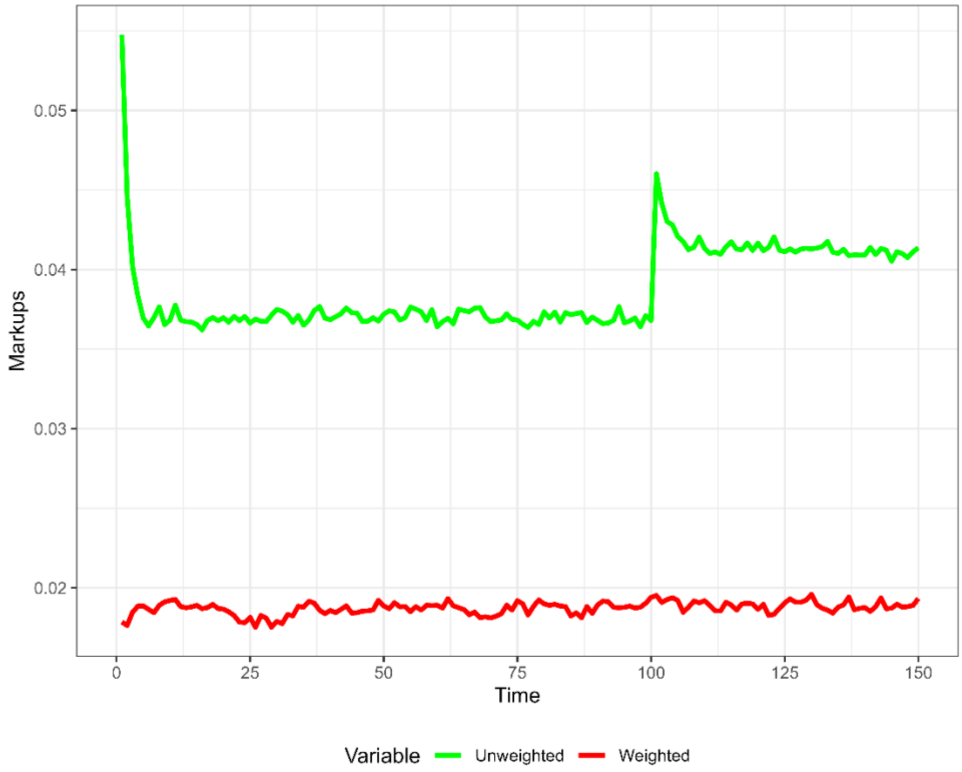

Figure 4: Firms' sales-weighted and unweighted markups in the baseline model specification.

Zooming in on the consumer side, Figure 5 shows the Coefficient of Variation of the price dispersion (top) as well as the size of the consideration set consumers are able to oversee and assess (bottom). As expected, the price dispersion increases drastically in $t = 100$ and continues to fluctuate more erratically as existing firms as well as new entrants continue to be exposed to persistent cost shocks drawn from the Beta distribution. As the bottom plot shows, consumers are not sensitive to the increased price dispersion and continue to choose from all 50 goods in the market.

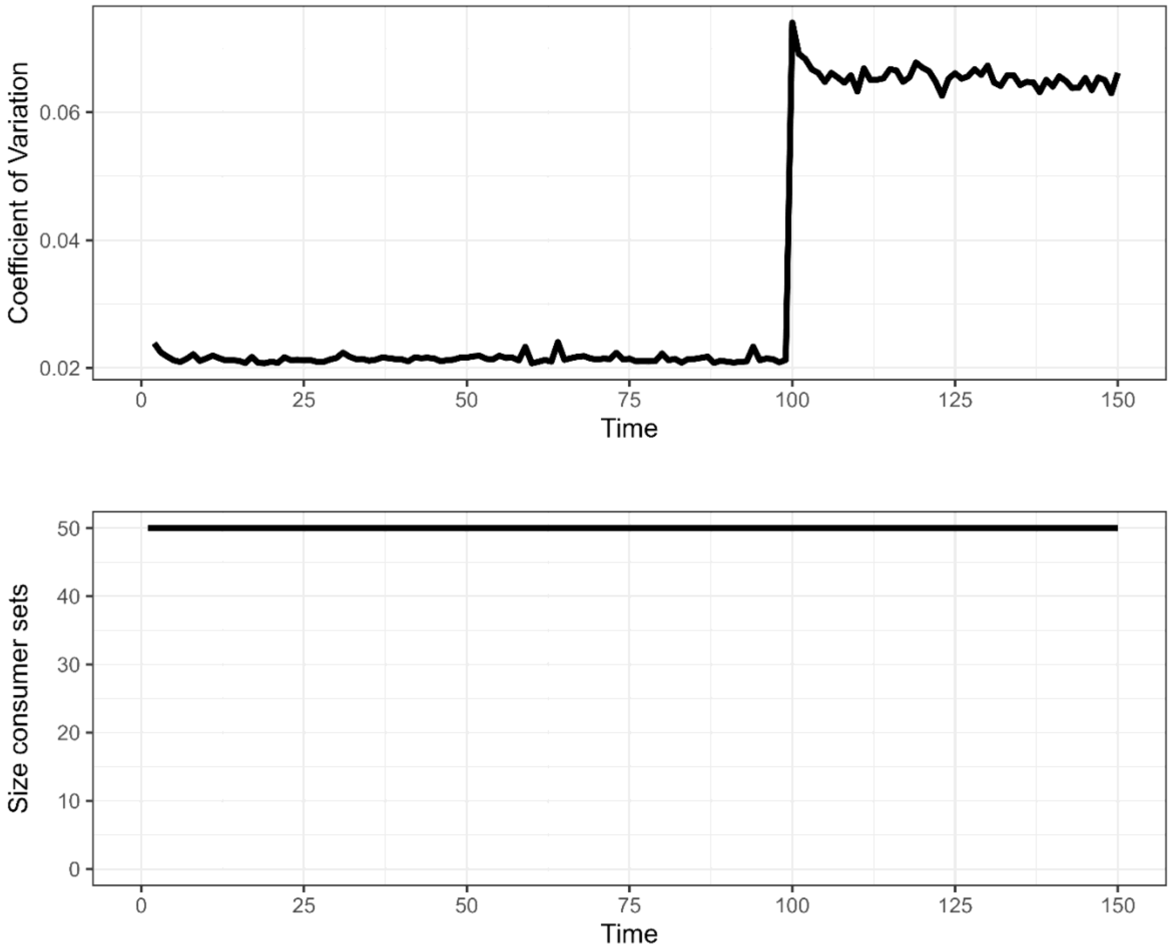

Figure 5: Price dispersion given as the Coefficient of Variation (top) and number of goods' prices consumer oversee and assess (bottom) in the baseline model specification.

Since rising market concentration is often levied as a potential explanation for sellers' inflation, we plot the Herfindahl-Hirschman Index (top) and the share of the 5 largest firms (bottom) over time in Figure 6. It shows that the baseline scenario exhibits substantial market concentration, with a notable increase during the cost shock in period 100. However, this concentration increase coincides with the absence of sellers' inflation in the baseline model, suggesting that additional factors beyond concentration are necessary for sellers' inflation to emerge in our model.

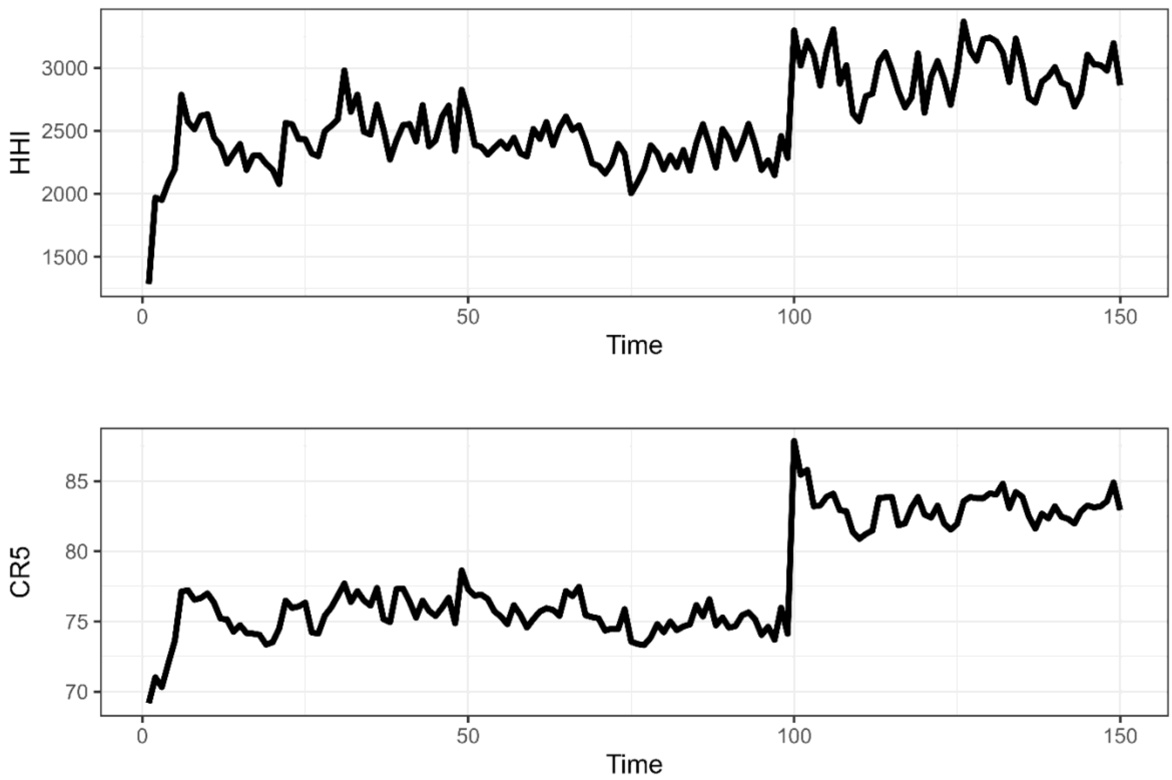

Figure 6: Herfindahl-Hirschman-Index (top) and the share of the 5 largest firms (bottom) in the baseline specification.

Lastly, we discuss aggregate productivity developments and allocative efficiency in the baseline model. Aggregate productivity growth can be broken down into four components: (1) productivity shifts among surviving firms; (2) market share reallocations among surviving firms, which can also be interpreted as allocative efficiency; (3) market share reallocations due to entrants and (4) market share reallocations due to exiting firms. To capture all four components, Melitz and Polanec (2015) extend the Olley-Pakes decomposition to include entry and exit. Figure 7 shows the results of the Dynamic Olley-Pakes productivity decomposition[7] where the components of entering and exiting firms summarized under net entry. Three results emerge which are in line with the empirical investigation by Decker et al. (2017). First, there is negative average productivity growth within surviving firms. Second, the largest driver of productivity growth is the reallocation of sales toward more productive firms, suggesting

[7] We decompose the change in the level of productivity. See Appendix B for the full decomposition.

allocative efficiency in the model's underlying dynamic. Third, net entry has a positive albeit smaller contribution than the reallocation. In period 100 during the price shock, the average productivity growth becomes slightly negative, driven by both smaller reallocation and net entry effects.

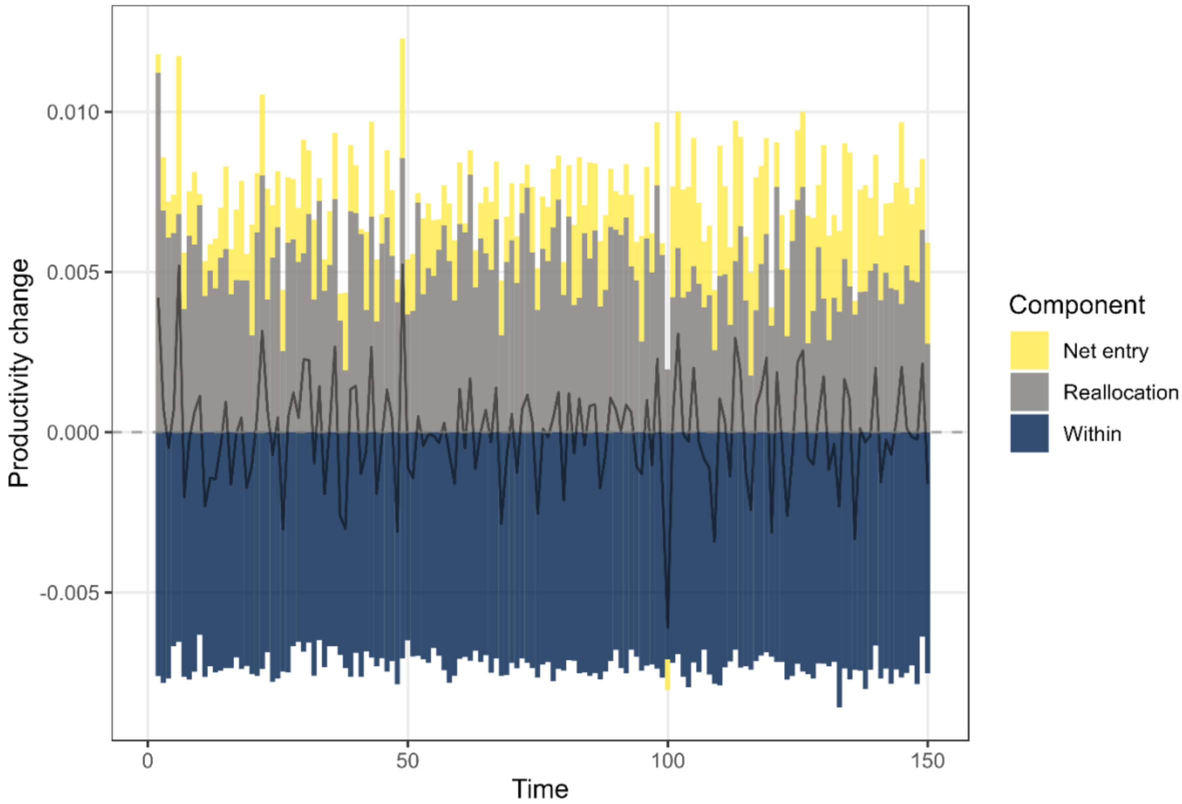

Figure 7: Productivity growth decomposition in levels for the baseline model. The black line represents the sum of the three components.

Next, we turn to the model specification in which consumers' ability to oversee and assess prices is sensitive to informational costs. Namely, the greater the price dispersion across firms, the smaller the system of relative prices a consumer oversees. To simulate informational costs for consumers we reduce the parameter ρ from 1000 to 0.01. Figure 8 shows the absolute (top) and relative (bottom) changes in the producer cost (red) and CPI (green) over 150 timesteps. Again, prices persistently fluctuate around their mean with the CPI being consistently elevated vis-à-vis the producer costs but also slightly elevated compared to the CPI in the baseline model specification for $t < 100$. As we will see below, the latter is due to consumers assessing a smaller fraction of the overall market from the get-go. Crucially, in period 100, when firms face an exogenous price shock, the CPI overshoots the increase in production cost by approximately 0.2 percentage points and remains elevated. Thus, firms disproportionally pass through actual cost increases – a first indication for the emergence of a sellers' inflation dynamic.

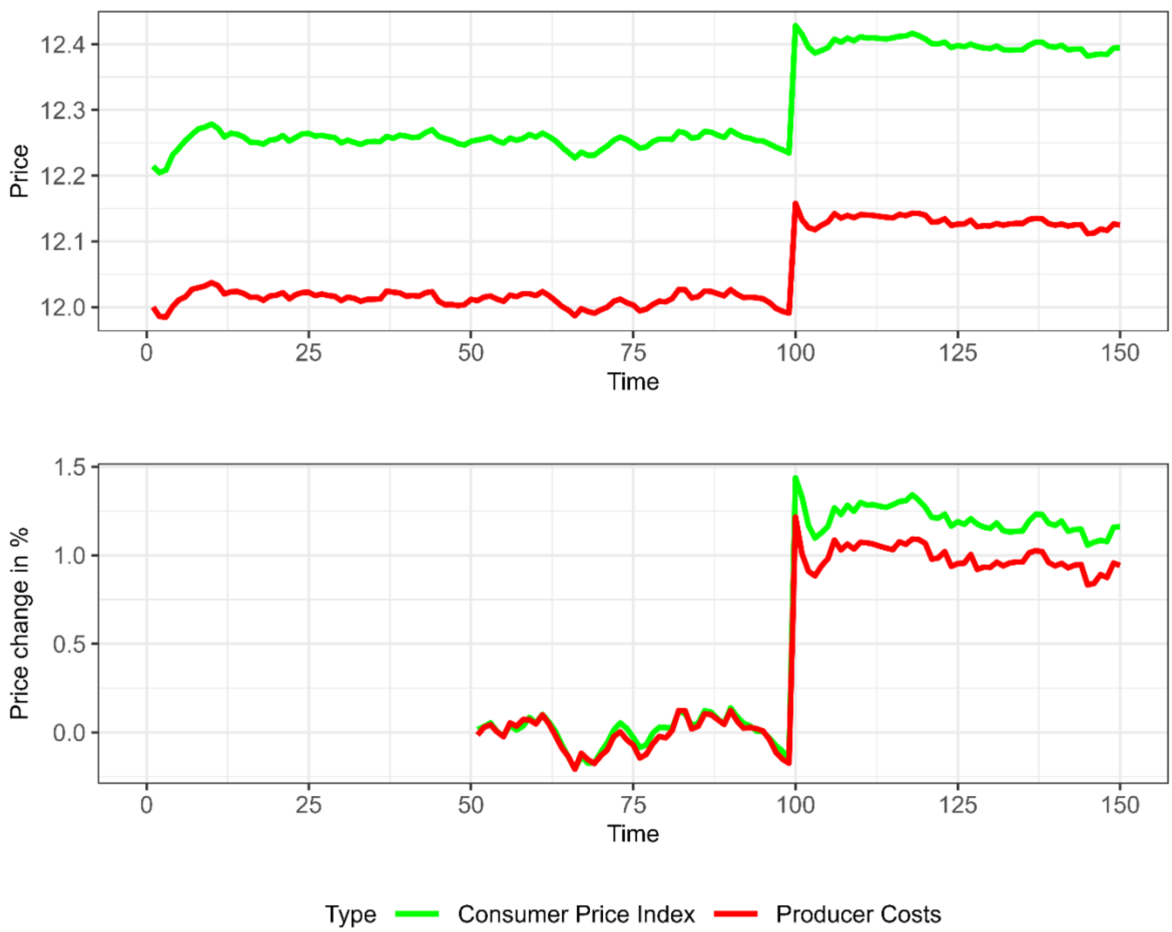

Figure 8: Producer costs (red) and synthetic Consumer Price Index (green) in the informational cost specification. Absolute price changes at the top and relative price changes with the baseline in period 50 at the bottom.

Assessing firms' average profits (Figure 9) and markups (Figure 10) substantiates this impression. Notably, already prior to the cost shocks, profits and markups appear slightly elevated relative to the baseline model specifications. This suggests, in line with results from Gwin and Taylor (2004), that environments characterized by high search cost (proxied here by informational cost) are conducive for firms to assert higher profits and markups. During the cost-push shock in period 100, profits as well as the sales-weighted markup rise. Importantly, the unweighted markup stays constant since firms set their markup in the previous period. As a result, the difference between the unweighted and sales-weighted markup shrinks in period 100. Following the Olley-Pakes decomposition, the negative covariance between size and markups becomes smaller. This can be interpreted as a decrease in the strength of household substitution. Similar to the baseline specification, firms try to increase their markups in period 101. However, this time successfully since household substitution is weaker than in the baseline model. In the following periods, the price dispersion decreases and consumers return to oversee a larger share of the market. Accordingly, the markup slightly decreases before stabilizing. These results suggest that increased price dispersion and the resulting search and informational cost pose a promising explanation for sellers' inflation dynamics.

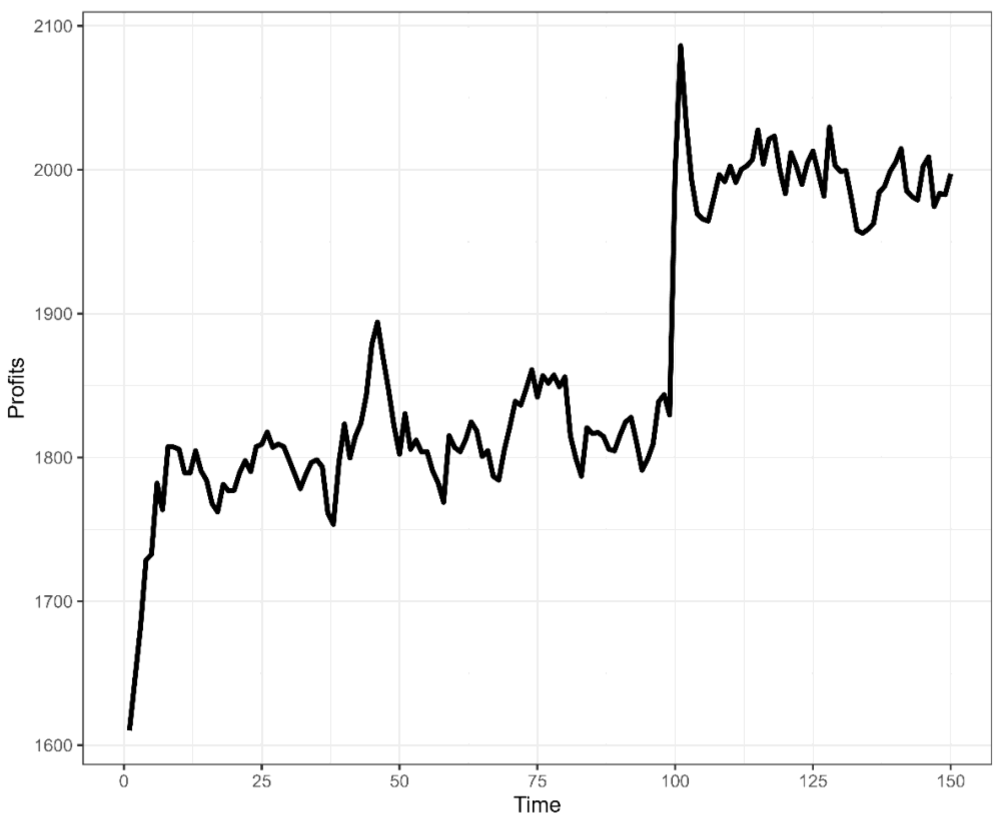

Figure 9: Firms' average absolute profits (top) in the informational cost specification.

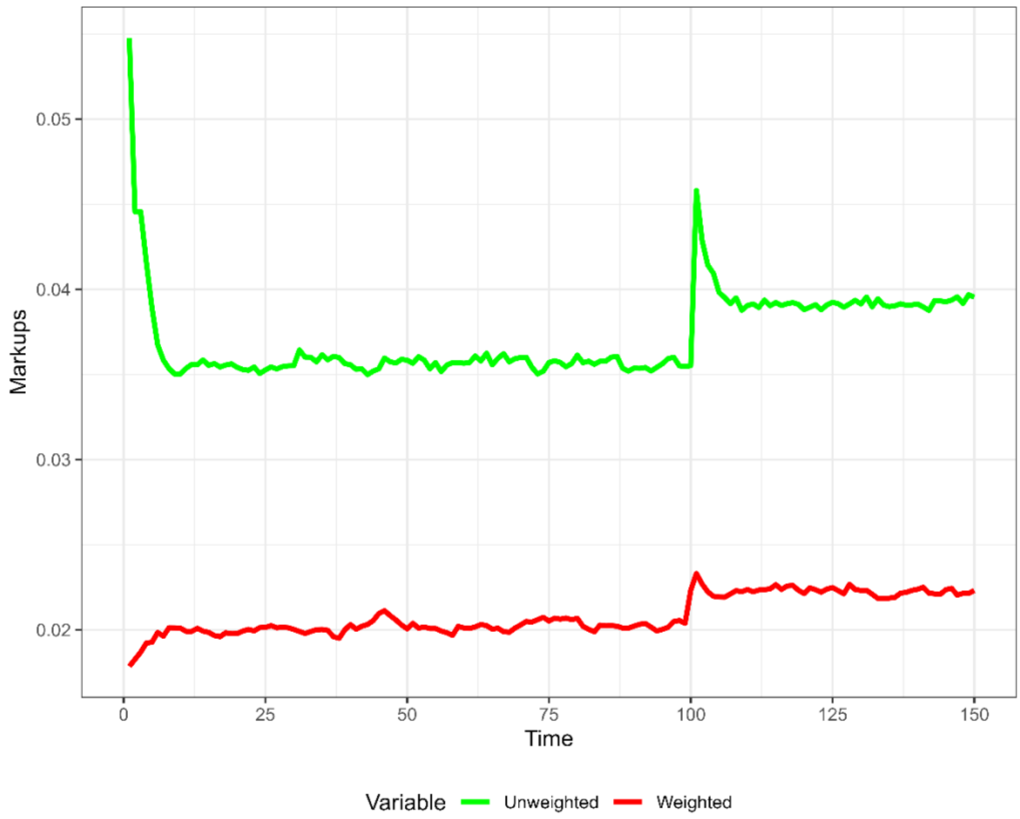

Figure 10: Firms' sales-weighted and unweighted markups in the informational cost specification.

Zooming in on the consumer side of this model specification, the bottom graph of Figure 11 shows that consumers already start with a substantially smaller set of prices they survey and from which they choose to consume compared to the baseline specification. This explains the slightly elevated CPI as well as increased profits and markups of firms prior to the cost shocks in period 100. As soon as the price dispersion sparks, consumer sets are further reduced, reflecting their increased difficulties to oversee and assess relative price differences.

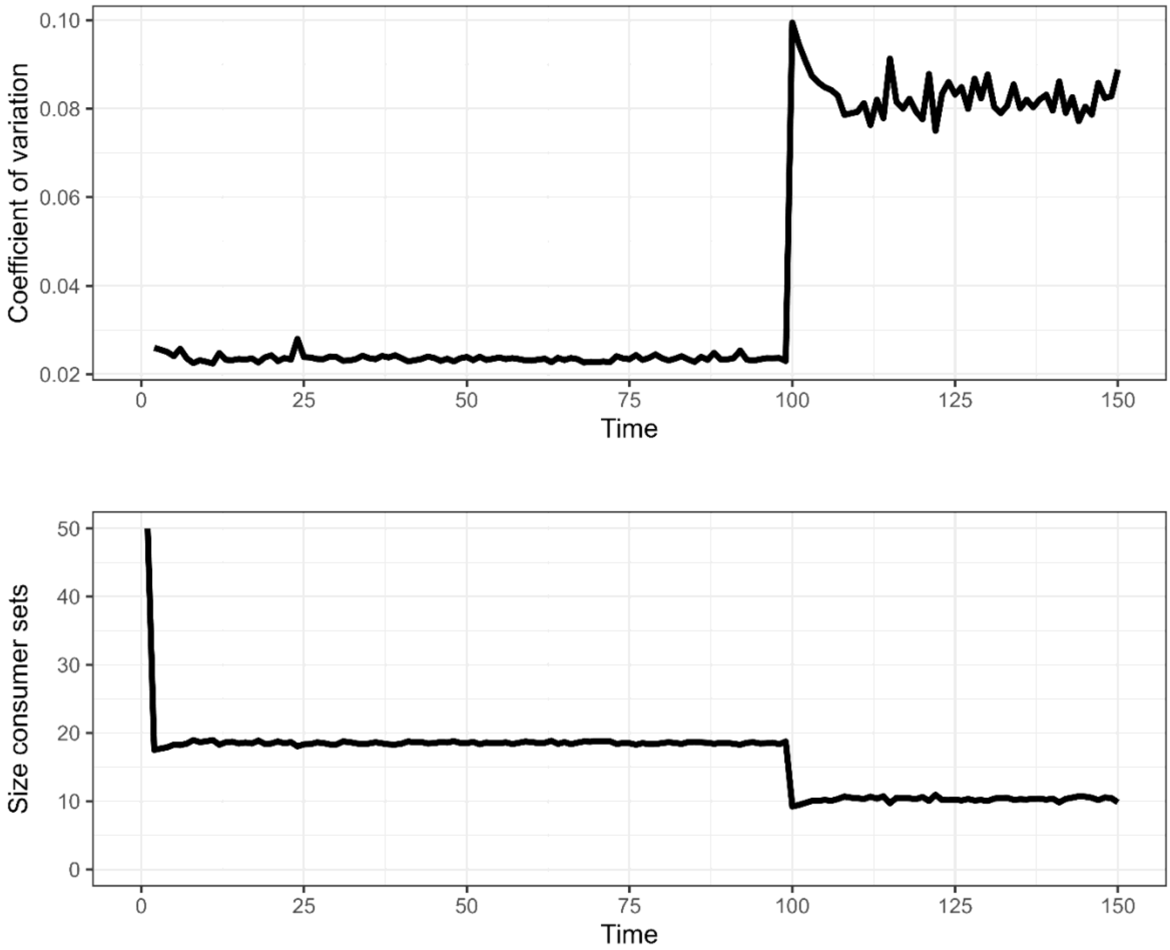

Figure 11: Price dispersion given as the Coefficient of Variation (top) and number of goods' prices consumer oversee and assess (bottom) in the baseline model specification.

The market dynamics in Figure 12 show a surprising result. While the overall concentration is slightly lower than in the baseline scenario, the cost-push shock leads to a further reduction in market concentration. This finding is particularly notable because sellers' inflation emerges despite declining concentration levels, demonstrating that market concentration is neither necessary nor sufficient for sellers' inflation to occur in our model framework. By contrast, the concentration in the baseline case appears to reflect allocation based on genuine productivity and cost differences that are obscured in the informational cost scenario.

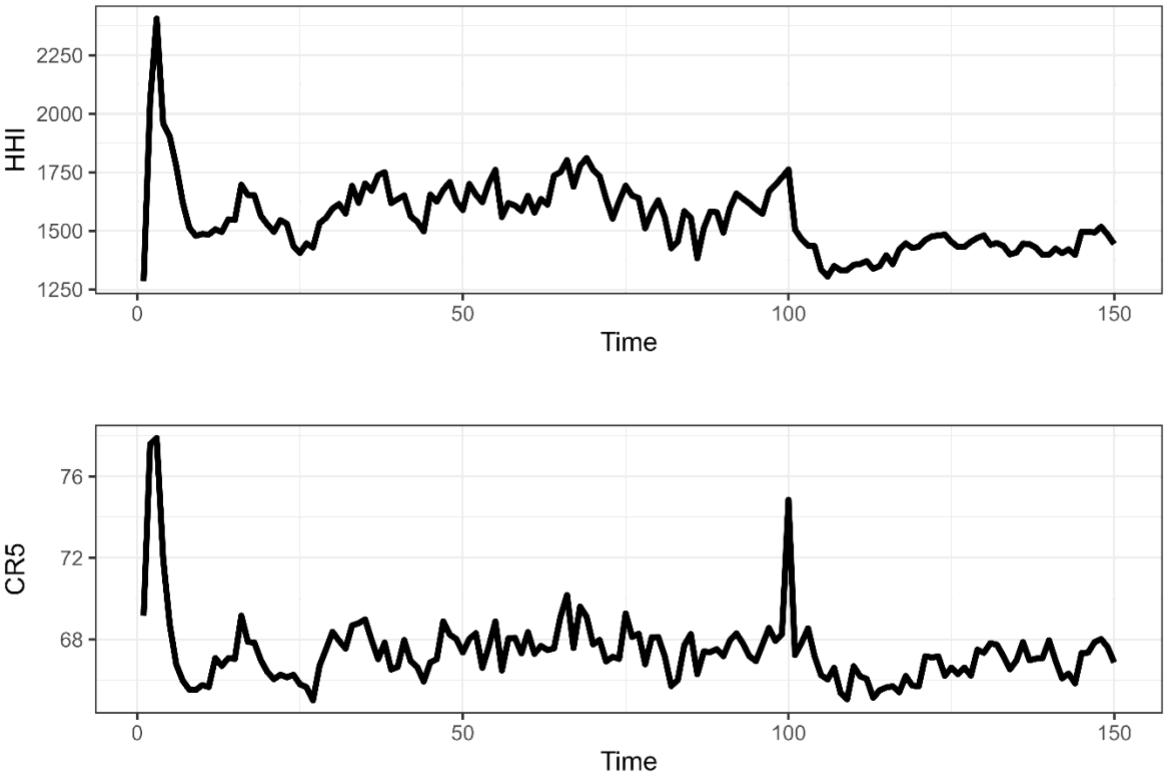

Figure 12: Herfindahl-Hirschman-Index (top) and the share of the 5 largest firms (bottom) informational cost specification.

Turning again to the productivity developments (Figure 13) in the model with informational costs, the overall dynamics prior to the price shock appear to be similar to the baseline specification. However, during the price shock in period 100, productivity growth declines sharply and turns negative. The decline primarily stems from the allocation term becoming negative, indicating that productive firms are losing market share. Including informational costs in the baseline model thus not only generates sellers' inflation but also misallocation during cost shocks.

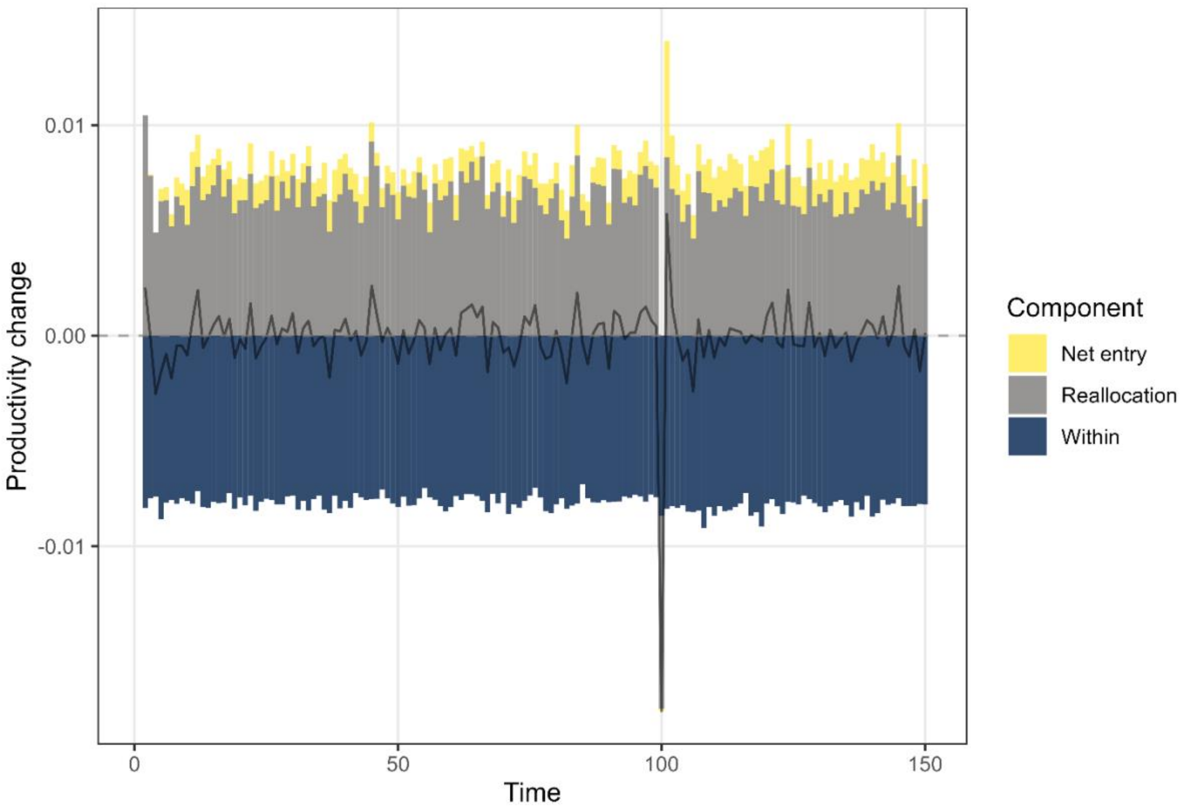

Figure 13: Productivity growth decomposition in levels for the informational costs specification. The black line represents the sum of the three components.

Finally, we conduct a sensitivity analysis of the key parameters in our model. Namely, we vary the two parameters that govern consumer choice to explore the role in explaining the emergence of sellers' inflation: γ, which regulates the price sensitivity of consumers as in Dawid et al. (2019) and ρ, which regulates consumers' sensitivity to price dispersion and the resulting informational frictions. Here, lower values indicate greater sensitivity and thus smaller consideration sets for consumers. Figure 14 reports the excess contribution of sellers' inflation to the initial cost increases in percentage terms averaged over periods 100-105. It shows that the existence of sellers' inflation crucially hinges on our proposed mechanism: the sensitivity of consumers to informational costs. This result holds even under very different intensities of price competition, suggesting that informational frictions are a robust mechanism for generating sellers' inflation across various market conditions. Accordingly, the results in the preceding sections appear not to be driven by a particular parameter setting.

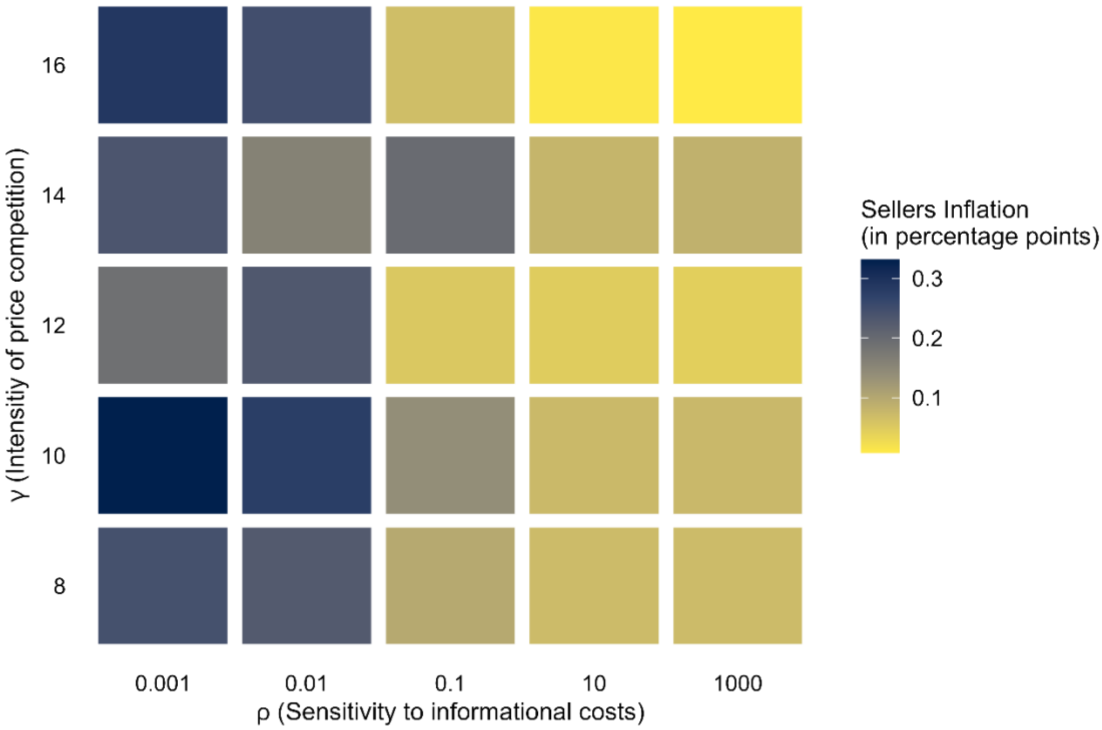

Figure 14: Degree of sellers' inflation in percentage points over periods 100-105 for different parameter constellations.

5. Conclusion

In this paper, we provided a novel candidate explanation for recent increases in firms' markups and profits that are often referred to as sellers' inflation. Our approach builds on the textbook inflation cost of distorted price signals, leading to an increased complexity in consumers' decision-making. We argue that rising price dispersion reduces the system of relative prices a consumer can oversee and assess. Importantly, this demand-side mechanism does not rely on excess demand or some form of market imbalance but rather works through an endogenous change in consumers' price elasticity during times of inflation. We show, building an agent-based model of heterogeneous, interacting firms and consumers, that, depending on the sensitivity of consumers to increased informational cost, firms are indeed able to increase their markups and profits following wide-ranging input cost shocks. Importantly, our results can explain two central questions relating to the recent period of sellers' inflation: why did firms that previously refrained from increasing prices to protect their market share i) raise prices in proportion or even excess of the initial shock and ii) did so without impeding their market share and profitability. The answer is that, given the increased informational costs during periods of high price dispersion, consumers fail to correctly evaluate price changes and therefore fail to adequately punish or reward firms for raising or maintaining prices. This leads to reduced allocative efficiency, which in turn enables individual firms to raise prices without fearing a decline in demand. While our results do not rule out other potential markup and profit inflation channels, such as windfall monopolies or implicit collusion, we provide a simpler and more generally applicable explanation that is not limited to these special cases.

In principle, our argument remains agnostic regarding whether markups and corporate profits are the main drivers of the recent inflationary episode. Instead, we provide microfoundations for the relationship between search and informational costs, firms' markups, and overall inflation dynamics in times of increased price dispersion. While our results do suggest that the informational costs of dispersed prices reduce the elasticity of consumers' demand and thereby increase firms' discretionary pricing power and in turn their markups, the importance of this markup inflation channel most likely differs across industries due to differences in search costs (Gwin and Taylor, 2004) as well as other economic contexts. Future research could aim at investigating the relative importance of this channel for different inflationary episodes and industry dynamics. Here, it would be of great interest to see whether firms in industries that are characterized by higher search costs on the consumer side can capitalize on increased price dispersion. Moreover, an explicit modeling of propagation effects on the supply side rather than a stochastic shock process would be desirable. Finally, our model could be enhanced to accommodate various goods and varying degrees of price sensitivity. Yet, it is important to note that assuming a homogeneous good tends to bias the results toward lower levels of sellers' inflation, given the greater ease of substitution in such a setting. Given that we can demonstrate the emergence of sellers' inflation even under conditions where substitution is most feasible and no quality differentiation exists, it follows *a fortiori* that sellers' inflation will also arise in markets for differentiated goods, where substitutability is more limited. Notwithstanding these limitations, we provide a promising candidate explanation for firms' markup and profit dynamics in times of inflation.

The following policy implications can be drawn from our model: Given our findings that market concentration does not provide a sufficient explanation for sellers' inflation, policies focused solely on reducing market concentration through antitrust measures may be of limited effectiveness in curbing the emergence of sellers' inflation. Instead, our results suggest that alternative approaches targeting informational costs could prove more effective. Specifically, policies aimed at reducing informational costs for consumers and enhancing their price sensitivity may help mitigate sellers' inflation. Real-time price-comparison websites exemplify one such initiative for market transparency. Several countries, including Germany, France, and Austria, have implemented such platforms for gasoline markets, with evidence suggesting that displaying an optimal number of nearby low-price options to consumers can effectively reduce prices (Martin, 2024). By utilizing market design principles to present only the cheapest goods available in a given area, consumers' rational inattention could be leveraged as an advantage, incentivizing firms to compete not only on price but also for consumers' limited attention.

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Appendix A: Empirical Studies on Sellers' Inflation

Study	Sample	Findings on Markups	Main Channel (if applicable)	Findings on Sellers' Inflation
Acharya et al. (2023)	EU Business and Consumer Surveys, ECB Consumer Expectations Survey, Compustat Global	Markups increased significantly, especially for firms with strong price-setting power.	Supply constraints; firms' price-setting power	Inflation primarily driven by supply constraints and firms' pricing power.
Alvarez et al. (2024)	Global manufacturing data, online pricing data (PriceStats)	Markups and pricing strategies along supply chains adjusted significantly.	-	No evidence that increased markups drove inflation.
Arquié & Thie (2023)	France (INSEE data, energy sector data, FICUS-FARE sectoral data)	Markups increased notably, particularly in sectors with high concentration.	Excess pass-through; market structure	Energy costs significantly passed through, supporting sellers' inflation.
Bijnens et al. (2023)	Belgium (non-financial firm-level data)	Markups increased notably post-COVID.	Firm-specific markup strategies	Inflation partly driven by rising markups.
Bilyk et al. (2023)	Firm-level financial statements (Canada)	Markups of non-financial firms increased from 10% to 13%.	Corporate profitability; pricing power	Inflation linked to increasing corporate markups post-COVID.
Bräuning et al. (2023)	Industry-level US data (producer prices, markups, HHI concentration)	Cost shocks increased prices beyond initial shocks, particularly in concentrated markets.	Market concentration	Sellers' inflation significant in highly concentrated markets.

Colonna et al. (2023)	Italy (national accounts data)	Markups rose sharply in 2022, driven mainly by industry and construction sectors.	Industry structure; sector-specific effects	Inflationary pressures partly driven by markup increases.
Conlon et al. (2023)	Compustat annual revenue and costs (US)	Markups increased over the analyzed period.	Corporate pricing power	Indications of inflation driven by increased corporate markups.
Cucignatto et al. (2023)	OECD ICIO data (France, Italy, Spain)	Markups rose significantly, especially in France (38 of 44 sectors).	Market structure	Evidence of inflation strongly linked to increased markups.
Davis (2023)	Compustat data (US non-financial firms, 1950-2022)	Aggregate markups increased post-pandemic.	Firm-level profitability	Inflation strongly correlated with rising markups and profits.
Glover et al. (2023)	US aggregate economic data (1948-2021)	Corporate profits contributed to inflation significantly, especially post-pandemic.	Corporate profitability	Inflation substantially driven by high corporate profits.
Guschanski & Onaran (2025)	UK listed and private firms (2014-2022)	Markups increased by approximately 31% during the period.	Firm-specific pricing behavior	Sellers' inflation linked explicitly to rising markups and profit margins.
Konczal & Lusiani (2022)	US financial account data (1955-2021)	Markups and profits reached historical highs.	Corporate profits; pricing power	Inflation strongly driven by corporate markups and profits.
Koppenberg et al. (2025)	EU firm-level balance sheets, food and beverage industry (2013-2022)	Markups generally decreased, especially in 2022.	-	Negative relationship between markups and input prices. No evidence of sellers' inflation.

Matamoros (2024)	AMECO, Haver Analytics, OECD data (1970-2022)	Markup inflation relevant in the context of corporate power.	Corporate power dynamics	Inflation correlated with corporate power and markup increases.
Nikiforos et al. (2024)	Compustat annual dataset (1962-2022)	Markups increased moderately; limited evidence for extensive markup-driven inflation.	Profit-driven inflation	Moderate support for sellers' inflation driven by profit increases.
Scanlon (2024)	US CPI and product prices (2001-2023)	Price level uncertainty masked relative price changes, enabling higher markups.	Informational frictions; price uncertainty	Sellers' inflation driven by increased price-level uncertainty.
Storm (2023)	US data on prices, costs, profits per unit of output (2020Q1-2022Q4)	Growth in US GDP deflator driven primarily by profit-per-unit output, not labor costs.	Profit-led pricing power	Strong empirical evidence for profit-led (sellers') inflation.
Uxó et al. (2025)	Spain (Observatorio de Márgenes Empresariales data, 2021-2023)	Increased markups observed only in roughly 30% of analyzed goods.	Sector-specific markup dynamics	Did not find widespread sellers' inflation but some evidence for specific sectors.

Appendix B: Dynamic Olley-Pakes Decomposition

We use the decomposition of aggregate productivity proposed Melitz & Polanec (2015) to decompose relative changes in productivity levels following closely the derivations in the appendix of Melitz and Polanec (2015). The authors extend the traditional Olley and Pakes (1996) decomposition of aggregate productivity (Φ_t)

$$\Phi_t = \sum_i \phi_{i,t} \; s_{i,t} \tag{i}$$

where s_{it} is the market share for a firm i at time t and ϕ_{it} is the productivity of firm i. Following Olley and Pakes (1996) aggregate productivity can be decomposed as follows:

$$\begin{aligned} \Phi_\mathrm{t} &= \bar{\phi}_t \sum_i \left(s_{i,t} - \bar{s}_t\right)(\phi_{i,t} - \bar{\phi}_t) \\ &= \bar{\phi}_t + \; cov\left(s_{i,t}, \phi_{i,t}\right) \end{aligned} \tag{ii}$$

Where $\bar{\phi}_t$ is the unweighted productivity mean at time *t* and $\bar{s}_t$ is the mean market share at time *t*. This decomposition does not consider firms entering or exiting the market and Melitz & Polanec (2015) propose an extension to the decomposition. Let *S, E,* and *X* denote the sets of surviving, entering, and exiting firms. s_{Gt} represents the aggregate market share of group G of firms and define $\Phi_{G,t} = \sum_i \left(\frac{s_{i,t}}{s_{G,t}}\right) \phi_{i,t}$ as that groups' aggregate market-share weighted productivity. The aggregate productivity of each period can be expressed as:

$$\begin{aligned} \Phi_1 &= s_{S1}\Phi_{S1} + s_{X1}\Phi_{X1} = \Phi_{S1} + s_{X1}(\Phi_{X1} - \Phi_{S1}) \\ \Phi_2 &= s_{S2}\Phi_{S2} + s_{E2}\Phi_{E2} = \Phi_{S2} + s_{E2}(\Phi_{E2} - \Phi_{S2}) \end{aligned} \tag{iii}$$

From this the relative change can be expressed and decomposed as:

$$\frac{\Phi_2-\Phi_1}{\bar{\Phi}} = \frac{\Phi_{S2}-\Phi_{S1}}{\bar{\Phi}} + s_{E2}\frac{\Phi_{E2}-\Phi_{S2}}{\bar{\Phi}} + s_{X1}\frac{\Phi_{S1}-\Phi_{X1}}{\bar{\Phi}}$$

$$= \frac{1}{1-\overline{\widetilde{\text{cov}}}_S}\frac{\bar{\Phi}_S}{\bar{\Phi}}\left(\frac{\Delta\bar{\phi}_S}{\bar{\Phi}_S} + \Delta\widetilde{\text{cov}}_S\right) + s_{E2}\frac{\Phi_{E2}-\Phi_{S2}}{\bar{\Phi}} + s_{X1}\frac{\Phi_{S1}-\Phi_{X1}}{\bar{\Phi}} \quad \text{(iv)}$$

where $\bar{\Phi} = \frac{1}{2}(\Phi_1+\Phi_2)$; $\overline{\Phi}_S = \frac{1}{2}(\Phi_{S1}+\Phi_{S2})$; $\overline{\widetilde{\text{cov}}}_S = \frac{1}{2}(\widetilde{cov}_{S1}+\widetilde{cov}_{S2})$ represent time averages and $\widetilde{cov} = \frac{cov(s,\phi)}{\Phi}$ a scale-independent covariance measure between market shares and productivity.

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