

# The Curse of Inflation

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November 26, 2014

## 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 induces lower monopolistic 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: consumers misattribute the higher prices arising from higher money supply to higher markups; the misperception of higher markups angers them and makes their demand for goods more elastic; in response, monopolists reduce their markups, thus stimulating economic activity. Through a similar mechanism, an increase in technology induces higher output but higher monopolistic markups and lower hours worked.

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# 1 Introduction

A trove of empirical evidence suggests that people care about fairness and dislike paying prices that they view as unfair. [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 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 show that these two well-documented psychological traits—concern for fairness and failure to infer information rationally—naturally explain the nonneutrality of money. The analysis is based on the canonical macroeconomic model by [Blanchard and Kiyotaki \[1987\]](#), modified to incorporate these two psychological traits. The Blanchard-Kiyotaki model is a static general-equilibrium model with goods, labor, and money, and monopolistic competition on the goods and labor markets.

In modeling fairness concerns, we assume that the utility people derive from a good depends upon the perceived fairness of its purchase price. People dislike paying prices that exceed a fair markup on firms' marginal costs. Since paying a higher markup for some good lowers the marginal utility of consuming that good, consumers withhold demand when they perceive prices to be unfairly high. Specifically, we assume that consumption utility is scaled by a factor that measures the perceived fairness of the transaction, based on the observed price and the consumer's estimate of the good's marginal cost. 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  $\mu_i^f$ , 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  $\phi$  parametrizes fairness concerns and  $\mu^P$  is the average perceived markup across all goods. When  $\phi = 0$  we have the classic case without fairness concerns. When  $\phi > 0$  consumption utility is sensitive to the perceived fairness of the transaction.

Such fairness concerns alter two properties of the price-elasticity of the demand for good  $i$ . In the Blanchard-Kiyotaki model, the elasticity of the demand for good  $i$  is constant and equal to  $\varepsilon$ , the elasticity of substitution across goods. Consider now the model with fairness concerns. First, an increase in the price of good  $i$  increases the opportunity cost of consumption, as in the standard case, but it also increases the perceived markup, thus decreasing the enjoyment of consumption and reducing further the demand for good  $i$ . As a result, the elasticity of the demand for good  $i$  is greater than  $\varepsilon$ . Second, we show that the elasticity of the demand for good  $i$  increases with the elasticity of the fairness factor  $\psi_i$  with respect to  $P_i$ . As  $P_i$  increases,  $\psi_i$  falls because consumers feel less fairly treated, and  $\partial\psi_i/\partial P_i$  remains constant. Hence, the elasticity  $(P_i/\psi_i) \cdot (\partial\psi_i/\partial P_i)$  clearly increases. As a result, the elasticity of the demand for good  $i$  increases with  $P_i$ . The properties that the elasticity of the demand for good  $i$  is greater than  $\varepsilon$  and increasing with  $P_i$  are critical to understand the properties of the model with fairness concerns.

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 monopolistic firms to set lower markups. This renders the economy more competitive: output and hours worked exceed their no-fairness levels. But the qualitative features of the economy do not differ from the case without fairness concerns; importantly, money remains neutral.

In light of 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. Specifically, we make the crude but tractable assumption that consumers make no inference about marginal costs from prices, nor from any other available information. We regard this failure to infer as a form of neglect: consumers simply fail to think through how prices are contingent upon marginal cost in equilibrium. 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*.

This simple assumption is consistent with failures of contingent thinking captured by the fully

cursed equilibrium of [Eyster and Rabin \[2005\]](#) and the analogy-based expectation 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 by drawing upon a limited set of scenarios that come more easily to mind; here, higher prices suggest increased markups and greed rather than higher marginal costs. Also related is the coarse-thinking model of [Mullainathan, Schwartzstein and Shleifer \[2008\]](#). Households in our model are coarse thinkers in that they do not distinguish between the scenarios where price changes reflect cost changes and those where they reflect markup changes.

When the assumptions of fairness concerns and cursed inference are combined, money is no longer neutral. Instead, we find that an increase in money supply causes monopolistic markups to fall, stimulating economic activity. After an increase in money supply, consumers misattribute the higher prices to higher markups. The misperception of higher markups angers consumer and increases the elasticity of demand. In response, monopolists reduce their markups. Two critical properties of the general equilibrium are that (1) the markup is equal to the inverse of the real marginal cost, and (2) the real marginal cost is an increasing function of hours worked. Therefore, a lower markup implies higher real marginal cost and thus higher hours worked, which in turn implies higher output.

We also find that the price level rises less than proportionally with money supply. Hence, our model generates a mild form of price rigidity. The pass-through—the elasticity of the price level to money supply—measures the amount of rigidity. We find that when consumers are more sensitive to fairness or when the economy is less competitive, the pass-through is lower and the price level therefore more rigid.

Even though an increase in money supply stimulates the economy, it lowers welfare. On the one hand, an increase in money supply reduces markups and thus the inefficiency due to monopolistic competition. On the other hand, and even though actual markups fall, an increase in money supply raises perceived markups due to consumers' mistaken inference, in turn upsetting consumers who mistakenly believe that transactions have become less fair. 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.

Last, we analyze the effects of technology shocks. We find that higher technology leads to higher output but higher markups and lower hours worked. The logic mirrors that following a monetary shock. After an increase in technology, consumers fail to infer that lower prices reflect lower marginal costs. Hence, the perceived markup and thus the elasticity of demand falls, leading firms to charge higher markups. The higher markups reduce the number of hours worked. Although markups increase, people mistakenly believe that transactions have become more fair.

**Relation to the Literature.** Explaining the nonneutrality of money is a classical problem in macroeconomics, addressed by many models. Most feature monopolistic firms selling goods subject to some exogenous price-setting friction.<sup>1</sup> In these models as in ours, money-supply shocks propagate through the economy via the monopolistic markups: increasing money supply raises prices but lowers markups and thus stimulates output. But in existing models, consumers correctly infer markups from prices, so they understand that, although prices increase 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 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 nonneutrality of money with the evidence presented by Shiller: consumers feel cheated by higher prices after an increase in money supply because they believe that higher prices reflect higher markups. Hence, the model helps bridge the gap between the attitudes that people have about inflation and those implied by macroeconomic models. Romer [2001, p.519] describes this gap as follows: "Inflation's costs are not well understood. There is a wide gap between the popular view of inflation and the costs of inflation that economist can identify. Inflation is intensely disliked."

The preferences in our model share features with those used in the literature on reciprocity and fairness in that consumers care not only about the quantities that they consume but also about the

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<sup>1</sup>These frictions take many 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]. Blanchard [1990] surveys early theories of the nonneutrality of money; Mankiw and Reis [2010] and Sims [2010] survey recent theories.

surpluses enjoyed by firms.<sup>2</sup> [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, 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 nonneutrality.

In this paper, we retool the psychological assumption of [Rotemberg \[2005\]](#) that consumers refuse to purchase from firms whose prices reveal a lack of concern for their welfare by assuming that consumers experience less enjoyment of a good the less fair they regard its price. Despite broad similarities, the two assumptions differ conceptually and have different predictions. Unlike ours, Rotemberg's assumption implies that consumers would not withhold demand unless doing so hurt firms. Yet in many large market settings, consumers cannot easily cause firms significant harm.<sup>3</sup> In monopolistically competitive markets, consumers can reduce profits by withholding demand, but the effect is likely to be small in large markets. [Rotemberg \[2005\]](#) bypasses this difficulty by assuming that consumers' taste for harming non-altruistic firms is arbitrarily strong.

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 one in which consumers continuously reduce demand as the unfairness of the transaction or their concern for fairness increases. This continuous formulation is more tractable: it lends itself to comparative-statics analysis, welfare analysis, and delivers analytical expressions for key elasticities. It has important macroeconomic effects even when consumers care much more about consumption than fairness. Last, it enables us to introduce fairness while modifying only minimally the Blanchard-Kiyotaki model—we only add one parameter,  $\phi$ , to measure people's concern for fairness.

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<sup>2</sup>See for instance the preferences of [Rabin \[1993\]](#), which embed intention-based fairness concerns, or the social preferences of [Fehr and Schmidt \[1999\]](#), which exhibit aversion to unequal outcomes.

<sup>3</sup>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 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.<sup>4</sup>

### 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.<sup>5</sup> We also assume that consumers regard it

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<sup>4</sup>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.

<sup>5</sup>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.<sup>6</sup> 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 increases in technology. 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. \[1998\]](#), researchers have surveyed firms about their pricing

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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  $x\%$ .

<sup>6</sup>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.



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

strategies. In these surveys, managers tasked with setting prices were presented with economic theories of price setting and asked to rate the importance of each as a cause of their own firm’s price stickiness.<sup>7</sup> 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.

<sup>7</sup>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, such as coordination failure and quality signaling.

## 2.3 Firms Attempt to Communicate their Costs to Consumers

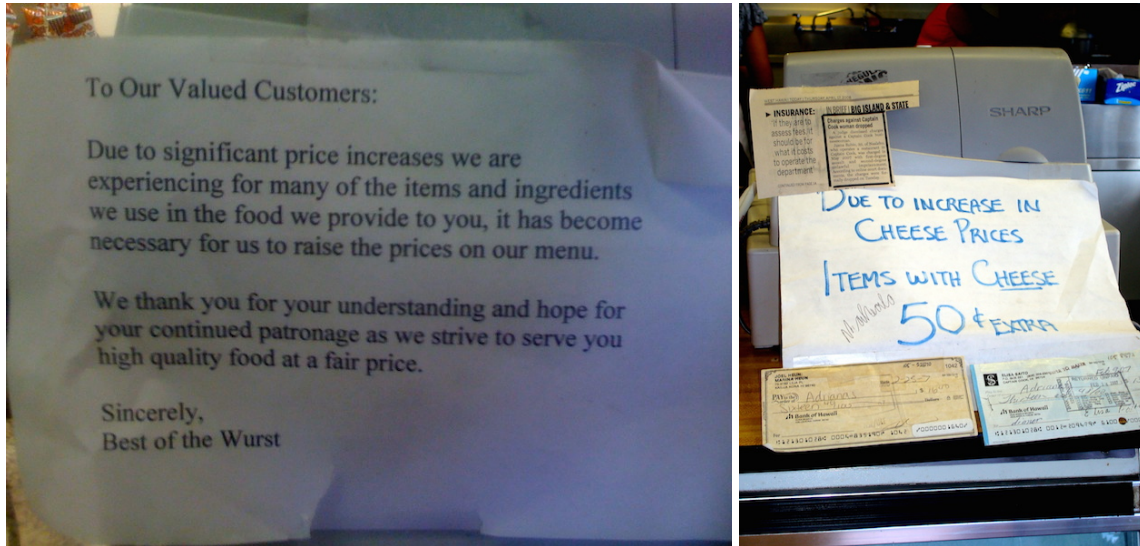
Last, our assumption that buyers care not only about consumption but also about sellers' markups has implications for the type of cost information that firms wish to transmit to consumers. Firms with high marginal costs wish to reveal them to consumers whose estimates are too low. Firms with low marginal 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 statements 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 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 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



(a) Sandwich Shop in Columbus, OH, 2008 (Photo: Slav Petrov) (b) Taqueria in Kona, HI, 2008 (Photo: Pascal Michailat)

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

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.<sup>8</sup> 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-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.

<sup>8</sup>See the statement of Shmuel, page 49b of Bava Metzhia, Nezikin, [halakhah.com/pdf/nezikin/Baba\\_Metzia.pdf](http://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.



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.

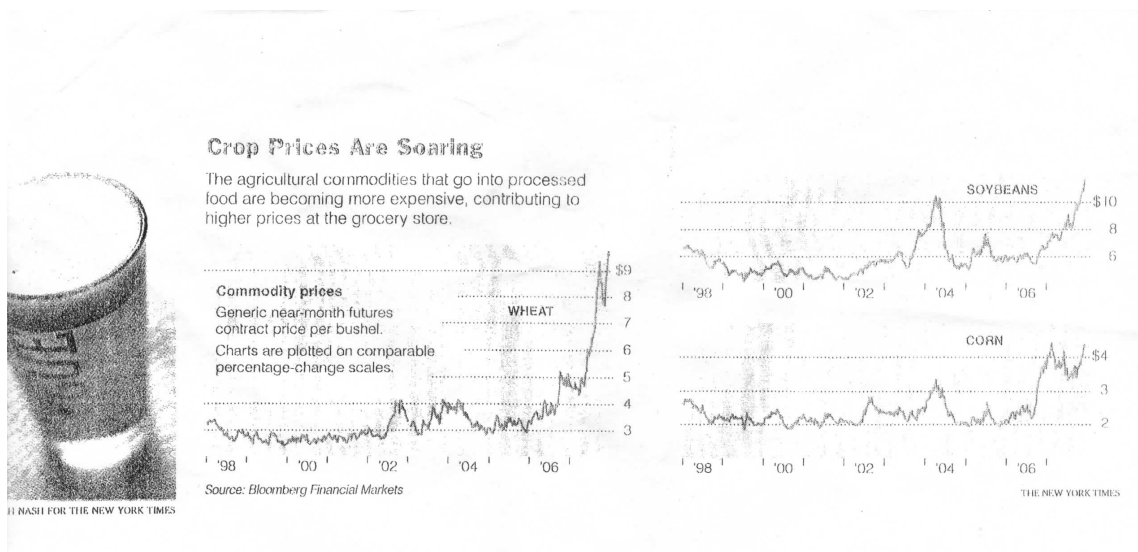
- Our flour cost has more than tripled in the past month.
- On Monday (2/25/08) the price of March spring wheat on the Minneapolis Grain Exchange hit \$24 a bushel, double its cost two months ago and the highest price ever for wheat.
- The high-quality wheat we use to make artisan breads and bagels is 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 & Mehafeey 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)

## 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 underappreciate adverse selection in trade. The papers collected in [Kagel and Levin \[2002\]](#) present evidence that bidders underattend to the “winner’s curse” in common-value auctions. In a metastudy of social-learning experiments, [Weizsäcker \[2010\]](#) finds evidence that subjects behave as if they underinfer their predecessors’ private information from their actions. Last, 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”.

## 3 The Model

We extend the [Blanchard and Kiyotaki \[1987\]](#) model to include fairness concerns on the goods market. The economy is composed of a continuum of firms indexed by  $i \in [0, 1]$  and a continuum of households indexed by  $j \in [0, 1]$ . Firms produce goods that are imperfect substitutes for each other, and households supply labor services that are also imperfect substitutes. As a result, each firm has some monopoly power on the goods 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 goods, and money holdings. Fairness matters on the goods 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

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

where the fairness factor  $\psi_i$  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

$$\psi_i = 1 - \frac{\phi}{\mu^P} \cdot (\mu_i^P - \mu_i^f).$$

The deviation  $\mu_i^P - \mu_i^f$  of the perceived markup from the fair markup is scaled by  $\phi/\mu^P$ , 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.<sup>9</sup> The fairness parameter indicates the importance of fairness concerns: when  $\phi = 0$ , consumers do not care about fairness; as  $\phi > 0$ , they care about the perceived fairness of the transaction. A higher  $\phi$  means that a consumer is more upset when consuming an overpriced item and more content when consuming an underpriced item. We divide  $\phi$  by  $\mu^P$  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 are antagonized by consuming what they perceive to be an overpriced good. 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. Finally, the fairness factor is differentiable everywhere in  $P_i$  and does not exhibit a kink at the fair price. In fact, the fairness factor is linear in  $P_i$ , so consumers enjoy a price any amount below the fair price as much as they dislike a price that same amount above the fair price.<sup>10</sup>

Household  $j$ 's fairness-adjusted consumption of the different goods are aggregated into a con-

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<sup>9</sup>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.

<sup>10</sup>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.

sumption index

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

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  $\varepsilon \rightarrow \infty$ , goods become perfect substitutes.

The utility of household  $j$  is given by

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

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

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

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.

Household  $j$  maximizes utility subject to the constraint imposed by firms' demand for labor service  $j$  and the budget constraint

$$M_{0j} + W_j \cdot h_j + \Pi_j - M_j - \int_0^1 P_i \cdot c_{ij} di = 0, \quad (2)$$

where  $M_{0j} > 0$  is its endowment of money supply,  $W_j$  is its nominal hourly wage, and  $\Pi_j$  is its share of nominal profits. Households take prices, profits, and money supply as given.

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

function

$$c_i = a_i \cdot h_i^\alpha, \quad (3)$$

where  $c_i$  is its output of good  $i$ ,  $a_i$  is its technology level,  $\alpha < 1$  is the extent of diminishing marginal returns to labor, and

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

is an employment index. In the employment index,  $h_{ij}$  is the number of hours of labor service  $j$  hired by firm  $i$ , and  $\gamma > 1$  is the elasticity of substitution between different labor services. The parameters  $\gamma$  and  $\alpha$  apply to all firms.

Taking wages as given, firm  $i$  maximize profits

$$\Pi_i = P_i \cdot c_i - \int_0^1 W_j \cdot h_{ij} dj \quad (4)$$

subject to the constraints imposed by its production function and consumers' demand for good  $i$ . We assume that firms' marginal costs are unobservable to other firms and consumers—they are private information—and that firms are not strategic: firm  $i$  does not attempt to influence consumers' beliefs about its marginal cost  $MC_i$  by choosing a price  $P_i$ .<sup>11</sup> Formally, firm  $i$  takes the demand for good  $i$  as given, which means that it takes  $MC_i$  as 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.

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<sup>11</sup>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.



### 3.2 Solution to the Households' and Firms' Problems

To maximize their utility, households make two decisions: first, they choose how to divide their wealth across goods and money balances; second, they choose which wage to post for their labor services. Integrating the demand for good  $i$  over all households yields the demand for good  $i$ :

$$c_i^d(P_i) = \frac{z}{\psi_i} \cdot \left( \frac{P_i/\psi_i}{\hat{P}} \right)^{-\varepsilon}, \quad (5)$$

where  $z \equiv \int_0^1 z_j dj$  describes the level of aggregate demand. The price of a unit of  $z_i$  is  $P_i/\psi_i$  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, household  $j$  equates the marginal rate of substitution between money and fairness-adjusted consumption with their price ratio, which gives an equation linking fairness-adjusted consumption to nominal money balances:

$$\frac{z_j}{\eta M_j} = \frac{1}{\hat{P}}. \quad (6)$$

Households choose which wage to post given firms' demand for their labor

$$h_j^d(W_j) = h \cdot \left( \frac{W_j}{W} \right)^{-\gamma}, \quad (7)$$

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. 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. To maximize utility, household  $j$  sets its wage at a markup of  $\gamma/(\gamma-1) > 1$  over its marginal rate of substitution between leisure and money holdings:

$$W_j = \frac{\gamma}{\gamma-1} \cdot v \cdot h_j^\xi \cdot \eta \cdot M_j. \quad (8)$$

To maximize profits, firms also make two decisions: first, they choose how much of each type of labor to hire ; second, they choose which price to post for their good. Integrating the demand for labor  $j$  over all firms yields the labor demand (7). It is optimal for firm  $i$  to mark its price up

over its marginal cost by setting

$$P_i = \frac{e_i}{e_i - 1} \cdot \frac{W}{a_i \cdot \alpha \cdot h_i^{\alpha-1}}. \quad (9)$$

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 (5) to compute  $e_i$ :

$$e_i = \varepsilon + (\varepsilon - 1) \cdot e_i^\Psi, \quad (10)$$

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

$$e_i^\Psi = \frac{\phi}{\mu^P} \cdot \frac{\mu_i^P}{\psi_i}. \quad (11)$$

Fairness concerns modify two properties of the price-elasticity  $e_i$  of firm  $i$ 's demand, and these modifications have important implications. First, without fairness concerns, the price-elasticity of the demand faced by firms is  $\varepsilon$ , the elasticity of substitution across goods. Indeed, setting  $\phi = 0$  in (11) and (10) yields  $e_i^\Psi = 0$  and  $e_i = \varepsilon$ . But the introduction of fairness concerns makes households more sensitive to prices, which increases the price-elasticity of the demand faced by firms and thus reduces firms' monopoly power. Indeed, with  $\phi > 0$ , we have  $e_i^\Psi > 0$  so  $e_i > \varepsilon$ . Intuitively, with fairness concerns, an increase in the price of good  $i$  increases the opportunity cost of consumption, as without fairness concerns, but it also decreases the enjoyment of consumption by increasing the perceived markup, thus reducing further the demand for good  $i$ .

Second, without fairness concerns, the price-elasticity of the demand faced by firms is constant. But with fairness concerns, households' perceptions of markups affect the price-elasticity of the demand faced by firms. In fact, the introduction of fairness concerns implies that the price-elasticity of the demand faced by firms is not constant but increasing with the perceived markup. Indeed, as the perceived markup  $\mu_i^P$  increases, the fairness factor  $\psi_i$  falls, so  $e_i^\Psi$  increases by (11) and thus  $e_i$  increases by (10).<sup>12</sup>

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<sup>12</sup>This property that  $e_i^\Psi$  increases with  $\mu_i^P$  is robust. It would hold for any function  $\psi_i$  that is decreasing and concave in  $P_i$  (our function  $\psi_i$  is decreasing and linear in  $P_i$ ). That is, it would hold for any function  $\psi_i$  such that households enjoy a price any amount below the fair price less than they dislike a price that same amount above the fair price.

### 3.3 General Equilibrium

We describe the general equilibrium. We focus on a symmetric setting. All households regard the same markup 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. In equilibrium, all households post the same wage and all firms set the same price. Since the equilibrium is symmetric, all the exogenous and endogenous variables are the same for all the households and firms; we drop the subscripts  $i$  and  $j$  from all the variables to denote their value in the symmetric equilibrium. All the derivations are relegated to Appendix A.

We condense the symmetric general equilibrium to a pair  $(P, h)$ , from which all other variables can be recovered. Here we derive the two equations that determine  $(P, h)$ .

In a symmetric equilibrium,  $z = \psi \cdot c$ ,  $\hat{P} = P/\psi$ , and  $M = M_0$ . Combining the marginal-rate-of-substitution condition (6) with the production constraint (3) gives the first equation characterizing the general equilibrium:

$$\ln(P) = \ln(M_0) + \ln(\eta) - \ln(a) - \alpha \cdot \ln(h). \quad (12)$$

This equation 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 consumption. Since, in equilibrium, households must remain indifferent between consumption and money holdings, real money balances  $M_0/P$  must increase to lower the marginal utility from holding money. As the money supply is fixed to  $M_0$ , the price level  $P$  must fall.

Combining (12) with households' wage-setting equation, given by (8), we express the real wage  $W/P$  as an increasing function of hours worked:

$$\ln\left(\frac{W}{P}\right) = (\xi + \alpha) \cdot \ln(h) + \ln(a) + \ln(v) + \ln\left(\frac{\gamma}{\gamma - 1}\right). \quad (13)$$

The real wage increases with hours worked because the disutility from labor is convex and the utility from consumption concave. Firms' real marginal cost is the real wage divided by the marginal

product of labor:

$$mc = \frac{W/P}{a \cdot \alpha \cdot h^{\alpha-1}}.$$

Using (13), we express the real marginal cost as an increasing function of hours worked:

$$\ln(mc) = (1 + \xi) \cdot \ln(h) + \ln(v) - \ln(\alpha) + \ln\left(\frac{\gamma}{\gamma-1}\right).$$

The real marginal cost increases with hours worked because the real wage increases with hours and the production function has diminishing marginal returns to labor.

Firms' price-setting equation, given by (9), implies that the markup set by firms is the inverse of the real marginal cost:

$$\mu = \frac{1}{mc},$$

This is a typical property in models of monopolistic competition. Equation (9) also shows that the markup is  $e/(e-1)$  where  $e = \varepsilon + (\varepsilon - 1) \cdot (\phi/\psi)$  is the price-elasticity of the demand faced by firms, obtained from (10) and (11). Hence, when the markup perceived by households is  $\mu^p$ , the markup set by firms is

$$\mu(\mu^p) = \frac{1}{\varepsilon - 1} \cdot \left( \varepsilon - \frac{\phi}{1 + \phi \cdot \mu^f / \mu^p} \right). \quad (14)$$

The following lemma describes how the markup set by firms depends upon fairness concerns and  $\mu^p$ . Figure 3 illustrates the results of the lemma.

**LEMMA 1.** *When households do not care about fairness ( $\phi = 0$ ), the markup  $\mu(\mu^p)$  coincides with the standard monopolistic markup of  $\varepsilon/(\varepsilon - 1)$ . When households care about fairness ( $\phi > 0$ ), the markup  $\mu(\mu^p)$  lies below the standard monopolistic markup of  $\varepsilon/(\varepsilon - 1)$ , decreases in  $\phi$ , and is bounded from below above one. Furthermore, it reverts to  $\varepsilon/(\varepsilon - 1)$  when  $\mu^p = 0$ , decreases in  $\mu^p$ , and converges to  $(\varepsilon - \phi)/(\varepsilon - 1) \geq 1$  as  $\mu^p \rightarrow +\infty$ .*

Combining the results on the real marginal cost and markup, we express hours worked as a

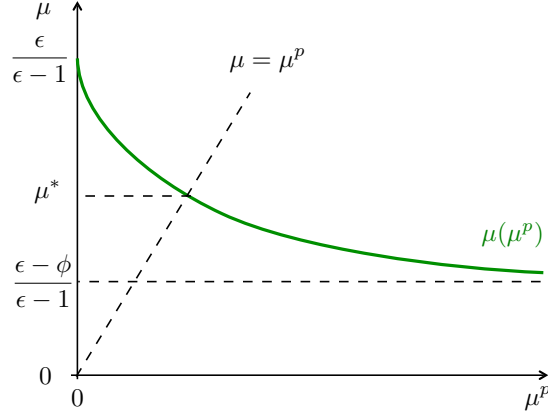


Figure 3: Relation Between the Perceived Markup and the Markup Set by Firms

*Notes:* This graph represents the markup  $\mu(\mu^P)$  set by monopolistic firms to maximize profits when the markup perceived by households is  $\mu^P$ . The properties of the function  $\mu(\mu^P)$  are described in Lemma 1.

decreasing function of the markup:

$$(1 + \xi) \cdot \ln(h) = -\ln(\mu(\mu^P)) + \ln(\alpha) - \ln(v) - \ln\left(\frac{\gamma}{\gamma - 1}\right), \quad (15)$$

which is the second equation characterizing the general equilibrium.

## 4 The Case with Rational Inference

In this section, we analyze the economy when households rationally infer firms' marginal costs. The following proposition summarizes the properties of the equilibrium:

**PROPOSITION 1.** *Consider an economy in which households make rational inferences. The markup is the fixed point  $\mu^*$  of the function  $\mu(\mu^P)$ , which satisfies*

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

*An increase in the fairness parameter  $\phi$  renders the economy more competitive: the markup decreases in  $\phi$ ; output, hours, and real wages increase in  $\phi$ ; prices decrease in  $\phi$ , as do real profits when  $\mu < 1 + \alpha$ . Importantly, the markup is independent of money supply and technology. Hence, money-supply and technology shocks have the following effects:*

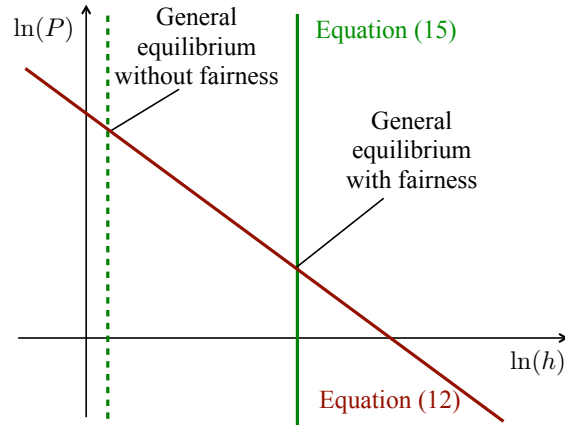


Figure 4: The General Equilibrium with Rational Inference

- *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 proof of this proposition and the other in the paper are relegated to Appendix A. The main result of this proposition is that when households make rational inferences, money is neutral: hours and output do not depend on the money supply. In the case where people do not care about fairness ( $\phi = 0$ ), 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 the neutrality result also holds when people care about fairness ( $\phi > 0$ ).

The intuition for the neutrality of money 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 households are rational, fairness concerns simply increase the elasticity of demand. Fair-

ness 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  $\mu$  to be between 1.05 and 1.3, and  $\alpha$  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, 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  $\eta$ . An increase in  $\eta$  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  $\eta$  enter exactly similarly in all the equilibrium conditions, increasing  $\eta$  has exactly the same effects as increasing  $M_0$ . Therefore, even if households care about fairness, aggregate demand is neutral when households make rational inferences. Likewise, we could study the effects of a labor-supply shock parameterized by a change in the preference parameter  $\nu$ .

## 5 The Case with Cursed Inference

Although households see and use prices when purchasing goods, 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, households could also further update about firms' marginal costs using received profits and labor demand, but they may neglect this sort of indirect information. The evidence in Section 2.5 suggests that people fail at precisely this type of inference. Accordingly, in this section we assume that households 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 con-

cept of cursed equilibrium by [Eyster and Rabin \[2005\]](#) and analogy-based expectation equilibrium by [Jehiel \[2005\]](#) and [Jehiel and Koessler \[2008\]](#).<sup>13</sup> Of course, without fairness concerns ( $\phi = 0$ ), inference about marginal costs plays no role, so the equilibrium with cursed inference is exactly the same as the equilibrium with rational inference. Hence, this section considers only on the case with fairness concerns ( $\phi > 0$ ), in which cursed inference plays a critical role.

## 5.1 Cursed Inference

Household  $j$  seeks to maximize the expectation of the utility  $u_j$ , given by (1), subject to its known budget constraint, given by (2). In this constrained optimization problem, the household knows everything except for the  $MC_i$  terms that enter the fairness factors,  $\psi_i = 1 - (\phi/\mu^p) \cdot (P_i/MC_i - \mu_i^f)$ . Rational households would use their understanding of firms' pricing rules as well as their observations to infer these marginal costs. By contrast, cursed households take expectations of  $u_j$  given their prior beliefs over  $MC_i$  (which can be derived from prior beliefs over  $\{a_i\}$  and  $M_0$ ).<sup>14</sup>

To simplify, we assume that households' priors about nominal marginal costs are highly concentrated around a nominal value  $\overline{MC}$  so that we can replace households' expected utility with their utility given a marginal cost  $\overline{MC}$ .<sup>15</sup> 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.

## 5.2 Characterization of the Cursed General Equilibrium

The key effect of cursed inference is that the equilibrium markup is no longer independent of the price level. A higher price causes households to perceive a higher markup, which in turn increases the elasticity of demand and reduces the markup charged by firms. Specifically, the markup is

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<sup>13</sup>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.

<sup>14</sup>A richer model would include some rational households who infer marginal costs from prices and some households 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.

<sup>15</sup>We expect but have not proven that none of the qualitative results depend upon this simplifying assumption.



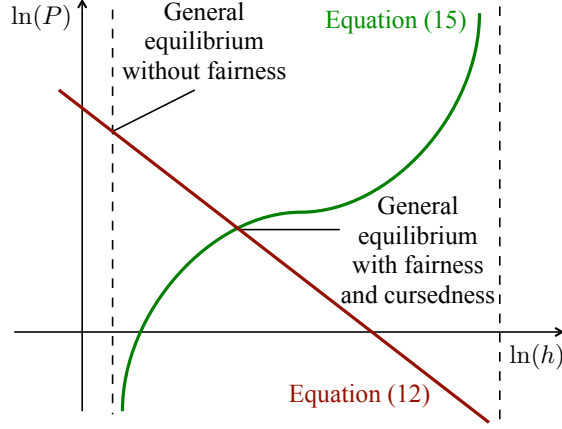


Figure 5: The General Equilibrium with Fairness Concerns and Cursed Inference

given by  $\mu(P/\overline{MC})$ , where the function  $\mu(\mu^P)$  is given by (14).

Figure 5 illustrates how equation (15) is no longer independent of the price level. Instead, it gives rise to an increasing relationship between the price level and hours. Furthermore, this curve has two closed-form asymptotes:

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

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

These establish the existence and uniqueness of general equilibrium.

Because money-supply and technology shocks shift 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.

### 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 households care about fairness ( $\phi > 0$ ) and make cursed inferences. Money is not neutral. An increase in money supply has the following effects: the markup decreases; hours worked, output, and real wage increase; real profits de-*

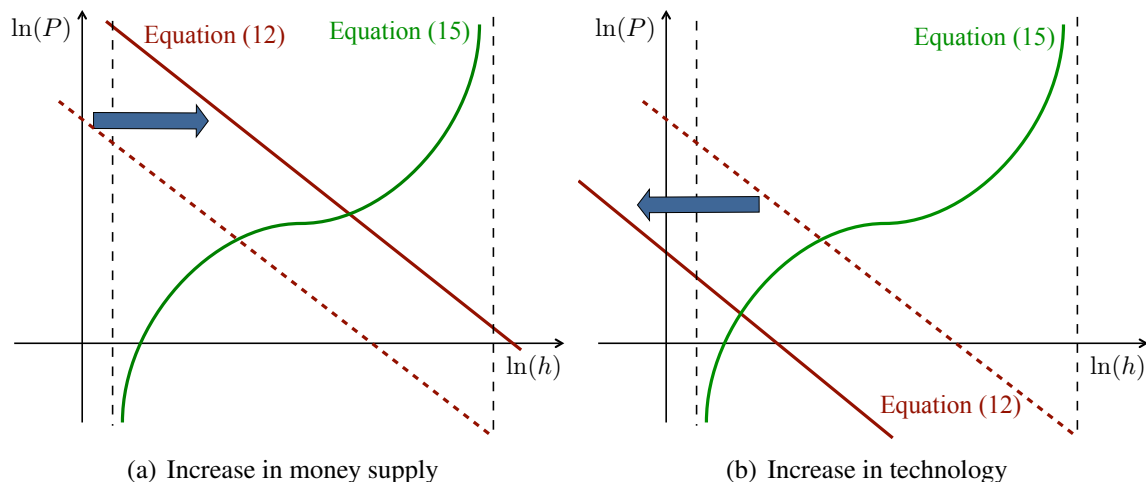


Figure 6: Comparative Statics with Fairness Concerns and Cursed Inference

*crease 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 assumptions of fairness concerns and cursed inference, money is no longer neutral. Instead, we find that an increase in money supply causes monopolistic markups to fall, stimulating the economy. After an increase in money supply, households misattribute the higher prices to higher markups. The misperception of higher markups angers consumer and increases the elasticity of the demand curves faced by monopolists; in response, monopolists reduce their markups. This result is formally established by Lemma 1, which shows that the equilibrium markup is a decreasing function of the perceived markup. We know that in a symmetric general equilibrium the markup is equal to the inverse of the real marginal cost and the real marginal cost is an increasing function of hours worked. Therefore, a lower markup implies higher real marginal cost and thus higher hours worked, which in turn implies higher output.

The nonneutrality result is illustrated in Figure 6(a). A high realization of money supply raises the downward-sloping curve; therefore, hours worked are higher in equilibrium. The price level is also higher.

Unlike in traditional monetary models, the nonneutrality of money happens without any constraint on price setting. In our model, there is no long-term nominal contracting, price-adjustment cost, or staggered pricing. Instead, it is firms' optimal price setting in the presence of consumers

concerned about fairness and making cursed inferences that leads to the nonneutrality of money.

With fairness concerns and cursed inference, the economy exhibits a form of price rigidity in that the price level always moves less than the money supply. To understand why the price level is necessarily rigid, suppose that starting from equilibrium the money supply  $M_0$  and the price level  $P$  were to double. In this hypothetical equilibrium with price flexibility,  $M_0/P$  would remain the same, so output (through households' indifference between consumption and money holdings) and hours worked (through firms' production function) would remain the same. Accordingly, the real marginal cost faced by firms and thus the markup would not change (in general equilibrium, the real marginal cost is an increasing function of hours worked and the markup is the inverse of the real marginal cost). But observing higher prices, households would fail to infer the increase in the underlying nominal marginal costs and would mistakenly perceive higher markups, which would increase the elasticity of demand, leading monopolistic firms to set lower markups. Hence, the economy cannot be in equilibrium. Consequently, the price level rises less than proportionally with money supply; increased real money balances lead to increased output and hours worked, increased real marginal cost, and decreased markup.

Our model predicts the same response of the markup to money-supply shocks as many other monetary models. For instance, New Keynesian models give rise to markups that are countercyclical under monetary shocks because firms take time to adjust their prices. But unlike firms in these models, which always desire the same markup, firms in our model optimally tailor their markups to the money supply. In that respect, our model is closer to models of business-cycle fluctuations based on endogenous markups [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 countercyclical 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. Bilal [1989] predicts low markups with high demand when firms find it most profitable to expand their customer base.

Although the response of the actual markup to money-supply shocks is the same in our model as in many existing monetary models, the response of the perceived markup is sharply different. In existing models, consumers correctly infer markups from prices, so they understand that, although prices rise after an increase in money supply, markups fall. In our model, in contrast, the perceived markup increases because cursed households fail to appreciate that firms have higher nominal marginal costs due to higher money supply. Households mistakenly believe that transactions have become less fair although firms enjoy lower per-unit real profits and generally lower total real profits. Households' misperception in our model accords well with the survey responses in [Shiller \[1996\]](#), in which respondents report that when they “go to the store and see that prices are higher”, they “feel a little angry” at the “greed” of “manufacturers”, “store owners”, and “businesses”. While an increase in money supply raises perceived markups and angers households, it also lowers markups and increases economic efficiency. We will return to the effect of these two opposing forces on welfare in [Section 5.6](#).

## 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 households care about fairness ( $\phi > 0$ ) and make cursed inferences. An increase in technology has the following effects: the 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 proportionally to technology; even though the actual markup increases, the perceived markup decreases and the fairness factor increases.*

The main result from the proposition is that an increase in technology leads to higher output but lower hours worked. The logic mirrors that following a monetary shock. After an increase in technology, households fail to infer that lower prices reflect lower marginal costs. Hence, the perceived markup and thus the elasticity of the demand curves faced by monopolists decrease. The lower elasticity of demand leads monopolists to raise their markups. In general equilibrium,

a higher markup implies a lower real marginal cost and this a lower number of hours worked. Relative to the case without fairness concerns, the positive effect of the increase in technology on output is diminished.

The result that hours worked fall after an increase in technology is illustrated in Figure 6(b). A high realization of technology lowers the downward-sloping curve; therefore, hours worked are lower in equilibrium. The price level is also lower.

The discrepancy between actual and perceived markups is the mirror image of that following a positive monetary shock. Since cursed households fail to appreciate that firms have lower marginal costs due to improved technology, the perceived markup decreases at the same time as the actual markup increases. Households mistakenly believe that transactions have become more fair although firms enjoy higher per-unit real profits as well as higher total real profits.

## 5.5 Pass-Through

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

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

$$\sigma \equiv \frac{d \ln(P)}{d \ln(M_0)} = \left[ 1 + \frac{\alpha}{1 + \xi} \cdot \left( \frac{\varepsilon}{\varepsilon - 1} \cdot \frac{1}{\mu} - 1 \right) \cdot \left( 1 - \frac{1}{\psi + \phi} \right) \right]^{-1}. \quad (16)$$

*When households do not care about fairness ( $\phi = 0$ ), the pass-through equals 1. When households care about fairness ( $\phi > 0$ ), the pass-through is below 1 but above  $(\varepsilon - 1)/\varepsilon$ . The pass-through approaches 1 when the economy approaches perfect competition ( $\varepsilon \rightarrow \infty$ ),*

The fact that the pass-through is less than one when households 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.

Proposition 4 expresses the pass-through as a function of standard macroeconomic parameters, the fairness parameter  $\phi$ , the markup  $\mu$ , and the fairness factor  $\psi$ . Under the additional assumption that we start from an equilibrium in which the actual, perceived, and fair markups coincide, the pass-through can be simplified to depend only on standard macroeconomic parameters and  $\phi$ .

**COROLLARY 1.** *Consider an economy in which households 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*

$$\sigma^s = \left[ 1 + \frac{\alpha}{1+\xi} \cdot \left( \frac{\phi}{1+\phi} \right)^2 \cdot \frac{1}{\varepsilon - \phi/(1+\phi)} \right]^{-1}. \quad (17)$$

When households care about fairness ( $\phi > 0$ ), the pass-through increases with the competitiveness of the economy,  $\varepsilon$ , and decreases with fairness concerns,  $\phi$ .

Following the same steps, we can compute the pass-through of technology shocks into prices, defined as  $d \ln(P)/d \ln(a)$ . Since higher technology means lower marginal costs, the price level declines after an increase in technology and the pass-through is negative. Because  $\ln(a)$  and  $-\ln(M_0)$  enter symmetrically into (12) and (15), the pass-through of technology shocks into prices is simply minus the pass-through of monetary shocks into prices. An implication is that a fall in technology leads to a smaller price increase when the economy is less competitive and when households care more about fairness.<sup>16</sup>

## 5.6 The Effect of Money-Supply Shocks on Welfare

We now turn to the welfare implications of our approach. We define two notions of welfare, one with an emotional component and one without. Since a household's utility is given by (1) and we focus on a symmetric equilibrium, we define *overall welfare* to be

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

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<sup>16</sup>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].

We distinguish this from a second notion of welfare that omits fairness considerations; we define *unemotional welfare* to be

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

Unemotional welfare is obtained by setting  $\psi = 1$  in the overall welfare; it evaluates social welfare as if households' well-being did not depend upon their fairness concerns.

An increase in money supply affects overall welfare in two ways: it has a positive effect by lessening the inefficiency due to monopolistic competition on the goods market; and it has a negative effect by increasing perceived markups, thereby reducing the perceived fairness of transactions and angering households. The following proposition characterizes the response of overall welfare to an increase in money supply, and contrasts it with the response of unemotional welfare.

**PROPOSITION 5.** *When households care about fairness ( $\phi > 0$ ) and make cursed inferences, 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 and unemotional welfare, it reduces overall welfare because households feel unfairly treated when they see higher prices. The increase in unemotional welfare is directly tied to the decrease in overall welfare. The very reason why unemotional welfare increases is that monopolistic markups decrease; this happens because firms know that higher prices upset households and thus make their demand for goods more elastic; households' anger in turn reduces overall welfare. If households were not upset at higher prices (for instance, if they were rationally inferring marginal costs from prices), overall welfare would not decrease, but unemotional welfare would not increase either. The proposition also indicates that an econometrician looking only at a conventional measure of welfare based on 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.

Our model predicts that expansionary monetary policy may be unpopular by upsetting people with higher prices more than gratifying them with higher output. The impact of expansionary monetary policy on overall welfare in our model accord well with the survey responses in [Shiller \[1996\]](#), in which 85% of respondents report that they dislike inflation. In our model as in the

survey, households 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 response of overall welfare to an increase in money supply in our model also sheds light on the evidence provided by [Di Tella, MacCulloch and Oswald \[2001, 2003\]](#) that social well-being is strongly reduced by inflation. Their data comes from the Euro-Barometer survey, which records happiness and life-satisfaction information for nearly 265,000 people in 12 European countries during the 1975–1991 period. They analyze how the residual macroeconomic well-being (the level of well-being not explained by individual characteristics) depends on inflation. They find that in terms of well-being, increasing the inflation rate by 1 percentage point has a large cost, similar to the cost of increasing the unemployment rate by 0.6 percentage point.

While our model may be too simple to draw detailed implications for optimal monetary policy, it does suggest that inflation can lead to first-order cost on welfare through people’s emotional response to higher prices. This welfare cost is very different from the welfare cost of inflation in existing monetary models. For instance, the standard New Keynesian model predicts that the welfare cost of inflation arises from the price dispersion it creates when firms are subject to staggered pricing [[Galí, 2008](#)]. In our model, by contrast, inflation imposes a welfare cost that is psychological. This cost derives from a mistaken belief by households that when prices rise after an increase in money supply, transactions have become less fair. This misperception of unfairness in turn reduces households’ welfare.

## **5.7 Evidence on Comparative-Statics Predictions**

We discuss empirical evidence on the comparative-statics predictions of the model in which households care about fairness and make cursed inferences.

Proposition 2 predicts that in business cycles generated by money-supply shocks, markups are countercyclical: higher money supply leads to lower markup and higher output, and conversely, lower money supply leads to higher markups and lower output. Despite the large volume of empirical work measuring the cyclical variation of markups, no consensus on cyclicity has emerged. [Rotemberg and Woodford \[1999\]](#) provide an exhaustive survey of the empirical evidence. This



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. In our model the marginal and the average cost are proportional; thus, this empirical evidence implies that the marginal cost is countercyclical and hence the markup is procyclical (recall that the markup is the inverse of the marginal cost in a symmetric equilibrium). However, [Rotemberg and Woodford \[1999\]](#) list several reasons why marginal cost may be more procyclical than average cost. For instance, in good times workers earn overtime pay in excess of normal earnings [[Bils, 1987](#)]. Adjusting the fluctuations of the labor share for such corrections, they conclude that the markup is countercyclical. More recently, using the cyclical behavior of inventories, [Bils and Kahn \[2000\]](#) also estimate a countercyclical markup. But recent work by [Nekarda and Ramey \[2013\]](#) using updated methods and data do not find a significant response of the markup to aggregate-demand shocks—if anything, they find that a slightly procyclical markup.

Proposition 3 predicts that an increase in technology leads to higher output but lower hours worked. This prediction is consistent with the empirical findings of several influential papers. [Gali \[1999\]](#) uses a structural vector autoregression to show that higher technology lead to higher output but lower hours worked. The robustness of Gali’s findings is demonstrated by [Francis and Ramey \[2005, 2009\]](#). Last, using a measure of technological change that they have constructed, [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 predicts that in business cycles generated by technology shocks, markups are procyclical under: higher technology leads to higher markups and higher output, and conversely, lower technology leads to lower markups and lower output. [Nekarda and Ramey \[2013\]](#) report empirical evidence consistent with this prediction.

Corollary 1 predicts that the pass-through is smaller in less-competitive economies. Proposition 4 shows that the pass-through even 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 households 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  $\phi$  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

This paper builds a macroeconomic model in which the nonneutrality of money arises from 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.

One advantage of our formulation is that it introduces only one new parameter—the fairness parameter  $\phi$ —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 used to address standard macroeconomic questions. The model could also be used for quantitative analysis: this would only require to calibrate  $\phi$ , which could be achieved by matching the elasticity of output with respect to money supply,  $d \ln(c)/d \ln(M_0)$ , in the model and in the data. Estimating this elasticity in the data would offer an estimate of the pass-through  $\sigma$  because  $\ln(c)/d \ln(M_0) = 1 - \sigma$ . When evaluated around a long-run equilibrium, the pass-through only depends on  $\phi$  and standard parameters, as showed by (17). Hence, the estimate of  $\sigma$  would provide a calibration for  $\phi$ .

Another advantage of our formulation of fairness is that affects general equilibria, even with perfect competition.<sup>17</sup> In that, our approach differs from many models of social preferences that have been developed to capture fairness concerns, such as [Fehr and Schmidt \[1999\]](#) and [Charness and Rabin \[2002\]](#). Our approach is different because in our model, consumers who feel mistreated by firms withhold demand not to punish firms, as in models of social preferences, but instead because they derive less joy from consuming unfairly priced goods. A pivotal difference is that many social preferences, including Fehr-Schmidt and Charness-Rabin preferences, satisfy a *separability* condition, in the sense of [Dufwenberg et al. \[2011\]](#), whereas our preferences do not satisfy this

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<sup>17</sup>Because we focus on a symmetric equilibrium with a common fair markup across goods, we found that fairness played no role in the competitive limit of our model ( $\varepsilon \rightarrow \infty$ ). But with different fair markups for different goods, fairness would matter even in the competitive limit.

condition.<sup>18</sup> [Dufwenberg et al. \[2011\]](#) show that preferences satisfying the separability condition do not affect general equilibria with perfect competition. Our preferences do not satisfy this condition, which is why they would affect the general equilibrium even with perfect competition, and also why they have large effects on the general equilibrium with monopolistic competition. We view both of these approaches as psychologically valid. We agree with [Schmidt \[2011\]](#) that social preferences that satisfy separability may play an important role in organizational settings with agency problems such as moral hazard. We also believe that our preferences may play an important role in macroeconomic general-equilibrium settings.

The main limitation of the model is that our modeling of the labor market is less than ideal: households are monopolistic suppliers of labor setting their wage to maximize utility, so there is no involuntary unemployment and no nominal-wage rigidity. Extending the model to have involuntary unemployment and nominal-wage rigidity would influence the positive and especially the welfare analysis. These extensions would affect the impact of a positive money-supply shock on welfare in at least three ways. First, as [Akerlof, Dickens and Perry \[1996\]](#) proposed, an increase in money supply would erode real wages in the presence of nominal-wage rigidity, thus reducing unemployment and improving economic efficiency beyond the improvement on the goods market studied in this paper. Second, in the presence of involuntary unemployment, our analysis suggests that an increase in money supply may leave an average worker with a stable job—who looks very much like the representative household in the model—worse-off because the anger from higher perceived markups dominates the added utility from higher consumption. However, an increase in money supply might benefit an unemployed worker immensely by improving employment prospects through increased labor demand and higher hours worked. If unemployment is very costly, either because of psychological and health costs or because workers are not well insured against unemployment, then reducing unemployment would have a large positive effect on welfare.<sup>19</sup> Third, people seem to fear that rising prices outpace wages, and that inflation impoverish them. This fear features preeminently in [Shiller \[1996\]](#), and it could add to the cost of inflation if both nominal wages and prices sluggishly adjust to shocks.

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<sup>18</sup>Our preferences violate separability because each consumer's preferences over her own consumption bundles depend implicitly upon price.

<sup>19</sup>It is well documented that the state of unemployment has high psychological and health costs [for example, [Clark and Oswald, 1994](#); [Hawton and Platt, 2000](#); [Sullivan and von Wachter, 2009](#)]. It is also established that consumption drops significantly upon unemployment [for example, [Gruber, 1997](#)].

Another limitation of the model is that, while it features a mild form of price rigidity whereby the price level moves less than proportionally to the money supply, it does not capture the stronger form of price rigidity uncovered in price microdata [for example, [Bils and Klenow, 2004](#); [Nakamura and Steinsson, 2008](#)]. In these data, prices remain fixed for months at a time. However, a natural extension of our model is likely to generate such rigidity. We could introduce a kink into the fairness factor  $\psi$  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 loss aversion by [Tversky and Kahneman \[1991\]](#). We conjecture that such a kink would create an inaction region where firms maintain their prices in the face of small money-supply shocks. This conjecture is informed by the work of [Sibly \[2002\]](#) and [Heidhues and Kőszegi \[2008\]](#), who incorporate loss aversion into models of price competition and find that prices remain unchanged following real cost shocks.<sup>20</sup>

A third limitation of the model is that firms have no ability to signal marginal costs to consumers. Of course, firms facing increased marginal costs in our model have incentive to reveal these costs to cursed consumers. The photos in [Section 2](#) are anecdotal evidence that firms engage in exactly this sort of signaling to fairness-minded consumers. The photos also suggest that consumers make cursed inferences: because rational consumers would infer the worst—low marginal costs—from the absence of signage, firms would always reveal their marginal costs. The fact that some firms conceal their marginal costs indicates not only that consumers make cursed inference but also that firms exploit consumers' error, leading them to underestimate markups systematically. By extending the model to allow for signaling, it would be possible to analyze formally the optimal signaling strategy by firms and the properties of the general equilibrium with signaling.

Last, we explain the nonneutrality of money in a static model. Our model is meant to represent the short-run response to monetary shocks. Of course, the effects of monetary shocks diminish over time, and money is usually thought to be neutral in the long run. We suspect that the dynamic extension of our model in which consumers gradually adjust their perceptions of marginal costs would make exactly this prediction.

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<sup>20</sup>These models define utility purely in real terms and impose rational expectations, so incorporating these approaches directly into a macroeconomic model would not explain the nonneutrality of money.

## Appendix A: Derivations and Proofs

### Solving the Households' Utility-Maximization and Firms' Profit-Maximization Problems.

Taking as given  $\{P_i\}$ ,  $M_{0j}$ , and  $\Pi_j$ , household  $j$  chooses  $\{c_{ij}\}$ ,  $M_j$ ,  $h_j$ , and  $W_j$  to maximize (1) subject to the constraint (2) (Lagrange multiplier  $\mathcal{A}_j$ ) and to the constraint  $h_j = h_j^d(W_j)$  (Lagrange multiplier  $\mathcal{B}_j$ ). 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  $(\psi_i/z_j) \cdot (z_{ij}/z_j)^{-1/\varepsilon} = \mathcal{A}_j \cdot P_i$ , where we used the fact that  $\partial z_j / \partial z_{ij} = (z_{ij}/z_j)^{-1/\varepsilon} di$ . Manipulating these first-order conditions yields

$$\mathcal{A}_j = \frac{1}{\hat{P} \cdot z_j}. \quad (18)$$

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

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

Integrating the consumption of good  $i$  over all households yields the demand (5) for good  $i$ . Next, the first-order condition with respect to  $M_j$  is  $1/(\eta \cdot M_j) = \mathcal{A}_j$ . Combining this condition with (18) yields (6).

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

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

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

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

Due to this property,  $\hat{P}$  is the price index used by households to deflate nominal money balances in

the utility function.

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 (4) subject to the constraint  $c_i = c_i^d(P_i)$  (with Lagrange multiplier  $\mathcal{C}_i$ ) and the constraint (3) (with Lagrange multiplier  $\mathcal{D}_i$ ). The demand curve  $c_i^d(P_i)$  is given by (5).

The first-order conditions with respect to  $h_{ij}$  for all  $j$  are  $W_j = \mathcal{D}_i \cdot a_i \cdot \alpha \cdot h_i^{\alpha-1} \cdot (h_{ij}/h_i)^{-1/\gamma}$ , where we used the fact that  $\partial h_i / \partial h_{ij} = (h_{ij}/h_i)^{-1/\gamma} dj$ . Manipulating these first-order conditions yields

$$\mathcal{D}_i = \frac{W}{a_i \cdot \alpha \cdot h_i^{\alpha-1}}, \quad (19)$$

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 (7) faced by household  $j$ .

Next, the first-order conditions with respect to  $c_i$  and  $P_i$  are  $P_i = \mathcal{C}_i + \mathcal{D}_i$  and  $c_i = -\mathcal{C}_i \cdot dc_i^d / dP_i$ . Combining these conditions with (19) yields (9).

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  $v \cdot h_j^\xi = \mathcal{A}_j \cdot W_j + \mathcal{B}_j$  and  $\mathcal{A}_j \cdot h_j = \mathcal{B}_j \cdot dh_j^d / dW_j$ . Combining these conditions with (18) and (6), and using the fact that  $-(W_j/h_j) \cdot (dh_j^d / dW_j) = \gamma$ , we find that household  $j$  sets its wage as in (8).

**Proof of Proposition 1.** Firms understand that households are rational and therefore able to infer their marginal cost  $MC$ . Rational households understand the pricing strategy of firms, namely that the markup satisfies  $\mu = \mu(\mu^p)$ , where  $\mu(\mu^p)$  is given by (14). For households to infer correct marginal costs, it must be that  $\mu^p = \mu$  in equilibrium. Hence the equilibrium markup  $\mu^*$  satisfies  $\mu^* = \mu(\mu^*)$ . Because households know all of the parameters that enter the function  $\mu(\mu^p)$ , they can indeed determine  $\mu^*$  and, hence, learn  $MC$ .

Since  $\mu = \mu^*$ , equation (15) implies that hours are independent of money supply and technology. Equation (13) implies that the real wage is independent of money supply but proportional to technology. Equation (3) implies that output is independent of money supply but proportional to technology. Equation (12) implies that the price level is proportional to money supply and inversely proportional to technology. By combining the definition of nominal profits, given by (4), the optimal pricing decision of firms, given by (9), and the production constraint, given by (3), we obtain an expression for real profits

$$\frac{\Pi}{P} = c \cdot \left(1 - \frac{\alpha}{\mu}\right). \quad (20)$$

that is independent of money supply but proportional to technology. The only remaining non-trivial 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. Equation (3) implies that  $d\ln(c)/d\ln(h) = \alpha$  and equation (15) 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 implies that  $d\ln(\Pi/P)/d\ln(\mu) = d\ln(c)/d\ln(\mu) + \alpha/(\mu - \alpha)$ . Combining these results, we obtain

$$\frac{d\ln(\Pi/P)}{d\ln(\mu)} = \alpha \cdot \left(\frac{1}{\mu - \alpha} - \frac{1}{1 + \xi}\right). \quad (21)$$

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

**Proof of Proposition 2.** Equation (12) 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. Equations (13) and (3) 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  $\mu^p$  is higher, Lemma 1 tells us that  $\mu = \mu(\mu^p)$  is lower. The response of  $\mu$  determines that of real profits,  $\Pi/P$ . The elasticity (21) of  $\Pi/P$  with respect to  $\mu$  remains valid here. As we have argued, this elasticity is positive when  $\mu < 1 + \alpha$ ; in this case,  $\Pi/P$  is lower.

**Proof of Proposition 3.** Equation (12) implies that a high realization of  $a$  shifts the downward-sloping curve downward in Figure 6(b). Hence,  $P$  and  $h$  are lower in equilibrium. Equation (13)

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  $\sigma$  satisfies (16) so  $\sigma \in (0, 1)$ . Hence,  $d\ln(W/P)/d\ln(a)$  is strictly less than 1 and it could be negative. Equation (15) 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, (6) implies that  $c$  increases but  $c/a$  decreases. Since  $P$  decreases,  $\mu^p$  decreases and  $\psi$  increases. Lemma 1 implies that  $\mu = \mu(\mu^p)$  increases. Since  $c$  increases and  $\mu$  increases, (20) implies that real profits increase. In fact, (20) implies that

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

Since  $\partial \ln(c)/\partial \ln(a)|_{\mu} = 1$ , (20) implies that  $\partial \ln(\Pi/P)/\partial \ln(a)|_{\mu} = 1$ . Furthermore,  $\partial \ln(\Pi/P)/\partial \ln(\mu)|_a$  is given by (21) 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.** Some algebra shows that the price-elasticity of  $\mu(P/MC)$  is

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

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, (15) and (12) imply that  $d\ln(h)/d\ln(\mu) = -1/(1 + \xi)$  and  $d\ln(P)/d\ln(M_0) = 1 - \alpha \cdot d\ln(h)/d\ln(\mu) \cdot d\ln(\mu)/d\ln(P) \cdot d\ln(P)/d\ln(M_0)$ . Combining these results yields (16).

**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: (6) 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



$\alpha$ : equations (3) and (6) 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 (15), which shows that  $(v/\alpha) \cdot h^{1+\xi} = 1/\mu$ , we obtain

$$\frac{du}{d \ln(M_0)} = (1 - \sigma) \cdot \left(1 + \frac{1}{\eta} - \frac{1}{\mu}\right) - \sigma \cdot \left(1 + \frac{1}{\eta}\right) \cdot \left(1 - \frac{1 - \phi}{\psi}\right). \quad (22)$$

We now determine the sign of  $du/d \ln(M_0)$ . Using the expression (16) for the pass-through, 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, (14) 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  $\mu \in (1, \varepsilon/(\varepsilon - 1))$ .

Last, we prove the first statement. We denote unemotional welfare by  $\hat{u}$ . Setting  $\phi = 0$  and

$\psi = 1$  in (22) yields

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

Since  $\sigma \in (0, 1)$ ,  $\mu > 1$ , and  $\eta > 0$ , we find that  $d\hat{u}/d\ln(M_0) > 0$ .

## 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.<sup>21</sup> 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 set freely.<sup>22</sup>

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 numbers of interviews is small; yet, the responses 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

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<sup>21</sup>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](#)].

<sup>22</sup>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](#)].

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.<sup>23</sup> 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). Bakers feel that a price rise would anger and drive away customers.

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<sup>23</sup>The webpage is at <http://www.boulangerie.net/forums/bnweb/prixbaguette.php>.

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