The Curse of Inflation

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ABSTRACT

This paper proposes a model that explains the nonneutrality of money from two well-documented psychological assumptions. The model incorporates into the general-equilibrium monopolistic-competition framework of Blanchard and Kiyotaki [1987] the psychological assumptions that (1) consumers dislike paying a price that exceeds some "fair" markup on firms' marginal costs, and (2) consumers do not know firms' marginal costs and fail to infer them from prices. The first assumption in isolation renders the economy more competitive without changing any of its qualitative properties; in particular, money remains neutral. The two assumptions together cause money to be nonneutral: greater money supply induce higher perceived markups, lower actual markups, higher hours worked, and higher output. Whereas an increase in money supply is expansionary, it decreases the fairness of transactions perceived by consumers to such an extent that it reduces overall welfare. The cost of inflation is a psychological one that derives from a mistaken belief by consumers that transactions have become less fair. In fact, it is this misperception that makes an increase in money supply expansionary. An increase in technology induces higher output and lower perceived markups, but higher actual markups and lower hours worked.

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1 Introduction

A trove of empirical evidence suggests that people care about the fairness of the transactions they engage in and dislike paying prices that they view as unfair. In a seminal paper, Kahneman, Knetsch and Thaler [1986] present evidence that while most people regard it as acceptable for firms to raise prices in response to higher marginal costs, they find it unfair for firms to raise prices in response to elevated demand. Because consumers typically do not know firms' marginal costs, their perceptions of how fairly firms price their goods depend upon their estimates of these marginal costs. Rational consumers should be able to invert firms' pricing rules and infer marginal costs in equilibrium. Yet copious evidence across a number of domains indicates that people infer less than rationally by failing to glean the informational content of other people's actions. Consumers who underinfer the hidden information that prices convey about marginal cost misattribute high prices to high markups rather than to high marginal costs and thus find rising prices unfair.

In this paper, we explore the implications of these two well-documented psychological assumptions for the economy. We tractably incorporate them into the standard macroeconomic model of monopolistic competition by Blanchard and Kiyotaki [1987]. The extended model provides a set of joint predictions on the impact of monetary and technological shocks on the economy along with their welfare implications.

In modeling fairness concerns in this general-equilibrium setting, we assume that the utility people derive from a good depends upon the perceive fairness of its purchase price. People dislike paying prices that exceed a fair markup on firms' marginal costs and buying at unfair prices reduces the joy of consumption. When they perceive prices to be unfairly high, consumers withhold demand because paying a higher markup for some good lowers the marginal utility of consuming that good.

We assume that consumption utility is scaled by a factor that measures the perceived fairness of the transaction - this is based on the observed price and the consumer's estimate of the good's marginal cost. Specifically, when good i is sold at price P_i and is produced at a perceived marginal cost of MC_i, consumers perceive its markup to be $\mu_i^p = P_i/MC_i$. When consumers judge the "fair" markup for good i to be some μ_i^f, they weight each unit of consumption of good i by a factor of $\psi_i = 1 - (\phi/\mu^p) \cdot (\mu_i^p - \mu_i^f)$. Here ϕ parametrizes consumers' fairness concerns and μ^p corre-

sponds to the perceived average markup across all goods. When $\phi = 0$ we have the classic case without fairness concerns. An increase in ϕ corresponds to an increased sensitivity of consumption utility to the perceived fairness of the transaction. A higher ϕ means that a consumer derives less joy or is more upset when consuming an item bought at an unfair price and is more content when consuming an item bought at a below-fair price, namely a bargain. Such fairness concerns increase the elasticity of demand as an increase in the price of good i increases the opportunity cost of consumption while decreasing the enjoyment of consumption.

In our model, because consumers do not know firms' marginal costs, the inference they draw about them in equilibrium plays a pivotal role. When consumers know or can rationally infer firms' marginal costs, and hence markups, from the prices they observe, their dislike of unfair markups increases the elasticity of demand, leading firms to optimally set lower markups. This renders the economy more competitive: output, hours worked, and real money balances all exceed their no-fairness levels. But the qualitative features of the economy do not differ from the case without fairness concerns; in particular, money is neutral—it has no effect on the real side of the economy.

In light of recent and robust evidence that people fail to think through the hidden information revealed by the actions of others, we also depart from the assumption of full rationality. Instead, we assume that although consumers attend to prices, which are salient, they fail to attend to the less direct information these prices reveal about hidden marginal costs. For analytical tractability, we make the extreme assumption that consumers make no inference about marginal costs from prices nor from any other available information such as received profits or labor demand. We regard this failure to infer as a form of neglect: consumers simply fail to think through how prices (and other variables) are contingent upon marginal cost in equilibrium.

This simple assumption is consistent with failures of contingent thinking captured by fully cursed equilibrium of Eyster and Rabin [2005], the analogy-based expectations equilibrium of Jehiel [2005] and Jehiel and Koessler [2008]. It is also broadly consistent with the salience logic of Gennaioli and Shleifer [2010], who assume that people infer information content by drawing upon a limited set of scenarios that come more easily to mind: higher prices suggest increased markups and greed, rather than higher marginal costs. Also related is the coarse-thinking model of Mullainathan, Schwartzstein and Shleifer [2008]. Consumers in our model are coarse thinkers in that they do not distinguish between scenarios where changes in price reflect changes in cost and

those where they reflect changes in markup. Formally, we assume that consumers do not update their prior beliefs over firms' marginal costs in response to anything they observe. We refer to consumers who fail to infer marginal costs from prices and other economic variables as *cursed*.

The above two assumptions imply that money is no longer neutral in the economy. Instead, we find that an increase in money supply causes real markups to fall, stimulating the economy but lowering welfare at the same time. For an intuition for why money is non-neutral, suppose that starting from equilibrium the supply of money and also all prices were to double. In this case, the amount of output demanded by consumers, hours worked, and the cost of labor would remain the same. Accordingly, the real marginal cost faced by firms would not change. Observing higher prices, consumers who failed to infer increases in underlying marginal costs would mistakenly perceive higher markups, which would increase the elasticity of demand, leading firms to optimally set lower markups. Hence, the economy could not be in equilibrium. Consequently, the equilibrium price level rises less than one-for-one with money supply; increased money supply leads to increased hours worked and output, increased real marginal costs, and decreased markups. In business cycles generated by money-supply shocks or other aggregate-demand shocks, markups are countercyclical. Actual markups fall because perceived markups rise as prices rise: consumers become angry at what they perceive as unfair markups after an increase in money supply.

An increase in money supply affects welfare through two channels: it reduces actual markups and thus the inefficiency due to monopolistic competition, at the same time, it increases perceived markups due to their mistaken inference and in turn upsetting consumers. Crucially, we find that the second effect dominates the first in consumers' utility so that overall welfare decreases after an increase in money supply. At the same time, ignoring the fairness component of utility—the disutility consumers experience from being angered by unfair prices—we find that " unemotional" welfare always rises. In fat, an increase in money supply creates the wedge between these two measures of welfare, which is the force at the heart of our monetary non-neutrality mechanism.

In addition to finding that profit-maximizing firms set prices that respond less than one-for-one to money supply leading endogenously to price-rigidity, we express the elasticity of the price level to money supply—the pass-through—as a function of the competitiveness of the economy and consumers sensitivity to fairness. When people care more about fairness, or when the economy is less competitive, the pass-through is lower.

We also analyze how the economy responds to technology shocks. We find that improved technology still leads to higher consumption but at the same time to higher markups and lower hours worked. The logic mirrors that following a monetary shock. Since consumers fail to infer that lower prices reflect lower marginal costs, they are willing to tolerate a higher actual markup than before. This increases firms monopoly power, driving real markups higher and decreasing the number of hours worked in equilibrium. Although actual markups increase, perceived markups fall and people's perception of the fairness increases. People are happy and are effectively more willing to buy at higher markups more so than before. We also express the elasticity of the price level to the parameter governing technology, with the same results as for money supply: cost savings get passed through less than one-for-one and less the more people care about fairness or the less competitive is the economy.

Determining the origin of money non-neutrality is a classical problem in macroeconomics addressed by many models. Most feature monopolistic firms selling goods subject to some exogenous price-setting frictions.[1] In these models as in ours without such frictions, money-supply shocks propagate through the economy via lower monopolistic markups: increasing money supply raises prices but lowers markups and thus stimulates output. But in existing models, because consumers correctly infer markups from prices, they understand that although prices go up after an increase in money supply, firms' per-unit profits fall. This prediction seems at odds with evidence that people feel cheated by rising prices. In a famous survey conducted by Shiller [1996], 85% of respondents report that they dislike inflation because when they " go to the store and see that prices are higher", they " feel a little angry at someone", the most commonly perceived culprits including " manufacturers", " store owners", and "businesses", and the most commonly identified cause being " greed".

Our model reconciles the non-neutrality of money with the behavioral evidence presented by Shiller [1996]: consumers feel cheated by higher prices after an increase in money supply because they believe that higher prices reflect higher markups. It helps bridge a gap between the attitudes that people have about inflation and those implied by macroeconomic models, as described by

[1]These price-setting frictions take a number of different forms. Classical frictions include staggered nominal contracts as in Akerlof [1969], Fischer [1977], and Taylor [1979], a quadratic price-adjustment cost as in Rotemberg [1982], infrequent pricing as in Calvo [1983], and a menu cost as in Mankiw [1985] and Akerlof and Yellen [1985]. See Blanchard [1990] for a comprehensive survey of the early theories of money non-neutrality, and Mankiw and Reis [2010] and Sims [2010] for surveys of more recent theories.

Romer [2012]: " There is a wide gap between the popular view of inflation and the costs of inflation that economist can identify. Inflation is intensely disliked." Moreover, the fact that consumers feel cheated by higher nominal prices is the very fact that leads firms to reduce actual markups, which is the mechanism that makes an increase in money supply expansionary in our setting.

The preferences in our model share features with those used in the literature on reciprocity and fairness—for instance, the preferences embedding intention-based fairness motives of Rabin [1993] or the social preferences exhibiting aversion to unequal outcomes of Fehr and Schmidt [1999]—in that consumers care not only about quantities of the goods that they consume but also about the surpluses enjoyed by firms. Akerlof [1982] and Akerlof and Yellen [1990] pioneered the study of the implications of fairness on the labor market, showing how unemployment arises when fairness considerations affect employment relations. Rotemberg [2005] initiated the product-market side of this agenda. Building on a large amount of empirical evidence on fairness concerns, Rotemberg assumes that consumers care about firms' altruism—their taste for increasing consumers' payoffs—which they re-evaluate after every price change. Consumers buy a normal amount from the firm unless they can reject the hypothesis that the firm is altruistic toward them, in which case they withhold all demand to lower the firm's profits. Given such discontinuity, firms react by refraining from passing on small cost increases, leading to money non-neutrality.

In this paper, we also retool the assumption of Rotemberg [2005] that consumers refuse to purchase from firms whose prices unambiguously reveal a lack of concern for their welfare by making the slightly different psychological assumption that consumers experience less enjoyment of a good the less fair they regard its price. Despite broad similarities, the two assumptions differ conceptually and lead to different predictions in important settings. Unlike ours, Rotemberg's assumption implies that consumers would not withhold demand unless doing so hurt firms.[2] Yet in many large market settings, consumers cannot easily cause firms significant harm. In fact Dufwenberg et al. [2011] show that under perfect competition, consumers with standard other-regarding preferences are observationally equivalent to those who care only for their own consumption: withholding a unit of demand does not harm a seller who earns zero profit on the marginal unit.

[2]Along his lines, Rullière, Marchand and Güth [1998] and Fischbacher, Fong and Fehr [2009] present evidence from a variant of the Ultimatum Game that responders will not give up their share of an unfair split unless doing so harms the proposer. However, because money is fungible in a way that consumer goods are not, people may be more willing to forego tainted consumption goods than tainted money: an overpriced peach may not taste as sweet as a fairly priced one, while an unfair $5 deposited into a checking account becomes simply another $5.

In monopolistically competitive markets, consumers can reduce profits by withholding demand, but the effect is likely to be small in large markets: Rotemberg [2005] assumes that consumers' taste for harming non-altruistic firms is arbitrarily strong. However, it is often difficult for consumers to harm firms appreciably in large-market settings. In our formulation, consumers do not discontinuously withhold demand to punish firms but do so smoothly because they enjoy consuming unfairly-priced goods less. This allows us to move away from Rotemberg's binary buy-normally-or-buy-nothing formulation to a tractable continuous one in which consumers continuously reduce demand as the unfairness of the transaction or their concern for fairness increases. The continuous formulation also enables us to calibrate the standard model with adding only a single parameter ϕ measuring people's concern for fairness. The continuous formulation also enables us to calibrated the standard model with adding only a single parameter ϕ measuring people's concern for fairness.

By decoupling consumers' distaste for consuming unfairly priced goods from its effect on firms' profits, our approach enjoys several distinct advantages. First, it adds fairness concerns to large markets in a way that is portable across models and analytically tractable; embedding the psychological assumption into the canonical macroeconomic model of Blanchard and Kiyotaki [1987] permits a number of comparative statics and analytical expressions for key elasticities. Second, it has sizeable macroeconomic effects even when consumers care much more about consumption than fairness. Third, it provides a sharp characterization of welfare and the corresponding misperception based cost of inflation.

The paper proceeds as follows. Section 2 presents evidence for the psychological assumptions of fairness concerns and cursed inference that underlie our model. Section 3 describes our model of the macroeconomy based on Blanchard and Kiyotaki [1987]. Section 4 analyzes the model when consumers care about fairness and rationally infer firms' marginal costs from their prices. Section 5 explores what happens when consumers care about fairness but fail to infer marginal costs from prices. Finally, Section 6 concludes.

2 Motivation for the Fairness and Cursedness Assumptions

In this section we provide empirical evidence that people care about the fairness of the markup charged by firms and that firms respond to such preferences. We then briefly summarize evidence in support of our assumption that people fail to infer firms' marginal costs from equilibrium prices.[3]

2.1 Fairness Matters for Consumers

Consumers care about the fairness of prices. The idea that they express hostility to price increases not explained by cost increases goes back at least to Okun [1981], who points out that "price increases that are based on cost increases are fair, while those based on demand increases often are viewed as unfair". In a seminal study based on survey data, Kahneman, Knetsch and Thaler [1986] explore people's attitude towards the fairness of prices. The responses to their survey establish a pattern wherein consumers deem it fair for firms to raise prices in response to increases in marginal costs but not in response to increases in demand. By assuming that people dislike paying above a fair markup on marginal cost, our model incorporates this finding.

In our model, we assume that consumers react angrily to a price increase that follows a demand increase and therefore involves an increase in markup. Kahneman, Knetsch and Thaler [1986] establish such a pattern. For example, they describe following situation: "A hardware store has been selling snow shovels for $15. The morning after a large snowstorm, the store raises the price to $20." Only 18% of consumers regard this pricing behavior as acceptable. 82% regard this behavior as unfair.

In our model, consumers do not mind a price increase that follows a cost increase as long as the markup remains constant. Kahneman, Knetsch and Thaler [1986] indeed find this, for instance in response to the following situation: "Suppose that, due to a transportation mixup, there is a local shortage of lettuce and the wholesale price has increased. A local grocer has bought the usual quantity of lettuce at a price that is 30 cents per head higher than normal. The grocer raises the price of lettuce to customers by 30 cents per head." 79% of consumers regard the grocer's behavior as acceptable, and only 21% find it unfair.[4] We also assume that consumers regard it

[3] See Rotemberg [2009] for a survey of the behavioral reactions of consumers to prices and the implications of these reactions for price setting by firms and for government policy.

[4] In this question, the additive markup does not vary across situations, yet, in our model, fairness perceptions depend

as unfair for firms not to pass along cost decreases despite the evidence that Kahneman, Knetsch and Thaler [1986] find for this being weaker.[5] For simplicity, and also because we expect that consumers would insist that cost savings be passed along in the long-run, we do not incorporate an asymmetry between consumers' reactions to cost increases and decreases. Doing so would not affect our results on surprise increases in money supply but would affect our results regarding decreases in money supply or technological progress. Nevertheless, we would obtain the same qualitative results, albeit quantitatively muted, if only a fraction of consumers contest that cost savings must be passed on.

The findings of Kahneman, Knetsch and Thaler [1986] have been confirmed in many studies, especially using laboratory experiments. For instance, Campbell [1999] provides evidence that consumers' inferences about the motives behind price increases influence how fair they judge the increase. Renner and Tyran [2004] provides additional evidence that price rigidity after a temporary cost shock is much more pronounced if price increases cannot be justified by cost increases.

2.2 Firms Understand that Fairness Matters for Consumers

The predictions of our model depend not only on the assumption that consumers respond to unfair markups but also on the assumption that firms understand how consumers trim demand at unfair prices. Blinder et al. [1998] find evidence that they do. 64% of firms say that customers do not tolerate price increases after increases in demand; 71% of firms say that customers do tolerate price increase after increase in cost. These responses suggest that the norm for fair pricing must take the form of a fair markup over marginal cost. Indeed, based on a survey of businessmen in the UK, Hall and Hitch [1939] report that the fair price is widely perceived to be a markup over average cost. Okun [1975] also observed by discussing with business people that "empirically, the typical standard of fairness involves cost-oriented pricing with a markup".

Moreover, ample evidence suggests that consumers' concern for fairness influences how firms set prices. Following Blinder et al. [1998], a number of researchers have surveyed firms about

upon proportional markups. We suspect that Kahneman, Knetsch and Thaler [1986] would have obtained the same results had they asked whether it is fair for firms to increase prices by $x\%$ following cost increases of $x\%$.

[5]For example, Kahneman, Knetsch and Thaler [1986] describe the following situation: "A small factory produces tables and sells all that it can make at $200 each. Because of changes in the price of materials, the cost of making each table has recently decreased by $20. The factory does not change its price of tables." 53% of respondents find this fair, even though the markup has increased.

their pricing strategies. In these surveys, managers tasked with setting prices were presented with a set of economic theories of price-setting and asked to rate the importance of each as a cause of their own firm's price stickiness.[6] Although the surveys do not explicitly include our theory, they do report on a closely related theory that they call "implicit contracts" and describe as follows: "firms tacitly agree to stabilize prices, perhaps out of fairness to customers." This theory receives abundant support from firms, as shown in Table 1: while no theory clearly dominates the surveys, such a fairness theory always finishes amongst the most relevant ones. Firms appear to incorporate fairness concerns into their price-setting.

In Appendix B, we report our own interviews of French bakers on their price-setting practices, as well as historical evidence of the role that fairness considerations played in French history. These provide further evidence that firms recognize that consumers care about markups.

2.3 Firms Attempt to Communicate their Costs to Consumers

Last, our assumption that buyers care not only about consumption but also about sellers' markups has implications for the type of cost information that firms wish to transmit to consumers. Firms with high marginal costs wish to reveal them to consumers whose estimates are too low. Firms with low marginal costs wish to conceal them from consumers whose estimates are too high. Ample evidence suggests that firms do indeed try to explain and thus to justify price increases caused by increases in costs. In their detailed study of the pricing process of a large industrial firm, Zbaracki et al. [2004] find that it expends substantial resources communicating and justifying price increases to customers. The observation that firms attempt to rationalize their prices rises dates at least as far back as Okun [1975], who noted that firms aim to "justify cost-oriented price increases—a desire evident in the dedicated, if fuzzy, statements that firms issue, insisting that higher costs force them to raise prices".

Our own observations suggest that these statement are indeed prevalent, as showed in the pictures of Figures 1 and 2. Figure 1(b) is particularly interesting because it was taken on a Hawaiian

[6]Table 5.1 in Blinder et al. [1998] summarizes the most commonly proposed theories. Amongst the ten or so theories included in these surveys are three leading macroeconomic theories of price rigidity—menu costs, nominal contracts, and informational frictions. While a useful modeling device, the infrequent pricing of Calvo [1983] does not provide a theory of price rigidity and therefore could not be evaluated. The other theories included IO theories of price rigidity, including coordination failure, and quality signaling.

Table 1: The Prevalence of Implicit Contracts with Customers ("Firms tacitly agree to stabilize prices, perhaps out of fairness to customers")

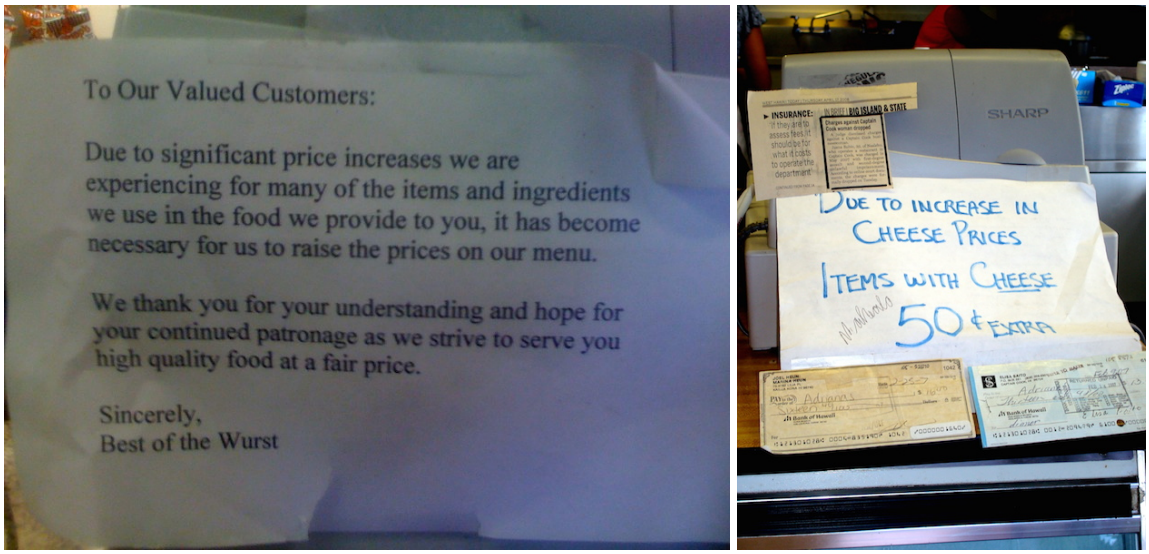
Study	Country	Period	Sample	Prevalence of implicit contracts
Blinder et al. [1998]	US	1990–92	200	4/12
Hall, Walsh and Yates [2000]	UK	1995	654	5/11
Amirault, Kwan and Wilkinson [2006]	Canada	2002–03	170	2/11
Apel, Friberg and Hallsten [2005]	Sweden	2000	626	1/13
Kwapil, Baumgartner and Scharler [2005]	Austria	2004	873	1/10
Aucremanne and Druant [2005]	Belgium	2004	1,979	1/15
Loupias and Ricart [2004]	France	2004	1,662	4/10
Lunnemann and Matha [2006]	Luxembourg	2004	367	1/15
Hoeberichts and Stokman [2006]	Netherlands	2004	1,246	1/8
Martins [2005]	Portugal	2004	1,370	1/12
Alvarez and Hernando [2005]	Spain	2004	2,008	1/9

Notes: Respondents to the surveys rated the relevance of each of a set of price-setting theories for price stickiness in their own firms. This table shows how the theory of implicit contracts ranks amongst the alternatives: a rank of 4/12 means that it was the 4th most popular of 12 proposed theories. Table 5.1 in Blinder et al. [1998] provides a short summary of all the theories proposed to respondents. This table draws on the following sources: Table 5.2 in Blinder et al. [1998]; Table 3 in Hall, Walsh and Yates [2000]; Table 8 in Amirault, Kwan and Wilkinson [2006]; Table 4 in Apel, Friberg and Hallsten [2005]; Table 5 in Kwapil, Baumgartner and Scharler [2005]; Table 18 in Aucremanne and Druant [2005]; Table 6.1 in Loupias and Ricart [2004]; Table 8 in Lunnemann and Matha [2006]; Table 10 in Hoeberichts and Stokman [2006]; Table 4 in Martins [2005]; and Table 5 in Alvarez and Hernando [2005].

island without competing taquerias; hence, the firm did not post its sign to signal higher competitor prices, something that firms have incentive to do when consumers face search costs. Figure 2 shows that producers go to great lengths to justify cost increases. It comprises two displays posted side-by-side in a bakery in Ithaca, NY. The first explains that the increase in the price of wheat price translated into an increase in the price of flour, a key ingredient for bagels. The second reproduces graphs from the New York Times to substantiate the claim.

2.4 Fairness According to Religious and Legal Texts

Surveys of consumers, firms, and French bakers suggest that a norm of fair prices over marginal costs is widespread today in the Western world. Religious and legal texts written over the ages



(a) Sandwich Shop in Columbus, OH, 2008 (Photo: Slav Petrov)

(b) Taqueria in Kona, HI, 2008 (Photo: Pascal Michaillat)

Figure 1: Examples of Firms Justifying a Price Increase by a Cost Increase

suggest that it corresponds to a general principle of fairness.

Religious texts provide evidence that norms of fair pricing have existed for a long time, and that the fair price often is a fair markup over cost of production or purchase for resale. For example, Talmudic law (Mishnah, Gemarah) states that there is a maximum percentage markup over cost that is fair and acceptable and should be allowed in trade [Wahrhaftig, 1999]. In particular, it posits that a good cannot be sold at a markup higher than 20% over the cost of producing the good—1/6 of the final price.[7] If the price deviates by more, the buyer is entitled to a refund.

Norms of fair pricing appear not only in religious but also in legal texts. For instance, during most of the 18th century in France, bread prices were fixed by local authorities. The police, supported by the Parliament, would determine a price of bread that would be "fair" for bakers and consumers; this fair price would be announced in an official decree. For example, in the city of Rouen, bread-price schedules would take into account the price of grain, costs of rent, milling, wood and labor, and grant a "modest profit" to the baker [Miller, 1999]. The schedule was decreed by the policy, and could be adjusted with large fluctuations in the price of grain. The entire price-

[7] See the statement of Shmuel, page 49b of Bava Metzhia, Nezikin, halakhah.com/pdf/nezikin/Baba_Metzia.pdf. The 20% rule also applies to middlemen, so that someone who sells an item previously purchased from producer can charge an additional 20% to compensate for the effort of selling.

COLLEGETOWN BAGELS
BROUS & MEHAFFEY
ITHACA BAKERY

February 28, 2008

TO OUR VALUED CUSTOMERS

Wheat is continuing to hit record prices, vastly increasing our costs for flour. To cope with this, we are forced to impose a surcharge on bread and bagels, effective immediately. This will include sandwiches. Each week, we will recalculate the surcharge, according to the price of wheat. We hope that this will be temporary, but industry experts do not know when—or if—prices will stabilize.

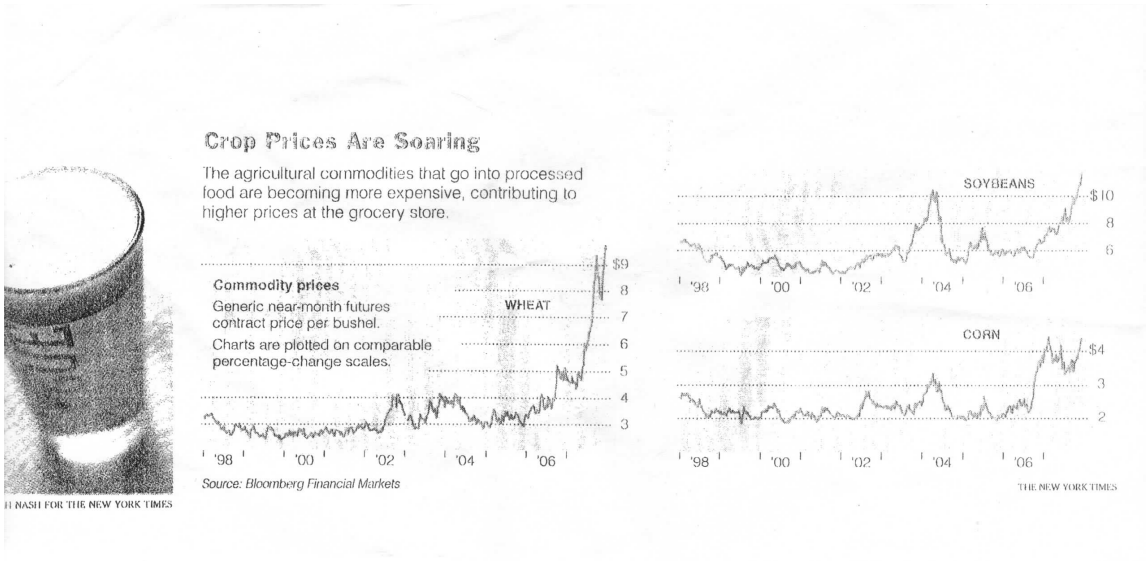
- Our flour cost has more than tripled in the past month.
- On Monday (2/25/08) the price of March spring wheat on the Minneapolis Grain Exchange hit $24 a bushel, double its cost two months ago and the highest price ever for wheat.
- The high-quality wheat we use to make artisan breads and bagels is getting harder to find.
- U.S. stocks of wheat are now at their lowest level in 60 years.

We can direct customers to substantial references for information about the wheat situation, online and in print.

When prices return to normal, we will drop the surcharge. Please bear with us as we try to address this very serious situation.

Sincerely,
The Brous & Mehaffey Family

(a) Justification for higher prices



(b) Evidence of higher costs

Figure 2: Another Example, from a Bakery in Ithaca, NY, 2008 (Photo: Daniel Benjamin)

cap map could be revised if the grain prices were too high during a dearth: bakers could petition to have the price cap increased. Price caps could also be lowered, thus reducing the price of bread. Police officers would patrol the marketplace to enforce the price caps.

2.5 Evidence of Cursed Inference

It is well documented that people fail to infer other people's information from their actions. Indeed, numerous experimental studies show that people underinfer other people's information from their actions. Samuelson and Bazerman [1985], Holt and Sherman [1994], and Carillo and Palfrey [2011], among others, provide evidence in the context of bilateral bargaining with asymmetric information that bargainers under-appreciate adverse selection in trade. The papers collected in Kagel and Levin [2002] present a wealth of evidence that bidders under-attend to the "winner's curse" in common-value auctions. In a meta-study of social-learning experiments, Weizsäcker [2010] finds evidence that subjects behave as if they underinfer their predecessors' private information from their actions. In an elegant voting experiment, Esponda and Vespa [2014] show that subjects underinfer others' private information from their votes, succumbing to a "swing voter's curse". Our assumption that people fail to account for the information that equilibrium prices (profits and labor demand) reveal about marginal costs is consistent with the game-theoretic concepts of cursed equilibrium developed by Eyster and Rabin [2005] and analogy-based-expectations developed by Jehiel and Koessler [2008]. It is also broadly consistent with the coarse-inference approach of Mullainathan, Schwartzstein and Shleifer [2008] and the salience approach of Gennaioli and Shleifer [2010].

3 The Model

We extend the Blanchard and Kiyotaki [1987] model of monopolistic competition to include fairness concerns on the product market. The economy is composed of a continuum of firms indexed by $i \in [0,1]$ and a continuum of households indexed by $j \in [0,1]$. The goods produced by firms are imperfect substitutes for each other, and the types of labor supplied by each household are also imperfect substitutes, so that each firm has some monopoly power on the product market, and each household has some monopoly power on the labor market.

3.1 Households and Firms

Household j derives utility from leisure, consumption of produced goods, and money holdings. Fairness matters on the product market. Specifically, an amount c_{ij} of good i bought at a unit price of P_i when the perceived marginal cost of production is MC_i yields the fairness-adjusted consumption

$$z_{ij} = \psi_i \cdot c_{ij}, \tag{1}$$

where the fairness factor ψ_i is a function of the fair markup $\mu_i^f \geq 0$ and the perceived markup $\mu_i^p \equiv P_i/MC_i$. Whereas the perceived markups are endogenous variables determined by prices and households' inferences about marginal costs, the fair markups are parameters of the model. For concreteness, we assume that all households care about fairness in the same way and that the fairness factor takes the form

$$\psi_i = 1 - \frac{\phi}{\mu^p} \cdot \left(\mu_i^p - \mu_i^f\right). \tag{2}$$

The deviation $\mu_i^p - \mu_i^f$ of the perceived markup from the fair markup is scaled by ϕ/μ^p, where $\phi \in [0,1]$ is the fairness parameter and $\mu^p \equiv \int_0^1 \mu_i^p di$ is the average perceived markup across all goods.[8] The fairness parameter indicates the importance of fairness concerns: when $\phi = 0$, consumers do not care about fairness; as ϕ rises, they care more about it. We divide ϕ by μ^p as a normalization.

The fairness factor is one when consumers do not care about fairness or when they perceive good i to be priced at its fair markup. When consumers perceive good i to be priced above its fair markup—that is, when $P_i > \mu_i^f \cdot MC_i$—the fairness factor is below one, and consumers antagonized. By Equation (1), it is as if consumers lost the fraction $1 - \psi_i > 0$ of each unit of consumption of good i bought at an unfair price, which will reduce their marginal utility of its consumption. Analogously, when consumers perceive good i to be priced below its fair markup, they enjoy heightened utility from consuming what they perceive to be an underpriced good. As the fairness factor depends only on markups, consumers evaluate fairness in real rather than nominal terms.

[8] We focus on situations where perceived markups satisfy $\mu_i^p \leq \mu_i^f + \mu^p/\phi$ so the fairness factor remains positive. These conditions are always satisfied in a symmetric equilibrium.

Since the fairness factor is symmetric, consumers enjoy a price any given amount below the fair price as much as they dislike a price that same amount above the fair price.[9] Finally, the fairness factor is everywhere differentiable; it has no kinks.

Household j's fairness-adjusted consumption of the different goods are aggregated into a constant-elasticity-of-substitution consumption index,

$$z_j \equiv \left(\int_0^1 z_{ij}^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}}, \tag{3}$$

where $\varepsilon > 1$ is the elasticity of substitution between different goods, which we assume to be common to all households. This functional form captures consumers' love of variety; as $\varepsilon \to \infty$, goods become perfect substitutes.

The utility of household j is given by

$$u_j = \ln(z_j) + \frac{1}{\eta} \cdot \ln\left(\frac{M_j}{\hat{P}}\right) - \nu \cdot \frac{1}{1+\xi} \cdot h_j^{1+\xi}. \tag{4}$$

The utility depends on the fairness-adjusted consumption index, z_j, the number of hours worked, h_j, and the ratio of nominal money balances M_j to the fairness-adjusted price index

$$\hat{P} \equiv \left[\int_0^1 \left(\frac{P_i}{\psi_i} \right)^{1-\varepsilon} di \right]^{\frac{1}{1-\varepsilon}}. \tag{5}$$

As we will see, $\hat{P}$ is the price of one unit of z_j. Hence, $M_j/\hat{P}$ indicates the number of units of z_j that can be purchased with M_j. Since it is z_j that enters the utility function, $M_j/\hat{P}$ indicates the value of the transaction services provided by the nominal money balances held by household j. It is therefore natural to divide M_j by $\hat{P}$ in the utility function. The parameters $\eta > 0$, $\nu > 0$, and $\xi > 0$ measure households' common propensity to spend money out of income, the level of the disutility from labor, and the curvature of the disutility from labor, respectively.

[9] Although this assumption does not allow consumers to be more sensitive to prices above the fair price than to prices below the fair price, as the work of Tversky and Kahneman [1991] on loss aversion might suggest, it greatly simplifies the model.

Household j maximizes utility subject to the budget constraint

$$M_{0j} + W_j \cdot h_j + \Pi_j - M_j - \int_0^1 P_i \cdot c_{ij} di = 0, \tag{6}$$

where $M_{0j} > 0$ is the money supply received by household j as an endowment, W_j is the nominal hourly wage of household j, and Π_j are nominal profits distributed to household j. Households take prices $\{P_i\}$, demand for their labor input $h_j = h_j^d(W_j)$, profits, and money supply as given.

Firm i hires labor to produce output using the constant-elasticity-of-substitution production function

$$c_i = a_i \cdot \left(\int_0^1 h_{ij}^{\frac{\gamma-1}{\gamma}} dj \right)^{\alpha \cdot \frac{\gamma}{\gamma-1}}, \tag{7}$$

where c_i is its output of good i, a_i its technology level, h_{ij} its demand of labor the number of labor from household j, $\gamma > 1$ the elasticity of substitution between types of labor, and $\alpha < 1$ the extent of diminishing marginal returns to labor. The parameters γ and α apply to all firms. To simplify notation, we introduce the employment index

$$h_i \equiv \left(\int_0^1 h_{ij}^{\frac{\gamma-1}{\gamma}} dj \right)^{\frac{\gamma}{\gamma-1}}.$$

Given $\{W_j\}$, firm i chooses $\{h_{ij}\}$, c_i, and P_i to maximize profits

$$\Pi_i = P_i \cdot c_i - \int_0^1 W_j \cdot h_{ij} dj \tag{8}$$

subject to the constraint that $c_i = c_i^d(P_i)$, consumers' aggregate demand for good i given prices $\{P_i\}$, derived in the Appendix.

We assume that firms' marginal costs are unobservable to other firms and consumers—they are private information. Throughout the paper, we also assume that firms are not strategic: firm i does not attempt to influence consumers' beliefs about its marginal cost MC_i by choosing a price P_i.[10] Formally, firm i takes its demand function as given, which means that it takes MC_i as

[10]When all firms share the same technology, as we later shall assume, this assumption becomes unnecessary. Nevertheless, we assume non-strategic firms throughout to ease exposition.

independent of P_i in consumers' fairness factor $\psi_i = 1 - (\phi/\mu^p) \cdot (P_i/MC_i - \mu_i^f)$. This assumption has no consequence when consumers do not care about fairness, since consumers then have no interest in marginal cost. It also has no consequence when consumers make cursed inferences (as in Section 5), because firms could not successfully signal any information about costs. It matters when consumers care about fairness and are rational (in Section 4), because in that case there may exist other equilibria where firms signal their marginal costs. Since that is not the main focus of our paper, we do not delve into these signaling equilibria.

3.2 General Equilibrium

For simplicity, we focus on a symmetric setting: consumers regard the same markups as fair for all goods; all households receive the same endowment of money and profits; and all firms share a common technology. Nevertheless, we assume that households do not know that they are symmetric: each household correctly believes that its money endowment is uncorrelated with the aggregate endowment, and we study only realizations where all households receive the same money. Let μ^f be the fair markup, M_0 be the money supply, and a be the technology. In equilibrium, all households will post the same wage and all firms demand the same number of hours of labor input and set the same price.

Consumers who maximize their utility subject to their budget constraints can be thought of as making two decisions: first, they choose how to divide a given wealth across consumption goods and money balances; second, they choose how much labor to supply. Given symmetry, their demand for the different consumption goods depends upon the relative prices of those goods in the following way:

$$c_i^d(P_i) = \frac{z}{\psi_i} \cdot \left(\frac{P_i/\psi_i}{\hat{P}} \right)^{-\varepsilon}, \tag{9}$$

where the average consumption index $z \equiv \int_0^1 z_j dj$ describes the level of aggregate demand. The price of a unit of z_i is P_i/ψ_i so the ratio $(P_i/\psi_i)/\hat{P}$ is the relative price of z_i. Demand for good i increases with aggregate demand but decreases with its relative price. In addition, they equate the marginal rate of substitution between money and fairness-weighted consumption with their price

ratio, which gives an equation linking aggregate demand to fairness-weighted money balances.

$$\frac{z_j}{\eta M_j} = \frac{1}{\hat{P}}. \tag{10}$$

Second, households choose how much to work given firms' aggregate demand for their labor

$$h_j^d(W_j) = h \cdot \left(\frac{W_j}{W}\right)^{-\gamma}, \tag{11}$$

where $W \equiv \left(\int_0^1 W_j^{1-\gamma} dj\right)^{\frac{1}{1-\gamma}}$ is the nominal wage index, and $h \equiv \int_0^1 h_i di$ describes the level of employment in the economy; in Appendix A, we derive this formula for labor demand from profit maximization. Due to imperfect competition in the labor market, household j sets its wage at a markup of $\gamma/(\gamma-1) > 1$ over its marginal rate of substitution between leisure and money holdings:

$$W_j = \frac{\gamma}{\gamma-1} \cdot \nu \cdot h_j^{\xi} \cdot \eta \cdot M_j. \tag{12}$$

The introduction of fairness concerns into the Blanchard and Kiyotaki [1987] model adds one equation into the system of equations describing the general equilibrium. The new properties arising from fairness concerns operate through this equation, which relates the actual markup charged by firms to the markup perceived by consumers. Although the actual markup and, hence, general equilibrium depend upon how consumers infer markups from prices, all the inference processes that we study in this paper give rise to a common structure of equilibrium.

Specifically, consumers' perceptions of markups affect the elasticity of demand faced by firms and, therefore, determine firms' optimal markups. Firms maximize profits using the markup

$$\mu^d(\mu^p) \equiv \frac{1}{\varepsilon-1} \cdot \left(\varepsilon - \frac{\phi}{1+\phi \cdot \mu^f/\mu^p}\right). \tag{13}$$

Our first result describes how the optimal markup depends upon fairness concerns and perceived markups.

LEMMA 1. *When consumers do not care about fairness ($\phi = 0$), firms' optimal markup $\mu^d(\mu^p)$ coincides with the standard monopolistic markup of $\varepsilon/(\varepsilon-1)$. When consumers care about fairness ($\phi > 0$), firms' optimal markup $\mu^d(\mu^p)$ lies below the standard monopolistic markup of*

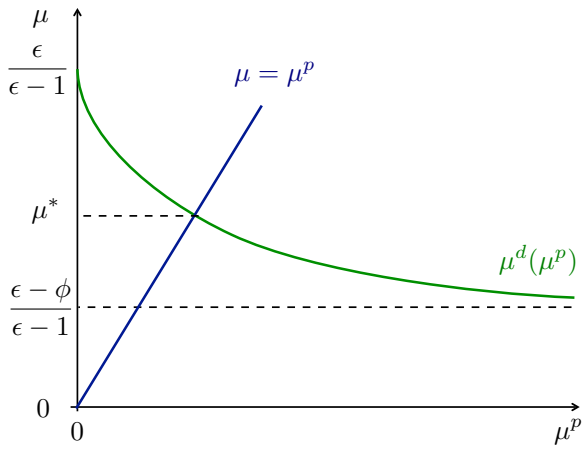


Figure 3: The Relationship between Actual Markup, μ, and Perceived Markups, μ^p, Arising from Profit Maximization by Firms

$\varepsilon/(\varepsilon-1)$, *decreases in* ϕ, *and is bounded from below above one. Furthermore, it reverts to* $\varepsilon/(\varepsilon-1)$ *when* $\mu^p = 0$, *decreases in* μ^p *for* $\mu^p > 0$, *and converges to* $(\varepsilon-\phi)/(\varepsilon-1) \geq 1$ *as* $\mu^p \to +\infty$.

Figure 3 illustrates properties described by the lemma.

All the other equations in the system describing the general equilibrium exist in the Blanchard and Kiyotaki [1987] model. We describe the general equilibrium by a pair (P,h), from which all other variables can be recovered. Here we derive the two equations that determine (P,h) and the equations that relate the other variables to (P,h).

In a symmetric equilibrium, $z = \psi \cdot c$, $\hat{P} = P/\psi$, and $M = M_0$. Combining the marginal-rate-of-substitution condition (10) with the production constraint (7), gives the first equation that characterizes general equilibrium:

$$\ln(P) = \ln(M_0) + \ln(\eta) - \ln(a) - \alpha \cdot \ln(h). \tag{14}$$

It expresses the price level as a decreasing function of hours worked. The intuition is that higher hours worked lead to more output and thus a lower marginal utility from consuming produced goods. Since, in equilibrium, households must remain indifferent between consuming produced goods and holding fairness-weighted money balances, real money balances must increase to lower the marginal utility from holding money. As the money supply is fixed to M_0, the price level P,

which moves in the same direction as the fairness-weighted price index, $\hat{P} = P/\psi$, must fall.

Combining (14) with households' wage-setting equation, given by (12), yields a relationship between the real wage W/P to hours worked:

$$\ln\left(\frac{W}{P}\right) = (\xi + \alpha)\cdot\ln(h) + \ln(a) + \ln(v) + \ln\left(\frac{\gamma}{\gamma - 1}\right). \tag{15}$$

Th real wage is an increasing function of hours worked because the disutility from labor is convex and the utility from consumption concave. In a symmetric equilibrium, all firms' relative price is one, which equals their optimal markup times the real marginal cost, which can be derived from profit maximization. This implies that

$$\mu^d(\mu^p) = \frac{1}{mc} = \frac{a\cdot\alpha\cdot h^{\alpha-1}}{W/P}, \tag{16}$$

which is a typical property in models of monopolistic competition. Combining this with (15)—implying that the labor market clears—gives an expression for hours worked as a decreasing function of the markup:

$$(1+\xi)\cdot\ln(h) = -\ln(\mu^d(\mu^p)) + \ln(\alpha) - \ln(v) - \ln\left(\frac{\gamma}{\gamma-1}\right), \tag{17}$$

which is the second equation that must hold in general equilibrium.

4 The Case with Rational Inference

In this section, we analyze the economy when all consumers rationally infer firms' marginal costs from observed prices, in which $\mu^p = \mu^d(\mu^p)$. The following proposition summarizes properties of the equilibrium:

PROPOSITION 1. *Consider an economy in which consumers are rational. The equilibrium markup is the fixed point μ^* of the function $\mu^d(\mu^p)$, which satisfies*

$$\mu^d(\mu^*) = \mu^* = \frac{\varepsilon}{\varepsilon - 1} - \frac{\phi}{\varepsilon - 1}\cdot\frac{1}{1+\phi\cdot\mu^f/\mu^*}. \tag{18}$$

The equilibrium markup decreases in ϕ, rendering the economy more competitive: output, hours, and real wages increase in ϕ; prices decrease in ϕ, as do real profits when $\mu < 1+\alpha$. Moreover, the markup is independent of money supply and technology.

- *Money is neutral: the money supply has no effect on hours, output, real wage, or real profits; the price level is proportional to the money supply.*

- *Technology influences quantities and prices: output, real wage, and real profits are proportional to technology; the price level is inversely proportional to technology; hours are independent of technology.*

The main result in the proposition is that money is neutral since hours and output do not depend on the money supply. In the case where $\phi = 0$, this result replicates the famous finding of Blanchard and Kiyotaki [1987] that money is neutral in an economy with monopolistic competition. The proposition shows that money neutrality also holds for any $\phi > 0$.

The intuition for money neutrality goes as follows. Since the markup is independent of money supply and technology and determines the real marginal cost, hours worked are independent of money supply and technology. All the other properties follow from this result, which is illustrated in Figure 4. The equilibrium pair $(\ln(h), \ln(P))$ lies at the intersection of the two curves. Because the vertical curve is independent of money supply and technology, it determines h irrespective of the downward-sloping curve. Thus, prices absorb the money supply and technology shocks, which do not influence hours worked.

When consumers are rational, fairness concerns simply increase the elasticity of demand. Fairness concerns affect the general equilibrium only by rendering the demand schedules faced by monopolists more price-elastic, leading to reduced markups. Since monopolistic competition gives rise to inefficiently low production because firms price in excess of marginal costs, fairness concerns, by increasing the elasticity of demand and reducing the markup, improve efficiency. Greater efficiency means higher output, more hours worked, higher real wages, and higher real money balances—or, equivalently, a lower price level. In fact, there is an isomorphism between the models with and without fairness concerns: for each $\phi > 0$ and $\varepsilon > 1$, the equilibrium coincides with the equilibrium of another economy with $\phi = 0$ for some $\varepsilon' > \varepsilon$. The effect on real profits depends on parameter values. Macroeconomists conventionally estimate μ to be between 1.05 and 1.3, and

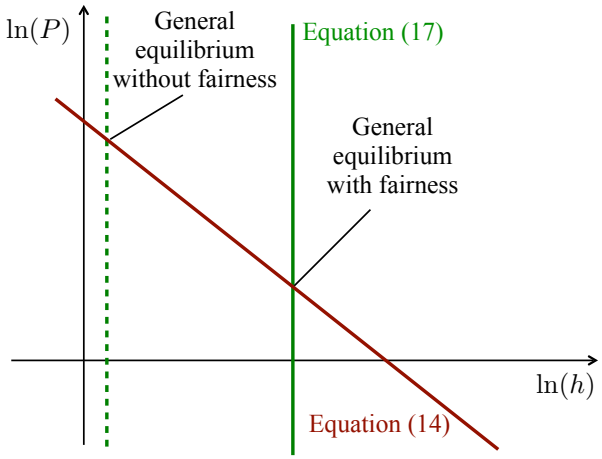


Figure 4: The General Equilibrium with Fairness Concerns and Rational Consumers

α between 0.66 and 1, in which case $\mu < 1 + \alpha$, so that fairness concerns decrease profits.

Although the proposition only describes money-supply and technology shocks—our main focus—it is possible to study other types of shocks. For instance, we could study the effects of an aggregate-demand shock parametrized by a change in the preference parameter η. An increase in η lowers the marginal utility of money balances, pushing households to consume more of the produced goods; it therefore can be interpreted as a positive aggregate-demand shock. Since M_0 and η enter exactly similarly in all the equilibrium conditions, increasing η clearly has exactly the same effects as increasing M_0. In particular, aggregate demand is neutral without fairness concerns. Likewise, we could also study the effects of a labor supply shock parameterized by a change in the preference parameter ν.

5 The Case with Cursed Inference

When purchasing goods, although consumers see and use prices, they may fail to infer the extent to which differences in prices convey information about differences in marginal costs. Whereas prices are salient, their equilibrium relationship to marginal cost is not. In equilibrium, although consumers could further update about firms' marginal costs using received profits and labor demand, they may neglect this sort of indirect information at the time of purchase. The evidence in Section 2.5 suggests that people fail at precisely this type of inference. Accordingly, in this sec-

tion we assume that consumers neglect the information that these variables provide about marginal costs.

The structure of the inference mistake that we assume, which we call *cursed inference*, is very closely related to the solution concept of cursed equilibrium by Eyster and Rabin [2005] and analogy-based-expectations by Jehiel [2005] and Jehiel and Koessler [2008].[11]

5.1 Cursed Inference

Household j seeks to maximize the expectation of

$$u_j = \ln(z_j) + \frac{1}{\eta} \cdot \ln\left(\frac{M_j}{\hat{P}}\right) - \nu \cdot \frac{1}{1+\xi} \cdot h_j^{1+\xi}. \tag{19}$$

subject to its known budget constraint (6). In this constrained optimization problem, the household knows everything except for the MC_i terms that enter the fairness factors, $\psi_i = 1 - (\phi/\mu^p) \cdot \left(P_i/MC_i - \mu^f\right)$, and the fairness-adjusted price index, $\hat{P}$. Rational consumers would use their understanding of firms' pricing rules as well as their observations to infer these marginal costs. By contrast, cursed consumers take expectations of u_j given their prior beliefs over MC_i (which can be derived from prior beliefs over $\{a_i\}$ and M_0).[12]

To simplify, we assume that consumers' priors about nominal marginal costs are highly concentrated around a given nominal value, $\overline{MC}$, so that we can replace consumers' expected utility with their utility given cost $\overline{MC}$.[13] As a consequence, all of our comparative statics describe reactions to surprise shocks, namely cost realizations assigned low prior probability. Overall, we find that introducing cursedness has important implications, notably causing money nonneutrality.

[11] We cannot apply any of these concepts exactly for two reasons. First, we study a market equilibrium, whereas cursed equilibrium and analogy-based-expectations equilibrium are game-theoretic concepts. Second, as emphasized in Eyster and Rabin [2005], these solution concepts all create artificial distinctions between exogenous versus endogenous variables, assuming either that people fail to appreciate the relationship between endogenous variables and exogenous variables, or that they fail to appreciate the relationship between endogenous variables and other endogenous variables, but not both. Our assumption comprises both.

[12] A richer model would include some rational consumers who infer marginal costs from prices and some consumers who do not. We suspect but have not proven that this sort of mixture model would deliver the same qualitative results as ours, most likely with muted effects.

[13] We expect but have not proven that none of the qualitative results depend upon this simplifying assumption.

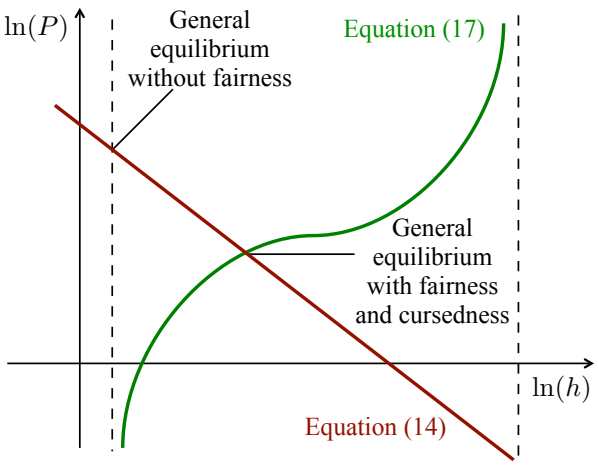


Figure 5: The General Equilibrium with Fairness Concerns and Cursed Consumers

5.2 Characterization of the Cursed General Equilibrium

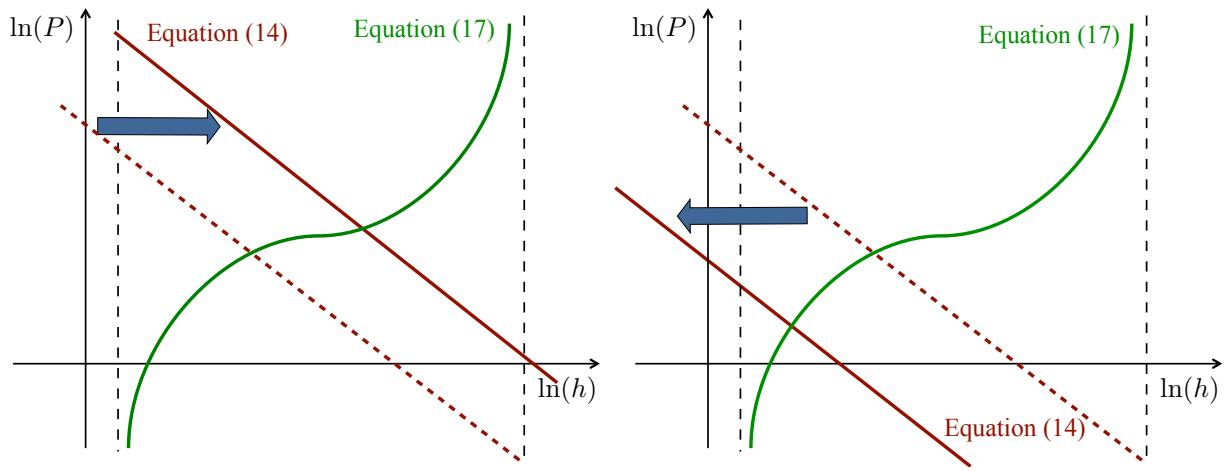
The key impact of cursed inference is that the equilibrium markup is no longer independent of the price level. Specifically, higher prices cause consumers to perceive higher markups, which in turn increase the elasticity of demand. Firms' optimal markup is given by $\mu^d(P/\overline{MC})$, where the function μ^d is given by Lemma 1.

Figure 5 illustrates how the markup equation (17) is no longer independent of the price level. Instead, it is upward sloping, which gives rise to an increasing relationship between the price level and hours. Furthermore, this curve has two closed-form asymptotes:

$$\lim_{\ln(P)\to-\infty} \ln(h) = \frac{1}{1+\xi}\cdot\left[\ln(\alpha)-\ln(\nu)-\ln\left(\frac{\gamma}{\gamma-1}\right)-\ln\left(\frac{\varepsilon}{\varepsilon-1}\right)\right],$$
$$\lim_{\ln(P)\to+\infty} \ln(h) = \frac{1}{1+\xi}\cdot\left[\ln(\alpha)-\ln(\nu)-\ln\left(\frac{\gamma}{\gamma-1}\right)-\ln\left(\frac{\varepsilon-\phi}{\varepsilon-1}\right)\right].$$

These establish the existence and uniqueness of general equilibrium.

Because money-supply and technology shocks shift affect only the downward-sloping curve, using Figure 5 it is straightforward to analyze how the equilibrium changes with the shocks, which we do in the next two subsections.



(a) Increase in money supply (b) Increase in technology

Figure 6: Comparative Statics with Fairness Concerns and Cursed Consumers

5.3 Money-Supply Shocks

The following proposition compares an equilibrium with a low realization of money supply to one with a high realization of money supply:

PROPOSITION 2. *Consider an economy in which consumers make cursed inferences. Money is not neutral. When $\phi > 0$, an increase in money supply has the following effects:*

- *the equilibrium markup decreases; hours worked, output, and real wage increase; real profits decrease when $\mu < 1 + \alpha$;*
- *the price level increases less than proportionally to the money supply;*
- *even though the actual markup decreases, the perceived markup increases and the fairness factor decreases.*

Under the joint assumption of fairness concerns and cursed inference, money is no longer neutral. An increase in money supply stimulates the economy, leading to higher output and hours worked. The economy also exhibits a form of price rigidity in that the price level always moves less than the money supply. After an increase in money supply, consumers fail to appreciate that higher prices signal higher marginal costs. Instead, they wrongly conclude that they face higher real markups and thus withhold demand. Firms best respond by lowering actual markups and

increasing production. In short, an increase in money supply increases perceived markups but decreases actual markups. We return to the net effect of these two opposing forces on welfare in Section 5.6.[14]

Unlike in traditional macroeconomic models, money nonneutrality happens absent any constraint on price setting: there are no long-term nominal contracts, price-adjustment costs, nor price-adjustment constraints. Instead, the assumption that consumers care about perceived markup, combined with a misperception of marginal cost, leads to money nonneutrality.

5.4 Technology Shocks

The following proposition compares an equilibrium with a low realization of technology to one with a high realization of technology:

PROPOSITION 3. *Consider an economy in which consumers make cursed inferences. When $\phi > 0$, an increase in technology has the following effects:*

- *the equilibrium markup increases; hours worked decrease; output increases, albeit less than proportionally to technology; the real wage increases less than proportionally to technology and might decrease; real profits increase, more than proportionally to technology when $\mu < 1+\alpha$;*
- *the price level decreases less than inversely proportional to technology;*
- *even though the actual markup increases, the perceived markup decreases and the fairness factor increases.*

The above result describes the impact of an increase in technology in our model. Relative to the case without fairness, the expansionary effect of an increase in technology on output is diminished. Output increases but less than proportionally to technology, which in turn implies fewer hours worked in the economy. The discrepancy between actual and perceived markups is the mirror image of that following a positive monetary shock. Since cursed consumers fail to appreciate that firms have lower marginal costs due to improved technology, in equilibrium perceived markups

[14] Of course, when $\phi = 0$, because inference about marginal costs plays no role, we get back the standard neutrality result.

decrease but actual markup increase. Consumers think that transactions are fairer even though firms in fact enjoy higher per-unit profits as well as possibly higher total profits.

5.5 Pass-Through

We have seen that fairness concerns and cursed inference change the qualitative features of equilibrium. One advantage of our approach is that its tractability allows for closed-form expressions describing how equilibrium prices and quantities respond to monetary and technology shocks. Below we express how price responds to monetary shocks, namely the pass-through of money-supply shocks into prices.

PROPOSITION 4. *Consider an economy in which consumers make cursed inferences. The pass-through of money-supply shocks into prices is*

$$\sigma \equiv \frac{d\ln(P)}{d\ln(M_0)} = \left[1 + \frac{\alpha}{1+\xi} \cdot \left(\frac{\varepsilon}{\varepsilon - 1} \cdot \frac{1}{\mu} - 1\right) \cdot \left(1 - \frac{1}{\psi + \phi}\right)\right]^{-1}. \tag{20}$$

The pass-through σ equals 1 when $\phi = 0$ and is below 1 but above $(\varepsilon - 1)/\varepsilon$ when $\phi > 0$. It converges to 1 when $M_0 \to 0$ and when $M_0 \to \infty$.

The fact that the pass-through is less than one when consumers make cursed inferences and care about fairness means that prices exhibit a mild form of rigidity by moving less than proportionally to the money supply. When $\varepsilon \to \infty$—the economy approaches perfect competition—the pass through approaches one. Proposition 4 expresses the pass-through as a function of standard macroeconomic parameters in addition to consumers' sensitivity to fairness ϕ and the fair markup μ^f.

Under the additional assumption that we start from an equilibrium in which the actual markup, the perceived markup, *and* the fair markup coincide, we can further simplify how equilibrium variables depend upon macroeconomic shocks. In particular, the pass-though above can be further simplified to depend only on standard macroeconomic parameters and only on the behavioral parameter ϕ. Combining this expression with estimates of standard marcroeconomic parameters would identify our added parameter ϕ.

COROLLARY 1. *Consider an economy in which consumers make cursed inferences. Starting from an equilibrium in which the actual markup, the perceived markup, and the fair markup coincide, the pass-through of money-supply shocks into prices is*

$$\sigma^s = \left[1 + \frac{\alpha}{1+\xi} \cdot \left(\frac{\phi}{1+\phi}\right)^2 \cdot \frac{1}{\varepsilon - \phi/(1+\phi)}\right]^{-1}. \tag{21}$$

When $\phi = 0$, the pass-through $\sigma^s = 1$. When $\phi > 0$, σ^s increases with the competitiveness of the economy, ε, and decreases with fairness concerns, ϕ.

Following the same steps, we can compute the pass-through of technology shocks into prices. Because $\ln(a)$ and $-\ln(M_0)$ enter symmetrically into (14) and (17), the pass-though of technology shocks into prices is simply minus the pass-through of monetary shocks into prices. An implication is that an increase in marginal cost caused by lower technology leads to a smaller price increase when the economy is less competitive and when consumers care more about fairness.[15]

5.6 The Effect of Money-Supply Shocks on Welfare

We now turn to the novel welfare implications of our approach. An increase in money supply affects welfare in two parallel ways. It has a positive effect on the real side of the economy by lessening the inefficiency due to monopolistic competition on the product and labor markets. It has a negative effect on emotional welfare by increasing perceived markups and thereby reducing the perceived fairness of transactions.

In order to analyze welfare, we define two notions, one including and one excluding an emotional component. Since we focus on a symmetric equilibrium, both measures average over all households. Since a household's utility is given by (4), we define *overall welfare* to be

$$u = \ln(c) + \frac{1}{\eta} \cdot \ln(M_0) - \frac{1}{\eta} \cdot \ln(P) + \left(1 + \frac{1}{\eta}\right) \cdot \ln(\psi) - \nu \cdot \frac{1}{1+\xi} \cdot h^{1+\xi}.$$

We distinguish this from a second notion of welfare that omits fairness considerations (namely by

[15] Once embedded into an international-trade model, our theory might help explain the incomplete pass-through of exchange rates into import prices. For evidence of this incomplete pass-through, see for instance Goldberg and Verboven [2001], Gopinath and Rigobon [2008], and Nakamura and Zerom [2010].

setting $\psi = 1$); we define *unemotional welfare* to be

$$\hat{u} = \ln(c) + \frac{1}{\eta} \cdot \ln(M_0) - \frac{1}{\eta} \cdot \ln(P) - \nu \cdot \frac{1}{1+\xi} \cdot h^{1+\xi}.$$

Unemotional welfare evaluates welfare in the economy as if consumers' well-being did not depend upon their fairness concerns.

We have seen that an increase in money supply reduces the inefficiency attributable to imperfect competition because it angers cursed consumers. The following proposition characterizes how our two notions of welfare depend upon money supply, where both are evaluated with respect to the equilibrium prices and quantities described in Section 5.2.

PROPOSITION 5. *When consumers make cursed inferences and $\phi > 0$, an increase in money supply increases unemotional welfare but decreases overall welfare.*

Proposition 5 contains the paper's main welfare result. Although an increase in money supply stimulates output, it reduces overall welfare because consumers feel unfairly treated when they see higher prices. Indeed, as previously emphasized, these two effects directly rely on each other. The very reason that monetary policy is expansionary in our model is that firms know that higher prices upset consumers.

Proposition 2 shows that while perceived markups increase, actual markups decrease in response to price inflation. In fact, the wedge between overall welfare and unemotional welfare stems from a misperception. Although transactions become fairer, consumers believe just the opposite. This very misperception is the root cause of the increase in unemotional welfare.

Our model predicts that an econometrican looking only at a conventional measure of welfare—consumption, hours worked and real money balances—would estimate an increase in welfare after an increase in money supply, even though overall welfare would fall. It also predicts that expansionary monetary policy may be unpopular by upsetting people more with higher prices than gratifying them with higher output. Consumers' responses to price increases following expansionary monetary policy accord well with the survey responses in Shiller [1996]. In our model as in the survey, consumers are unhappy following an increase in money supply because they are angry at what they perceive as higher markups after the increase in price—and in our model, they are unhappy despite the increase in output.

The wedge between full welfare and unemotional welfare may also have implications to political economy. Even if politicians only cared about citizens' unemotional welfare, they might shun inflation out of an understanding that monetary expansion reduces overall welfare in the short-run. Consistent with this idea, Persson and Tabellini [2000] report that for OECD countries in the post-war era, inflation typically increases shortly after elections.

While our model may be too simple to draw detailed implications for optimal monetary policy, it does suggest how inflation can lead to first-order harm on welfare through people's emotional response to higher prices. In a richer model that included involuntary unemployment, our results suggest that a surprise increase in money supply may leave an average consumer with a stable job—who looks very much like the representative household in the model—worse-off because the anger from misperceived higher markups dominates the added utility from extra consumption. Of course, an increase in money supply might benefit an unemployed worker immensely by improving employment prospects through increased labor demand and higher hours worked.

It is clear from the above result that our model has sharply different welfare implications than existing monetary models. For instance, the standard New-Keynesian model predicts that the welfare cost of inflation is the price dispersion it creates when firms are subject to staggered pricing [Galí, 2008]. In our model, by contrast, inflation imposes a welfare cost through high perceived markups that anger consumers while it increases unemotional welfare.

5.7 Evidence on Comparative-Statics Predictions

In this section, we provide evidence for the comparative-statics predictions of the model with consumers who make cursed inferences.

Our model predicts that in business cycles generated by money-supply shocks, markups are countercyclical: higher money supply leads to lower markups and higher output. Despite the large volume of empirical work measuring the cyclical variation of markups, no consensus on cyclicality has emerged, as described in the exhaustive survey by Rotemberg and Woodford [1999]. Empirical evidence suggests that the labor share—the ratio of the real wage bill $(W/P) \cdot h$ to output $a \cdot h^{\alpha}$—is countercyclical. With a Cobb-Douglas production function like that used in our model, marginal and average costs are proportional, and markups should be procyclical. However, Rotemberg and

Woodford [1999] list a number of reasons why estimated marginal costs maybe more procyclical than average costs. For instance, in good times workers earn overtime pay in excess of normal earnings [Bils, 1987]. Adjusting the fluctuations of the labor share for a number of such corrections, they conclude that markups are countercyclical. More recently, using the cyclical behavior of inventories, Bils and Kahn [2000] also estimate countercyclical markups. Yet with updated methods and data, Nekarda and Ramey [2013] do not find a significant response of markups to aggregate demand shocks—if anything, they find that markups are slightly procyclical. In sum, more empirical evidence is needed to determine the cyclicality of markups.

Our model predicts the same response of markups to aggregate-demand shocks as many other business-cycle models. For instance, New-Keynesian models give rise to markups that are countercyclical under aggregate demand shocks because firms take time to adjust their prices. Unlike in these models where they always desire the same markup, firms in our model optimally tailor their markups to aggregate demand. In that respect, our model better resembles models of endogenous, time-varying markups that produce business cycles [Stiglitz, 1984]. The closest ones generate cyclical markups from cyclical variations in the elasticity of demand faced by monopolists, an idea that dates back to Robinson [1932]. She predicts greater elasticity of demand for durables in expansions than in recessions, leading to countercylical fluctuations in markups. Galí [1994] gives a related model in which demand for consumption and investment goods have different elasticities; since their relative shares of output vary systematically over the business cycle, aggregate markups exhibit cyclical fluctuations. Other models generate cyclical markups through alternative mechanisms. For example, Rotemberg and Saloner [1986] predict lower markups in good times due to price wars among oligopolists when demand is high. Bils [1989] predicts low markups with high demand when firms find it most profitable to expand their customer base.

Proposition 3 describes that an increase in technology leads to higher output but lower hours worked, consistent with the empirical findings of a number of influential papers. Galí [1999] uses a structural vector autoregression (VAR) to show that higher technology lead to higher output but lower hours worked. The robustness of Galí's findings is demonstrated by Francis and Ramey [2005, 2009]. Using a technology series that accounts for variable capital and labor utilizations, Basu, Fernald and Kimball [2006] find that higher technology leads to slightly higher output but lower hours worked, confirming Gali's findings. Proposition 3 also establishes that markups are

procyclical under technology shocks: higher technology leads to higher markups and higher output, and conversely, lower technology leads to lower markups and lower output. Nekarda and Ramey [2013] reports empirical evidence consistent with this prediction.

Proposition 4 shows that the pass-through is smaller in less-competitive economies. In fact, $\lim_{\varepsilon \to +\infty} \sigma^s = 1$, which means that the pass-through goes to 1 as the economy becomes perfectly competitive. This property echoes the finding of Carlton [1986] that prices are more rigid in industries that are more concentrated. Proposition 4 also shows that the pass-through is smaller in economies in which consumers care more about fairness. Our theory bridges two facts reported by Kackmeister [2007]. The first fact is that the fairness of transactions matters less today than it did in 1890 because the personal relationship between retailers and customers is weaker today than it was in 1890. The second fact is that retail prices were much more rigid in 1889–1891 than in 1997–1999. In our model, the first fact implies that ϕ is lower today than it was in 1890. The implication is that the pass-through should be higher today than it was in 1890, and thus that prices should be more flexible today than in 1890. This is the second fact that Kackmeister documents.

6 Conclusion

In this paper, we have built a macroeconomic model in which the non-neutrality of money arises from two two well-documented psychological assumptions: (1) consumers are averse to paying prices in excess of a fair markup over marginal cost; and (2) consumers fail to infer information about marginal costs from their equilibrium relationship to other variables. We show that this this combination of assumptions provides novel joint predictions on welfare and economic activity.

One advantage of our formulation is that it introduces only one new parameter—the fairness parameter ϕ—into the canonical macroeconomic model of Blanchard and Kiyotaki [1987]. Furthermore, our model reduces to the Blanchard-Kiyotaki model for $\phi = 0$. Since the departure from the canonical model is minimal, our model could readily be simulated and used for quantitative analysis: this would only require to calibrate the parameter ϕ. We could calibrate ϕ by matching a moment that identifies it. A promising moment is the elasticity of output with respect to money supply, $d\ln(c)/d\ln(M_0)$. This elasticity has been estimated in the data and since $\ln(c)/d\ln(M_0) = 1 - \sigma$ in our model, this elasticity gives an estimate of the pass-through σ. The

pass-through only depends on ϕ and standard parameters when evaluated around a long-run equilibrium, as showed by (21). Hence, the estimate of σ would allow us to recover ϕ.

Abundant evidence demonstrates that consumers care about fairness. Our approach differs from other models of social preferences that attempt to capture some of this evidence such as Fehr and Schmidt [1999] and Charness and Rabin [2002]. In our model, consumers who feel mistreated by firms withhold demand not directly to measurably punish firms but instead because they derive less joy from consuming unfairly-priced goods. Dufwenberg et al. [2011] show that preferences satisfying a "separability" condition, including Fehr-Schmidt and Charness-Rabin preferences, do *not* affect general competitive equilibria. Our preferences do *not* satisfy this condition, which is why they do affect equilibirium.[16] We view both of these approaches as psychologically valid and, as emphasized by Schmidt [2011], believe that standard social preferences may play an important role in organizational settings where agency problems such as moral hazard are key. Because we have focused on symmetric settings with a fair markups that was homogenous across goods, we also found that in the competitive limit of our model ($\varepsilon \to \infty$), fairness played no role. This result follows from symmetry and no longer holds in settings where consumers tolerate different markups for different goods. Incorporating such heterogeneity in fairness norms across goods may help explain differential price rigidities across sectors.

Analyses of price microdata usually uncover a form of rigidity stronger than that predicted by our model because prices remain static for months at a time [for example, Bils and Klenow, 2004; Nakamura and Steinsson, 2008]. A natural extension of our model would be to introduce a kink into the fairness factor ψ to capture the property that consumers' reluctance to pay prices above the fair price is distinctly larger than their eagerness to pay prices below the fair price, which is similar to the non-differentiability at the heart of the theory of prospect theory by [for example, Tversky and Kahneman, 1991]. We conjecture that such a kink would create an inaction action where firms maintain their prices in the face of any money-supply shocks. Sibly [2002] and Heidhues and Kőszegi [2008] incorporate loss aversion into models of price competition, finding that prices remain unchanged following real cost shocks. There are a number of important differences between our approaches. For example, consumers care only about prices in their models and not

[16] Our preferences violate separability because each consumer's preferences over her own consumption bundles depend implicitly upon price.

at all about costs. In addition, because their models define utility purely in real terms and impose rational expectations, incorporating their approaches into a macroeconomic model with money would not generate real effects from monetary shocks, the focus of our paper.

In our model, we have assumed that firms have no ability to signal marginal costs to consumers. Of course, firms facing increased marginal costs in our model have incentive to credibly reveal these costs to cursed consumers. The photos in the Introduction provide anecdotal evidence that firms engage in exactly this sort of signalling to fairness-minded consumers. They also suggest that consumers make cursed inferences: because rational consumers would infer the worst—low marginal costs—from the absence of signage, all firms would reveal their marginal costs. The fact that some firms conceal their marginal costs is further consistent with our assumption that consumers make cursed inference and that firms exploit that error, leading consumers to systematically underestimate markups.

We found monetary neutrality in a static model. Of course, the impacts of monetary shocks likely diminish in the long-run. We suspect that a dynamic extension of our model where consumers gradually adjust their expectations over time, would make exactly this prediction.

7 Appendix A: Derivations and Proofs

We begin by solving consumers' utility maximization and firms' profit maximization problems.

Given $\{P_i\}$, M_{0j}, and Π_j, household j chooses $\{c_{ij}\}$, M_j, h_j, and W_j to maximize (4) subject to the constraint (6) (Lagrange multiplier $\mathscr{A}_j$) and to the constraint $h_j = h_j^d(W_j)$ (Lagrange multiplier $\mathscr{B}_j$). The labor demand $h_j^d(W_j)$ gives the total number of hours that the firms would choose to hire from household j at a nominal wage W_j. The labor demand is a decreasing function of W_j determined below. The first-order conditions with respect to c_{ij} for all i are $(\psi_i/z_j)\cdot\left(z_{ij}/z_j\right)^{-1/\varepsilon} = \mathscr{A}_j \cdot P_i$, where we used the fact that $\partial z_j/\partial z_{ij} = \left(z_{ij}/z_j\right)^{-1/\varepsilon} di$. Manipulating these first-order conditions yields

$$\mathscr{A}_j = \frac{1}{\hat{P}\cdot z_j}. \tag{22}$$

Combining these two results, we obtain the optimal consumption of good i for household j:

$$c_{ij} = \frac{z_j}{\psi_i} \cdot \left(\frac{P_i/\psi_i}{\hat{P}} \right)^{-\varepsilon}. \tag{23}$$

Integrating the consumption of good i over all households yields the product demand faced by firm i given in (9):

$$c_i^d(P_i) = \frac{z}{\psi_i} \cdot \left(\frac{P_i/\psi_i}{\hat{P}} \right)^{-\varepsilon},$$

where the average consumption index $z \equiv \int_0^1 z_j dj$ describes the level of aggregate demand.

Given household j's demand for good i, the fairness-adjusted price index has the property that the total cost of purchasing produced goods equals the fairness-adjusted price index times the fairness-adjusted consumption index:

$$\int_0^1 P_i \cdot c_{ij}\, di = \hat{P} \cdot z_j.$$

Due to this property, $\hat{P}$ is the price index that households use to deflate nominal money balances in the utility function.[17]

Next, the first-order condition with respect to M_j is $1/(\eta \cdot M_j) = \mathscr{A}_j$. Combining this condition with (22) yields (10):

$$\frac{z_j}{\eta M_j} = \frac{1}{\hat{P}},$$

which expresses that the marginal utility from a dollar spent on produced goods equals the marginal utility from a dollar held in money balances.

Because the number of hours worked by household j depends upon firms' demand for its labor, we turn to the firm's profit maximization problem before returning to the household.

The firm maximizes profits (8) subject to the constraint $c_i = c_i^d(P_i)$ (with Lagrange multiplier

[17] This property can be verified by substituting in the expressions for the optimal c_{ij}:

$$\int_0^1 P_i \cdot c_{ij} di = \hat{P} \cdot \int_0^1 \frac{P_i}{\hat{P}} \cdot c_{ij} di = \hat{P} \cdot z_j \cdot \int_0^1 \left(\frac{P_i/\psi_i}{\hat{P}} \right)^{1-\varepsilon} di = \hat{P} \cdot z_j \cdot \frac{\hat{P}^{1-\varepsilon}}{\hat{P}^{1-\varepsilon}} = \hat{P} \cdot z_j.$$

$\mathscr{C}_i$) and the constraint (7) (with Lagrange multiplier $\mathscr{D}_i$). The demand curve $c_i^d(P_i)$ is given by (9). The first-order conditions with respect to h_{ij} for all j are $W_j = \mathscr{D}_i \cdot a_i \cdot \alpha \cdot h_i^{\alpha-1} \cdot (h_{ij}/h_i)^{-1/\gamma}$, where we used the fact that $\partial h_i / \partial h_{ij} = \left(h_{ij}/h_i\right)^{-1/\gamma} dj$. Manipulating these first-order conditions yields

$$\mathscr{D}_i = \frac{W}{a_i \cdot \alpha \cdot h_i^{\alpha-1}}, \tag{24}$$

where $W \equiv \left(\int_0^1 W_j^{1-\gamma} dj\right)^{\frac{1}{1-\gamma}}$ is the nominal wage index. Combining these two results, we obtain the optimal number of hours of labor that firm i should hire from household j:

$$h_{ij} = h_i \cdot \left(\frac{W_j}{W}\right)^{-\gamma}.$$

Integrating the number of hours over all firms i yields the labor demand faced by household j:

$$h_j^d(W_j) = h \cdot \left(\frac{W_j}{W}\right)^{-\gamma}, \tag{25}$$

where the average employment index $h \equiv \int_0^1 h_i di$ describes the level of employment in the economy. The labor demand faced by household j increases with the level of employment in the economy but decreases with the relative wage W_j/W set by the household.

Next, the first-order conditions with respect to c_i and P_i are $P_i = \mathscr{C}_i + \mathscr{D}_i$ and $c_i = -\mathscr{C}_i \cdot dc_i^d/dP_i$. Combining these conditions with (24) shows that firm i marks its price up over its marginal cost by setting

$$P_i = \frac{e_i}{e_i - 1} \cdot \frac{W}{a_i \cdot \alpha \cdot h_i^{\alpha-1}}. \tag{26}$$

The markup is $e_i/(e_i-1) > 1$, where $e_i \equiv -(P_i/c_i) \cdot (dc_i^d/dP_i)$ is the price-elasticity of firm i's demand, normalized to be positive. We use (9) to compute e_i:

$$e_i = \varepsilon + (\varepsilon - 1) \cdot e_i^{\psi}, \tag{27}$$

where $e_i^{\psi} \equiv -(P_i/\psi_i) \cdot (d\psi_i/dP_i)$ is the price-elasticity of the fairness factor $\psi_i = 1 - (\phi/\mu^p) \cdot$

$(P_i/MC_i - \mu_i^f)$, normalized to be positive. We have

$$e_i^{\psi} = \frac{\phi}{\mu^p} \cdot \frac{\mu_i^p}{\psi_i}. \tag{28}$$

With fairness concerns, the elasticity of the product demand faced by firm i exceeds that of the standard model: $e_i^{\psi} > 0$ when $\phi > 0$ so $e_i > \varepsilon$. The introduction of fairness concerns makes consumers more sensitive to prices, which increases the elasticity of the demand faced by firms. Therefore, the markup charged by firms are lower than in the standard model without fairness concerns. Firms have less monopoly power in the presence of fairness concerns.

Having determined the labor demands faced by households, we come back to household j and determine the wage W_j that it sets. The first-order conditions with respect to h_j and W_j are $\nu \cdot h_j^{\xi} = \mathscr{A}_j \cdot W_j + \mathscr{B}_j$ and $\mathscr{A}_j \cdot h_j = \mathscr{B}_j \cdot dh_j^d/dW_j$. Combining these conditions with (22) and (10), and using the fact that $-(W_j/h_j) \cdot (dh_j^d/dW_j) = \gamma$, we find that household j sets its wage at a markup $\gamma/(\gamma-1) > 1$ over its marginal rate of substitution between leisure and holding money as in (12): $W_j = \frac{\gamma}{\gamma-1} \cdot \nu \cdot h_j^{\xi} \cdot \eta \cdot M_j$.

Proof of Proposition 1. Firms understand that consumers are rational and therefore able to infer their marginal cost MC. Rational consumers understand the pricing strategy of firms, namely that the markup satisfies $\mu = \mu^d(\mu^p)$, where μ^d is the function described in Lemma 1. For consumers to infer correct marginal costs, it must be that $\mu^p = \mu$ in equilibrium. Hence the equilibrium markup μ^* satisfies $\mu^* = \mu^d(\mu^*)$. Because consumers know all of the parameters that enter $\mu^d(\mu)$, as well as ϕ, ε and μ^f, they can indeed determine μ^* and, hence, learn MC.

Having established that $\mu = \mu^*$, Equation (17) implies that hours are independent of money supply and technology. Equation (15) implies that the real wage is independent of money supply but proportional to technology. The production constraint (7) implies that output is independent of money supply but proportional to technology. Equation (14) implies that the price level is proportional to money supply and inversely proportional to technology. By combining the definition of nominal profits, given by (8), the optimal pricing decision of firms, given by (26), and the

production constraint, given by (7), we obtain an expression for real profits

$$\frac{\Pi}{P} = c \cdot \left(1 - \frac{\alpha}{\mu}\right). \tag{29}$$

that is independent of money supply but proportional to technology. The only remaining nontrivial part of the proof is to compare profits in the equilibria with and without fairness concerns. To do so, we compute the elasticity of real profits with respect to the markup. The production constraint implies that $d\ln(c)/d\ln(h) = \alpha$ and equation (17) implies that $d\ln(h)/d\ln(\mu) = -1/(1+\xi)$ so $d\ln(c)/d\ln(\mu) = -\alpha/(1+\xi)$. The definition of real profits, given by (29), implies that $d\ln(\Pi/P)/d\ln(\mu) = d\ln(c)/d\ln(\mu) + \alpha/(\mu-\alpha)$. Combining these results, we obtain

$$\frac{d\ln(\Pi/P)}{d\ln(\mu)} = \alpha \cdot \left(\frac{1}{\mu-\alpha} - \frac{1}{1+\xi}\right). \tag{30}$$

Since $1/(1+\xi) < 1$, the elasticity is positive as long as $\mu < 1+\alpha$. □

Proof of Proposition 2. Equation (14) implies that a high realization of M_0 shifts the downward-sloping curve upward in Figure 6(a). Hence, P and h are higher in equilibrium. Equation (15) and the production constraint imply that W/P and c are higher. Since P is higher and the perceived cost, MC, remains the same, $\mu^p = P/MC$ is higher and $\psi = 1 - \phi + \phi \cdot \mu^f/\mu^p$ is lower. But when μ^p is higher, Lemma 1 tells us that μ is lower. The response of μ determines the response of real profits, Π/P. The elasticity of Π/P with respect to μ given by (30) remains valid here. As we have argued, this elasticity is positive when $\mu < 1+\alpha$, which holds in any conventional calibration. In this case, Π/P is lower. □

Proof of Proposition 3. Equation (14) implies that a high realization of a shifts the downward-sloping curve downward in Figure 6(b). Hence, P and h are lower. Equation (15) implies that W/P increases less than proportionally to technology. In fact, the elasticity of W/P with respect to a is $d\ln(W/P)/d\ln(a) = 1 - (1-\sigma)\cdot[1+\xi/\alpha]$ where $\sigma \equiv -d\ln(P)/d\ln(a)$ is the pass-through of technology shocks into prices. The analysis of the pass-through that we conduct below shows that σ satisfies (20) so $\sigma \in (0,1)$. Hence, $d\ln(W/P)/d\ln(a)$ is strictly less than 1 and it could be negative. Equation (17) also implies that $P \cdot a$ increases; in other words, P does not decrease as much as $1/a$. Since $P \cdot a$ increases but P decreases, (10) implies that c increases but c/a decreases.

Since P decreases, μ^p decreases and ψ increases. Lemma 1 implies that μ increases. Since c increases and μ increases, (29) implies that real profits increase. In fact, (29) implies that

$$\frac{d\ln(\Pi/P)}{d\ln(a)} = \frac{\partial\ln(\Pi/P)}{\partial\ln(a)}\bigg|_{\mu} + \frac{\partial\ln(\Pi/P)}{\partial\ln(\mu)}\bigg|_{a} \cdot \frac{d\ln(\mu)}{d\ln(a)}.$$

Since $\partial\ln(c)/\partial\ln(a)\big|_{\mu} = 1$, (29) implies that $\partial\ln(\Pi/P)/\partial\ln(a)\big|_{\mu} = 1$. Furthermore, $\partial\ln(\Pi/P)/\partial\ln(\mu)\big|_{a}$ is given by (30) so it is positive if $\mu < 1+\alpha$. Last, we have showed that $d\ln(\mu)/d\ln(a) > 0$. We conclude that $d\ln(\Pi/P)/d\ln(a) > 1$ if $\mu < 1+\alpha$. □

Proof of Proposition 4. Simple algebra shows that the price-elasticity of the function $\mu^d(P/MC)$ is

$$\frac{d\ln(\mu^d(P/MC))}{d\ln(P)} = \left[1 - \frac{\varepsilon}{\varepsilon-1}\cdot\frac{1}{\mu}\right]\cdot\left[1 - \frac{1}{\psi+\phi}\right] < 0.$$

The elasticity is negative because $\mu < \varepsilon/(\varepsilon-1)$ and $\psi+\phi = 1+\phi\cdot(\mu^f/\mu) \geq 1$. The logic behind the negative elasticity is that an increase in price raises the perceived markup, forcing firms to reduce their markup. Next, (17) and (14) imply that $d\ln(h)/d\ln(\mu) = -1/(1+\xi)$ and $d\ln(P)/d\ln(M_0) = 1-\alpha\cdot d\ln(h)/d\ln(\mu)\cdot d\ln(\mu^d)/d\ln(P)\cdot d\ln(P)/d\ln(M_0)$. Combining these results yields (20).

In two situations, the pass-through converges to one: as the money supply and thus the price level approach 0, and as the money supply and thus the price level approach $+\infty$. When the money supply converges to 0, the downward-sloping curve in Figure 6(a) shifts down so the price goes to 0; hence, the perceived markup goes to 0; and, as shown in Figure 3, the actual markup converges to $\varepsilon/(\varepsilon-1)$. Equation (20) implies that the pass-though converges to 1. Intuitively, as the perceived markup goes to 0, the markup converges to the standard monopolistic markup, and the real side of the economy converges to the standard monopolistic allocation. At this point, changes in money supply have no effect on the real side of the economy, so the price must move proportionally to the money supply in order to neutralize real effects. The fact that the pass-though is one in this case can be seen in Figure 5 because the upward-sloping curve is nearly vertical when $\mu \to \varepsilon/(\varepsilon-1)$, which implies a pass-through of nearly one. Essentially the same logic applies when the money supply goes to $+\infty$. In that case, the price level and thus the perceived markup go to $+\infty$, so

$\psi+\phi = 1+\phi\cdot(\mu^f/\mu^p) \to 1$ and (20) implies that the pass-through converges to one. The markup converges to $(\varepsilon-\phi)/(\varepsilon-1)$.

□

Proof of Proposition 5. We prove the second statement first by computing the effect $du/d\ln(M_0)$ of a money supply shock on welfare. The response of the price level to a money supply shock is the pass-through: $d\ln(P)/d\ln(M_0) = \sigma$. The response of consumption to a money supply shock is solely determined by the pass-through: (10) implies that $d\ln(c)/d\ln(M_0) = 1-\sigma$. The response of hours to a money supply shock is solely determined by the pass-through and the parameter α: the production constraint and (10) imply that $d\ln(h)/d\ln(M_0) = (1-\sigma)/\alpha$. In a symmetric equilibrium, $\psi = 1-\phi+\phi\cdot\mu^f\cdot MC/P$ so $d\ln(\psi)/d\ln(P) = -[1-(1-\phi)/\psi]$ and $d\ln(\psi)/d\ln(M_0) = -\sigma\cdot[1-(1-\phi)/\psi]$. Bringing all these effects together and using (17), which shows that $(\nu/\alpha)\cdot h^{1+\xi} = 1/\mu$, we obtain

$$\frac{du}{d\ln(M_0)} = (1-\sigma)\cdot\left(1+\frac{1}{\eta}-\frac{1}{\mu}\right) - \sigma\cdot\left(1+\frac{1}{\eta}\right)\cdot\left(1-\frac{1-\phi}{\psi}\right). \tag{31}$$

We now determine the sign of $du/d\ln(M_0)$. Using the expression for the pass-through in Proposition 4, we find that $du/d\ln(M_0) < 0$ if and only if

$$\frac{\alpha}{1+\xi}\cdot\left(\frac{\varepsilon}{\varepsilon-1}\cdot\frac{1}{\mu}-1\right)\cdot\frac{\psi}{\psi+\phi}\cdot\left(1-\frac{\eta}{1+\eta}\cdot\frac{1}{\mu}\right) < 1.$$

To obtain this inequality, we used the facts that $\sigma > 0$, $\eta > 0$, and $(1-\phi)/\psi \in (0,1)$ such that we could divide both sides of the inequality by $\sigma\cdot[1-(1-\phi)/\psi]\cdot(1+\eta)/\eta$ without changing its sign. Next, we have $\alpha/(1+\xi) \in (0,1)$ since $\xi > 0$ and $\alpha \in (0,1)$. We also have $1-\eta/[(1+\eta)\cdot\mu] \in (0,1)$ since $\eta > 0$ and $\mu > 1$. Hence, we find that $du/d\ln(M_0) < 0$ if

$$\left(\frac{\varepsilon}{\varepsilon-1}\cdot\frac{1}{\mu}-1\right)\cdot\frac{\psi}{\psi+\phi} < 1.$$

Given that $\psi = 1-\phi+\phi\cdot\mu^f/\mu^p$ in a symmetric equilibrium, (13) implies that $\psi/(\psi+\phi) =$

$(\varepsilon-1)\cdot(\mu-1)$. Thus, a sufficient condition for $du/d\ln(M_0)<0$ is

$$(\varepsilon-1)\cdot\left(\frac{\varepsilon}{\varepsilon-1}-\mu\right)\cdot(\mu-1)-\mu<0.$$

Let $Q(x)=(\varepsilon-1)\cdot(\varepsilon/(\varepsilon-1)-x)\cdot(x-1)-x$. In equilibrium, $\mu\in(1,\varepsilon/(\varepsilon-1))$. Hence, a sufficient condition for $du/d\ln(M_0)<0$ is $Q(x)<0$ for all $x\in(1,\varepsilon/(\varepsilon-1))$. The polynomial Q is of degree 2 with a negative coefficient on x^2 so it is strictly convex. Since $Q'(x)=2\cdot(\varepsilon-1)\cdot(1-x)$, $Q'(1)=0$ and the polynomial Q admits a global maximum in 1. Since $Q(1)=-1<0$, we infer that $Q(x)<0$ for all x. The implication is that $du/d\ln(M_0)<0$ for all $\mu\in(1,\varepsilon/(\varepsilon-1))$.

To prove the first statement, denoting by $\hat{u}$ unemotional welfare,

$$\frac{d\hat{u}}{d\ln(M_0)}=(1-\sigma)\cdot\left(1+\frac{1}{\eta}-\frac{1}{\mu}\right), \tag{32}$$

which corresponds to (31) where $\phi=0$ and $\psi=1$. Since $\sigma\in(0,1)$, $\frac{1}{\mu}<1$ and $\frac{1}{\eta}>0$, $\frac{d\hat{u}}{d\ln(M_0)}>0$.

□

8 Appendix B: Fairness According to French Bakers

To better understand how firms take fairness concerns into account, we interviewed 31 bakers in France in the summer of 2007. The French bread market provides a good example of a large market where sellers and buyers have personal relationships and where consumers likely care about the fairness of prices.[18] The French bread market also makes for a good case study because French people care a lot about the price of bread, which bakers can freely set themselves.[19]

[18] 65% of French households patronize a bakery at least once a week, and those who do so average 3.7 visits per week [Eymard, 1999]. Traditional bakeries employ broadly 148,000 workers, for a yearly turnover of 3.2 billion euros, which represents 68% of the total bread market [Fraichard, 2006].

[19] Since August 1978, French bakers have been free to set their own bread and pastry prices, except during the inflationary period between 1979 and 1987 when price ceilings and growth caps were mandated. For centuries, bread prices caused major social upheaval. Before the French Revolution, the king had incentive to ensure readily available and reasonably priced bread: Miller [1999] writes that "[a]ffordable bread prices underlay any hopes for urban tranquility". During the Flour War (May 1775), mobs chanted "[i]f the price of bread does not go down, we will exterminate the king and the blood of the Bourbons". (In French, this rhymes.) Following these riots, the king capped the price of bread at 2 sous per pound, the "ordinary" price of bread in the 18th century. During periods of scarcity, bakers were required to sell at some fair, historical price. Those who refused saw their bakeries and warehouses looted or robbed. Crowds pillaged bakeries in Paris during the Flour War, shouting "we must have bread" [Kaplan, 1996].

Following the approach of Bewley [1999], the interviews were only loosely directed. We sampled bakeries in cities and villages around Grenoble, Aix-en-Provence, Paimpol, and Paris. The small numbers of interviews preclude statistical analysis, yet responses do shed light on fairness constraints on pricing.

Overall, the interviews show that bakers' efforts to preserve customer loyalty constrain price variations. Price adjustments are guided by norms of fairness to avoid antagonizing customers; in particular, cost-based pricing is widely used. Bakers explained that they would raise the price of bread only in response to cost increases: when the price of flour goes up (generally once a year in September at the end of harvest), when utilities go up (especially gas, required to operate the oven), or when wages go up. Some bakers explained that their largest costs were the wages of their employees, which are linked to the minimum wage. Since the minimum wage is updated every July 1st and the bakers only change their price in response to a cost change, they only change their price once a year on July 1st.

In fact, bakers attach such importance to convincing their customers of fair markups that their trade union decomposes into minute detail the cost of bread and the rationale for any price rise, calculating the markups for various types of bread and explaining their evolution over time. They emphasize that prices increase only in response to cost increases, with any increase announced long in advance and explained carefully.[20] Baker behavior suggests that customers only tolerate price increases justified by cost increases. We have seen several signs posted in bakeries almost identical to those pictured in Figure 1.

Not only do bakers seem to set their price as a fixed markup over their cost, but they also consciously refuse to increase prices in response to increased demand: bakers find it unfair to respond to demand shocks. Several bakers explained that they refuse to change prices during the week-ends (when more people typically shop at bakeries), during the holiday absences of local competitors (when their demand and market power rise), or during the summer tourist season (again, when demand rises). In each case, bakers feel that a price rise would anger and drive away regular customers.

[20]The webpage is at http://www.boulangerie.net/forums/bnweb/prixbaguette.php.

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