# Using Market Prices as a Guide for Government Intervention*

# (Preliminary and Incomplete)

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**Abstract**

Many policy proposals call for government intervention to be based on the information in market prices of firm securities. Most of these proposals ignore the fact that market prices are endogenous to government intervention. In particular, when the government takes a corrective action based on price, the price might become less informative. We review a few channels by which this may occur, and develop a model that focuses on one such mechanism. We show that the fact that the government learns from the price when taking a corrective action might reduce the incentives of speculators to trade on their information, and hence reduce price informativeness.

## 1 Introduction

During the recent economic crisis, the prospect of government help was repeatedly a major driver of changes in asset prices, both in the US and many other economies. Good

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examples of this phenomenon are provided by market activity in the weeks leading up to the eventual announcement of government support for Fannie and Freddie, for Citigroup, and for General Motors. Moreover, it was widely perceived that government bailouts were often *reactions* to low market prices. In other words, government assistance was both an important *determinant* of asset prices, but may also have been in part *determined* by market prices. Although—unsurprisingly—no government official has publicly declared that government actions were responses to movements in asset prices, evidence for dependency exists for the period before the crisis (see Piazzesi, 2005; Feldman and Schmidt, 2003; Furlong and Williams, 2006; Krainer and Lopez, 2004).

The perceived failure of financial regulation has lead to a surge of recent policy proposals, many of which advocate the explicit use of market prices as a guide for government intervention. Most prominently, Hart and Zingales (2009) propose a mechanism, by which the government will perform a stress test on banks, whose market price deteriorates below a certain level, in order to evaluate whether there is a need for intervention. Such proposals have antecedents in the older proposals of Evanoff and Wall (2004), Herring (2004), and others about market-based bank supervision. These proposals all share the observation that the market prices of financial securities contain a great deal of information that could serve as a useful input into government decision-making.

However, for the most part calls to base government actions on market prices have overlooked a potentially important complication, namely that once the policy is in place, the information content of prices may change. This is the subject of the current paper.

We start by reviewing, in the next section, various mechanisms by which government intervention might reduce the informativeness of market prices. We generally consider government intervention to be corrective, i.e., one that aims to help firms in trouble (perhaps at the expense of those that are doing well). Then, in the next sections, we develop one of these mechanisms, which has not been studied in the literature. Specifically, we think about how market based governmental corrective actions might reduce the trading incentives of speculators and hence the ability of the financial market to aggregate speculators' dispersed information.

We develop a tractable version of a rational-expectations model, where speculators posses heterogeneous information about the fundamentals of an asset and trade on it in a market that is subject to noise/liquidity shocks. We add a government to this model, and assume that it observes the market price, in addition to a privately observed signal, and uses the information to make a decision about a corrective action, as defined above. The informativeness of the price in this model is determined by the trading incentives of speculators, i.e., the aggressiveness with which they trade on their information.

A key determinant of speculators' trading behavior is the uncertainty to which they are exposed. Being risk averse, they trade less when the risk is higher. Given that prices are subject to noise, speculators bear risk when trading and this hampers their trading incentives. In the face of such uncertainty, speculators benefit when the government uses information independent of the price, but correlated with their own signals, to dampen the effect of swings in the fundamental. Consequently, speculators can trade more aggressively on their information, and the equilibrium price is more informative. However, if the government increases its reliance on market prices as a source of information, this benefit is lost, and speculators trade less aggressively resulting in a less informative price.

Consequently, even though it is ex post optimal for a government to apply Bayes rule to extract information from market prices, it is ex ante suboptimal: we show that, for a moderate corrective action, a government would always want to commit to refrain, to some extent, from fully using market prices ex post. Our paper also delivers implications about transparency. We show that the government can increase trading incentives by hiding its information from market participants.

Overall, our paper highlights the importance of endogenizing trading incentives and information aggregation in financial markets when discussing policies of market-based government actions.

# 2 How does government policy affect price informativeness?

As we describe below, there are three distinct mechanisms via which government policy can reduce the informativeness of the price. Two of these mechanisms have been studied in detail in the existing literature. In this section, we provide a concise overview of these three distinct mechanisms. In the next sections, we flesh out the third of these mechanisms, which has not been studied in the literature, and do so in a simple and tractable model that can be easily incorporated into future research.

Suppose that the government is interested in regulating a firm. Absent any government action, the firm's shares have a fundamental value of $\theta$. Neither individual speculators nor the government observe $\theta$ directly, but instead both observe noisy signals of $\theta$—notationally, we write $s_i$ for the signal observed by speculator $i$, and $s_G$ for the signal observed by the government. Speculators care about the expected value of $\theta$ because it determines whether a profitable trading opportunity exists, while the government cares about the expected value of $\theta$ because it affects the action it would like to take. Specifically, given a signal $s_G$ and a price $P$ of the shares, the government's expectation of $\theta$ is $E[\theta|s_G, P]$, and it would like to transfer an amount $T(E[\theta|s_G, P])$ to the firm, where the function $T$ reflects the government's policy objectives.

We next use this simple framework to describe the three mechanisms via which government policy might reduce the informativeness of the price. For the most part, we assume that the government's desired action is *corrective*, in the sense that if the government had full information about $\theta$, then the value net of intervention, $\theta + T(\theta)$, would be less volatile than $\theta$ itself.

## 2.1 Even assuming full information acquisition and full information aggregation, the price may not communicate speculators' information

Governmental corrective actions may reduce speculators' incentives to acquire information, and may reduce how well this information is aggregated into the price. However, even if one assumes that information acquisition is exogenously fixed, and that information aggregation is efficient, it is still possible for government policy to reduce the informativeness of the price. In some ways this is the most surprising case, since by fixing information acquisition and aggregation we are giving the price its best chance of being informative. The first formal mention of this problem of which we are aware is by Bernanke and Woodford (1997). It is analyzed more generally and thoroughly in Bond, Goldstein and Prescott (2010).

In more detail, by efficient aggregation we mean that the price reflects speculators' best guess about the value net of intervention, $\theta + T$, in the sense that

$$P = E\left[\theta + T | \text{vector of all speculators' signals } s_i\right].$$

To see why the price may fail to convey information to the government even with efficient aggregation, consider the special case in which the government's signal $s_G$ is pure noise; and there are an infinite number of speculators receiving independent signals of $\theta$, so that together these signals reveal the true value of $\theta$. Suppose, moreover, that value net of intervention under full government information, $\theta + T(\theta)$, is non-monotone in $\theta$.

In this case, if the government ignored the price in making its intervention decision, it would always make the same decision, since it has no information. Consequently, the price would fully reveal the fundamental $\theta$.

In contrast, if the government tries to make use of the price, one reaches the dramatic conclusion that no equilibrium can exist. The proof is straightforward. On the one hand, the price cannot fully reveal the fundamental $\theta$, since if it did, the price would be $\theta + T(\theta)$, which is non-monotone in $\theta$—and hence does not fully reveal $\theta$. On the other hand, if the price does not fully reveal $\theta$, there must exist at least two realizations of $\theta$ associated with the same price—but this is impossible, since the government must make the same intervention decision at both fundamentals.

Bond, Goldstein and Prescott (2010) provide a more general analysis, allowing the government to have private information about $\theta$. They show that there are generally three cases. When the government's information is relatively imprecise, there is no rational-expectations equilibrium, which, they show can be interpreted as a market breakdown. The limit result described above is a special case of this more general result. When the government's information is relatively precise, there is a unique equilibrium, where the market reveals the signal to the government, and the government takes its desired action. Finally, when the precision of the government's information is in between, there are multiple equilibria, exhibiting either perfect information revelation or partial information revelation.

## 2.2 Governmental corrective action may reduce information acquisition

The idea here is related to papers by Dow, Goldstein and Guembel (2007) and Lehar, Seppi and Strobl (2007). Recall above that one way to think about the objective of the government in taking a corrective action is to reduce the volatility of cash flows, i.e., to take action $T$ as a function of the fundamental $\theta$, such that the cash flow after intervention $\theta + T(\theta)$ would be less volatile than the cash flow before intervention $\theta$.

When choosing whether to produce information about $\theta$, or how much to produce, speculators have to weigh the cost of information production against the benefit. The benefit comes from the trading profit which is a function of the uncertainty about the firm's final cash flows. By taking corrective actions, the government reduces the volatility, and hence the uncertainty about the firm's future cash flow. This reduces potential trading profits, and hence might lead to less information production. Eventually, the price becomes less informative about fundamentals.

### 2.3 Governmental corrective action may reduce information aggregation

The third mechanism to consider is one where market-based corrective actions may reduce the extent to which the price aggregates speculators' information. This mechanism is the focus of the current paper. To clearly distinguish this mechanism from the other two described, we will take speculators' signal accuracies as exogenously fixed (so that, trivially, information acquisition is unaffected), and the government's desired intervention to be such that $\theta + T(\theta)$ is monotonically increasing (so that if prices efficiently aggregated information, they would perfectly reveal the fundamental $\theta$). This will generate a very tractable framework that can be used in future research.[1]

## 3 The model

As noted, we want to use the simplest and most standard framework possible to show how government policy can affect information aggregation. Accordingly, we build a model in the style of Grossman and Stiglitz (1980). In this framework, informed speculators trade on heterogenous pieces of information about the fundamental value of an asset in a market that is subject to shocks unrelated to fundamental value; the literature attributes these shocks to the actions of "noise" or "liquidity" traders. The price then reflects fundamental value as well as noise, and the degree to which each one is reflected depends on the trading incentives of the informed speculators.

We focus on one firm, whose stock is traded in the financial market. In $t = 0$, speculators obtain signals about the cash flow that will be generated from the firm's operations, and trade on it. In $t = 1$, the government, who learns information about the expected cash flow

[1] Goldstein and Guembel (2008) study the effect of learning from the price on trading incentives, but in a model with one speculator, and focusing on the incentive to manipulate the price in such a context.

from the price of the stock, makes a decision about a corrective action. In $t = 2$, cash flows are realized and speculators get paid.

### 3.1 Cash flows and government intervention

Absent government intervention, the firm generates cash flow of $\theta$. We refer to $\theta$ as the fundamental of the firm. It is distributed normally with mean $\overline{\theta}$ and standard deviation $\sigma_\theta$. We denote the precision of prior information as $\tau_\theta \equiv \frac{1}{\sigma_\theta^2}$. The government's objective is to provide resources to the firm if the firm is expected to have weak cash flow and take resources from it if it is expected to have strong cash flow. At the background, this can be motivated by a desire to provide transfers to firms in trouble. Such transfers have to be financed by taking resources from stronger firms.

For tractability, we work with a linear policy rule, such that the transfer $T$ provided to the firm is given by:

$$T \equiv \lambda \left( \widehat{\theta} - E\left[\theta | I_G\right] \right). \tag{1}$$

Here, $E\left[\theta | I_G\right]$ is the expected cash flow of the firm given the information available to the government $I_G$. We will elaborate below about the sources of government information. $\widehat{\theta}$ is a threshold cash flow, such that firms with a lower cash flow receive a transfer from the government, while firms with a higher cash flow get taxed by the government. The parameter $\lambda$ is positive, reflecting that the government takes a corrective action, helping firms with low fundamentals at the expense of those with high fundamentals. The linear rule helps us maintain the linear solution that is always used in this literature, and thus is important for the tractability of the model.

## 3.2 Information and trading

There is a continuum $[0,1]$ of speculators in the financial market with CARA utility:

$$u(c) = -e^{-\alpha c}, \tag{2}$$

where $c$ denotes consumption and $\alpha$ is the absolute risk aversion coefficient. Each speculator $i$ receives a noisy signal about the fundamental:

$$s_i = \theta + \varepsilon_i, \tag{3}$$

where the noise term $\varepsilon_i$ is i.i.d. across speculators. It is drawn from a normal distribution with mean 0 and standard deviation $\sigma_\varepsilon$. We use $\tau_\varepsilon \equiv \frac{1}{\sigma_\varepsilon^2}$ to denote the precision of speculators' signals.

Each speculator chooses a quantity to trade $x_i$ to maximize his expected utility given his private signal $s_i$ and the price $P$ that is set in the market for the firm's stock:

$$x_i(s_i, P) = \arg\max E\left[-e^{-\alpha x_i(\theta+T-P)} | s_i, P\right]. \tag{4}$$

Here, trading a quantity $x_i$, the speculator will have an overall wealth of $x_i \cdot (\theta + T - P)$, where $\theta + T$ is the cash flow from the security after intervention, and $P$ is the price paid for it. The speculator's information consists of his private signal $s_i$ and the market price $P$.

In addition to the informed trading by speculators, there is a noisy supply shock, $-Z$, which is distributed normally with mean 0 and standard deviation $\sigma_z$. We again use the notation $\tau_z \equiv \frac{1}{\sigma_z^2}$. In equilibrium, the market clears and so:

$$\int x_i(s_i, P)\, di = -Z. \tag{5}$$

The government's information $I_G$ consists of two components. First, the government observes the price $P$, which provides a noisy signal of the fundamental $\theta$. Second, the government observes a private signal $s_G$ of the fundamental:

$$s_G = \theta + \varepsilon_G, \tag{6}$$

where the noise term $\varepsilon_G$ is drawn from a normal distribution with mean 0 and standard deviation $\sigma_G$. We use $\tau_G \equiv \frac{1}{\sigma_G^2}$ to denote the precision of the government's signal. The government then sets $T$ based on the rule in (1) using its two pieces of information $P$ and $s_G$.

# 4 Analysis

An equilibrium consists of a mapping from signal realizations and the supply shock $Z$ to price $P$, and individual demands $x_i(s_i, P)$, such that individual speculator demands maximize utility given $s_i$ and $P$ (according to (4)) and such that the market clearing condition (5) holds. In addition, here the government choice of $T$ is optimally based on its signal $s_G$ and the price $P$, as in (1).

As is standard in almost all the literature, we focus on linear equilibria. In a linear equilibrium, individual demand $x_i(s_i, P)$ is a linear function of the signal $s_i$ and the price $P$, the government's intervention is a linear function of the signal $s_G$ and the price $P$, and the price $P$ is a linear function of the fundamental $\theta$ and the supply shock $-Z$. (Note that, given linearity, $P$ depends only on the average realization of individuals' signals, i.e., on the fundamental $\theta$.)

Proposition 1 below formally establishes the existence of a linear equilibrium. In the main text, we provide a less formal derivation focusing on our main object of interest, namely the informativeness of the equilibrium price. This is measured by the ratio:

$$\rho \equiv \frac{\frac{\partial P}{\partial \theta}}{\frac{\partial P}{\partial Z}}.$$

Intuitively, the price of the security is affected by both changes in the fundamental $\theta$ and changes in the noise variable $Z$. The informativeness of the price about the fundamental can be summarized by the ratio between the effect of the fundamental on the price and the effect of noise on the price.

In a linear equilibrium, and given normality of the fundamental $\theta$ and the supply shock $-Z$, the price $P$ is itself normal. Consequently, given normality of the error term $\varepsilon_G$, the government's posterior of the fundamental $\theta$ is normal. Moreover, the government's estimate of the fundamental is linear in its own signal, $s_G = \theta + \varepsilon_G$, and in the price $P$; that is,

$$E\left[\theta | s_G, P\right] = w s_G + K_1 P + K_0,$$

where $w$, $K_0$ and $K_1$ are constants. In particular, $w$ is the weight the government puts on its own signal in estimating the fundamental. By the standard application of Bayes' rule to normal distributions it is given by:

$$w = \frac{\tau_G}{\tau_\theta + \rho^2 \tau_z + \tau_G}. \tag{7}$$

Intuitively, the weight that the government puts on its own signal is the precision of this signal ($\tau_G$) divided by the sum of precisions of the government's signal, the prior information ($\tau_\theta$) and the price ($\rho^2 \tau_z$). The precision of the price $\rho^2 \tau_z$ is a function of how much price moves with fundamentals relative to how much it moves with noise and the amount of variance in noise. As one would expect, the government puts more weight on its own signal when it is precise ($\tau_G$ high) and less when the price is informative ($\rho$ high). We sometimes write $w(\rho)$ to emphasize the dependence of $w$ on the informativeness $\rho$ of the price. Given the policy rule (1), the intervention is

$$T\left(s_G, P\right) = \lambda \hat{\theta} - \lambda w \cdot \left(\theta + \varepsilon_G\right) - \lambda K_1 P - \lambda K_0. \tag{8}$$

Similar to the government, each speculator assigns a normal posterior (conditional on his own signal $s_i$ and price $P$) to the fundamental $\theta$. Moreover, from (8) each speculator also assigns a normal posterior to the size of the intervention $T$. Consequently, the well known expression for a CARA individual's demand for a normally distributed stock applies,

$$x_i(s_i, P) = \frac{E[\theta + T|s_i, P] - P}{\alpha var[\theta + T|s_i, P]}. \tag{9}$$

Thus, the amount traded is the difference between the expected value of the security (fundamental + intervention) and the price, divided by the variance of the expected value. Intuitively, speculators want to trade more when they expect a higher gap between the value of the security and the price, but, due to risk aversion, this tendency is reduced by the variance in expected security value.

To characterize the equilibrium informativeness of the stock price, consider a simultaneous shock of $\delta \frac{\partial P}{\partial Z}$ to the fundamental $\theta$ and a shock of $-\delta \frac{\partial P}{\partial \theta}$ to the supply $Z$. By construction, this shock leaves the price $P$ unchanged. Moreover, the market clearing condition (5) must hold for all realizations of $\theta$ and $Z$. Consequently,

$$\delta \frac{\partial P}{\partial Z} \frac{\partial}{\partial \theta} \int x_i(s_i, P)\, di = \delta \frac{\partial P}{\partial \theta}.$$

Substituting in (8) and (9) yields equilibrium price informativeness

$$\rho \equiv \frac{\frac{\partial P}{\partial \theta}}{\frac{\partial P}{\partial Z}} = \frac{1}{\alpha} \frac{\frac{\partial}{\partial s_i} E[\theta + T|s_i, P]}{var[\theta + T|s_i, P]} = \frac{1}{\alpha} \frac{(1 - \lambda w) \frac{\partial}{\partial s_i} E[\theta|s_i, P]}{(1 - \lambda w)^2 var[\theta|s_i, P] + (\lambda w)^2 \tau_G^{-1}}, \tag{10}$$

where the reader should recall that, by (7), $w$ is itself a function of $\rho$.

Here, the informativeness of the price is essentially determined by how much speculators trade on their information about $\theta$. As explained above, this is determined by two factors: the relation between the information and the value of the asset, which appears in the numerator, and the variance in the value of the asset, which appears in the denominator. Regarding the first one, we see in the numerator that a \$1 change in expected fundamental changes expected value by $(1 - \lambda w)$, due to the expected government intervention. The variance of the expected value, which appears in the denominator, is a function of two components: the expected variance of the fundamental $\theta$ and the variance of the noise in government information. Depending on the strength of the corrective action $\lambda$ and the weight that the government puts on its own signal $w$, these two components determine the risk in trading for speculators.

**Proposition 1** *For $\lambda \leq 1$, a linear equilibrium exists. Equilibrium price informativeness $\rho$ satisfies (10). For any $\lambda$ sufficiently close to* 0*, there is a unique*[2] *linear equilibrium.*

# 5 Government policy and price informativeness

Our main interest in this paper is on how the government's decision to use prices as a basis for intervention affects the informativeness of the equilibrium price. As a benchmark, we first characterize the informativeness of the price for the case in which the government *completely ignores the price* in making its intervention decision. (We will consider below whether or not it is in the government's interest to do so.)

Equilibrium price informativeness if the government ignores the price in making its intervention decision is given by (10) with $w_0 = \frac{\tau_G}{\tau_\theta + \tau_G}$. Here, $w_0$ is the weight that the government puts on its own signal when it ignores market price (and only considers its signal and prior information). From (7), and just as one would expect, when the government uses the price as a basis of its estimate of the fundamental $\theta$, it places less weight on its own signal, i.e., $w(\rho) < w_0$.

To gain intuition on how price informativeness is affected by the government using the price in policy decisions, let us inspect the expression for $\rho$ in (10) more closely. We can see that $w$ enters the expression three times. First, a high $w$ reduces the expected change

[2] We have neither been able to establish uniqueness for arbitrary $\lambda$, nor find an example of nonuniqueness.

in firm value following an increase in signal $s_i$ about the fundamental (this is captured by $(1-\lambda w)\frac{\partial}{\partial s_i}E[\theta|s_i,P]$ in the numerator of the expression). This reduces the incentive to trade and hence price informativeness. The intuition is that, conditional on the price, the government's action is more correlated with speculators' signals when it places more weight on its private information (which is, of course, correlated with speculators' information). Since the government's action is corrective it goes against the direction of the signal and reduces the expected change in firm value. Conditioning on the price here is important, as speculators do not trade on the information in the price which is publicly known. They only trade on their private information and care how it is related to the government's action and hence to firm value.

The other two effects of $w$ on price informativeness are via the variance in the denominator of (10). In general, recall that a high variance reduces the incentive of speculators to trade on their information, and thus reduces price informativeness. A high $w$ reduces fundamental variance (captured by $(1-\lambda w)^2 var[\theta|s_i,P]$) for speculators, as it implies that, conditional on the price, speculators' signals will be more correlated with a corrective government action. On the other hand, a high $w$ increases variance from the noise in the government's signal (captured by $(\lambda w)^2 \tau_G^{-1}$), as it implies that the government is putting more weight on this signal and thus its action – and ultimately firm value – are more exposed to this noise.

The overall effect of the fact that the government is using the information in the price on price informativeness is determined by the sum of the above three forces. Our formal results in Proposition 2 focus on the case of a small $\lambda$. For this, it is useful to consider the following approximation of (10) for small values of $\lambda$,

$$\rho = \frac{1}{\alpha}\frac{1-\lambda w}{1-2\lambda w}\frac{\frac{\partial}{\partial s_i}E[\theta|s_i,P]}{var[\theta|s_i,P]}. \tag{11}$$

The final term equals $\tau_\varepsilon$. When $\lambda$ is positive—that is, when the government's policy is corrective—the term $\frac{1-\lambda w}{1-2\lambda w}$ is increasing in $w$. This implies that the use of the information in the price by the government reduces the quality of this information. Essentially, for a small $\lambda$, speculators are exposed to substantial fundamental uncertainty when they trade on their private information, and thus the effect of reducing this uncertainty when the government relies more on its private information and less on the price becomes the dominant effect. Speculators like the fact that the government "diversifies" their uncertainty by using information that is uncorrelated with the price; hence they trade more strongly, leading to an increase in price informativeness. Note that the opposite is true if instead $\lambda$ is negative, so that the government's policy amplifies the fundamental $\theta$. Consequently, we obtain (the appendix contains a formal proof):

**Proposition 2** *For mild corrective actions ($\lambda$ small and positive) price informativeness is reduced when the government uses the price as a basis of policy. In contrast, for amplifying actions ($\lambda$ negative) price informativeness is increased.*

Proposition 2 suggests that the government faces a trade-off. Ex post, using the price allows it to make a better decision. However, doing so decreases the informativeness of the price. The optimal balance between these two effects is hard to determine; in particular, it does not necessarily follow that the government should go to the extreme of completely ignoring the stock price. However, the following "local deviation" result follows easily from Proposition 2:

**Proposition 3** *Consider a mild corrective action ($\lambda$ small and positive), and let $\rho$ be the equilibrium price informativeness if the government uses the price in an ex post optimal way. Then there exists $\tilde{w} > w(\rho)$ such that the government would do better by ex ante committing to place weight $\tilde{w}$ on its own signal.*

The proposition implies that for mild corrective actions the government can be better off by committing ex-ante to put lower weight on market information than is ex-post efficient. Technically, making this statement requires a fully-specified objective function for the government. Hence, the result will be true for the objective functions, for which the government's policy rule constitutes the best response. The idea is that the loss in ex-post efficiency from deviating from the optimal ex-post weight on market information is a second-order effect, while the increase in price informativeness is a first-order effect.

Propositions 2 and 3 are both predicated on corrective actions being mild, i.e., on $\lambda$ being small and positive. The reason should be clear from (10). If instead $\lambda$ is large and positive, the dominant factor determining a speculator's residual uncertainty about $\theta + T$ is the government's error term $\varepsilon_G$. In this case, if the government puts more weight on its own signal $s_G$ by putting less weight the price, it only increases a speculator's residual uncertainty, and consequently, it reduces equilibrium price informativeness.

# 6 Transparency

Governments are regularly criticized for a lack of transparency about their intentions. However, our results suggest that preserving some opacity about future interventions may benefit the government by increasing price informativeness. The formal result can be stated as follows.

**Proposition 4** *For mild corrective actions, transparency reduces equilibrium price informativeness.*

In our model, transparency corresponds to whether or not the government publicly announces its own information $s_G$. In this case, conditional on the price $P$, speculators know what the government's intervention $T$ will be. Then, from (10), we know that $\rho = \frac{1}{\alpha}\frac{\frac{\partial}{\partial s_i}E[\theta+T|s_i,P]}{var[\theta+T|s_i,P]}$, and so given no uncertainty about $T$, $\rho = \frac{1}{\alpha}\frac{\frac{\partial}{\partial s_i}E[\theta|s_i,P]}{var[\theta|s_i,P]} = \tau_\varepsilon/\alpha$.[3] Comparing this with the expression in 11 for small $\lambda$, we see that transparency reduces price informativeness in this case.

[3] Note that this is the same as the equilibrium price informativeness in the standard model with no government action, i.e., $\lambda = 0$.

The intuition is related to that in Proposition 2. For moderate corrective actions, speculators like the reduction in uncertainty induced by the government taking an action that is correlated with their private information. This effect is lost when the government reveals its signal, as then the government's signal is already reflected in the price and, conditional on the price, is not correlated anymore with speculators' signals.

# 7 Conclusion

Our paper analyzes how market-based corrective government policy affects the trading incentives of risk-averse speculators in a rational-expectations model of financial markets. We show that when the government takes a moderate corrective action, basing this action on the market price creates more trading risks for speculators. This harms their trading incentives, and hence the ability of the financial market to aggregate information and the informativeness of the price as a signal for government policy.

The conclusion is that using market prices as an input for policy might not come for free and might damage the informational content of market prices themselves. Hence, there may be room to limit the reliance on market prices in order to increase their informational content. Also, counter to common belief, transparency by the government might be a bad idea in that it might reduce trading incentives.

Our insights are related to those developed in other papers reviewed in Section 2. While those papers emphasize the problems associated with information production and the inference from a non-monotone pricing function, the model in the current paper highlights problems with trading incentives and information aggregation.

# 8 Appendix

**Proof of Proposition 1:** We show that it is possible to choose constants $p_0$, $\rho$ and $p_Z$ such that $P = p_0 + \rho p_Z \theta + p_Z Z$ is an equilibrium.

Note that $P$ is normally distributed (given the normality of $\theta$ and $Z$). Moreover, the information content of $P$ is the same as the information content of

$$\tilde{P} \equiv \frac{1}{\rho p_Z} (P - p_0) = \theta + \rho^{-1} Z.$$

Hence the government's estimate of the fundamental, conditional on the price and its own signal $s_G$, is

$$E[\theta | s_G, P] = \frac{\tau_\theta \bar{\theta} + \rho^2 \tau_Z \tilde{P} + \tau_G s_G}{T_G(\rho)},$$

where $T_G(\rho) \equiv \tau_\theta + \rho^2 \tau_z + \tau_G$ is the precision of the government's estimate of $\theta$. So the government's intervention is

$$T = \lambda \left( \widehat{\theta} - \frac{\tau_\theta \bar{\theta} + \rho^2 \tau_Z \tilde{P} + \tau_G s_G}{T_G(\rho)} \right) = \lambda \left( \widehat{\theta} - \frac{\tau_\theta \bar{\theta} + \rho^2 \tau_Z \tilde{P}}{T_G(\rho)} - w(\rho)\,\theta - w(\rho)\,\varepsilon_G \right),$$

where $w(\rho) \equiv \frac{\tau_G}{T_G(\rho)}$ is the weight the government puts on its own signal in estimating $\theta$.

Conditional on seeing signal $s_i$ and price $P$, a speculator's conditional expectation of the government signal $s_G$ is

$$E[s_G | s_i, P] = E[\theta | s_i, P] = \frac{\tau_\theta \bar{\theta} + \rho^2 \tau_Z \tilde{P} + \tau_\varepsilon s_i}{T_\varepsilon(\rho)},$$

where $T_\varepsilon(\rho) \equiv \tau_\theta + \rho^2 \tau_z + \tau_\varepsilon$ is the precision of the investor's estimate of $\theta$. Hence an investor's estimate of the cash flow net of intervention, $\theta + T$, is

$$E[\theta + T | s_i, P] = \lambda \left( \hat{\theta} - \frac{\tau_\theta \bar{\theta} + \rho^2 \tau_Z \tilde{P}}{T_G(\rho)} \right) + (1 - \lambda w(\rho))\, E[\theta | s_i, P],$$

and the precision of his estimate of $\theta + T$ is

$$\left( (1 - \lambda w(\rho))^2 T_\varepsilon(\rho)^{-1} + (\lambda w(\rho))^2 \tau_G^{-1} \right)^{-1}.$$

From (9), total demand by all speculators is

$$\int x_i(s_i, P)\, di = \frac{1}{\alpha} \frac{\lambda \left( \hat{\theta} - \frac{\tau_\theta \bar{\theta} + \rho^2 \tau_Z \tilde{P}}{T_G(\rho)} \right) + (1 - \lambda w(\rho)) \frac{\tau_\theta \bar{\theta} + \rho^2 \tau_Z \tilde{P} + \tau_\varepsilon \theta}{T_\varepsilon(\rho)} - P}{(1 - \lambda w(\rho))^2 T_\varepsilon(\rho)^{-1} + (\lambda w(\rho))^2 \tau_G^{-1}}.$$

This is a linear expression in the random variables $\theta$ and $Z$. Consequently, market clearing (5) is satisfied for all $\theta$ and $Z$ if and only if the coefficients on $\theta$ and $Z$ both equal zero (the price intercept $p_0$ is then chosen to make sure total speculator demand equals supply $Z$), i.e.,

$$-\lambda \frac{\rho^2 \tau_Z}{T_G(\rho)} + (1 - \lambda w(\rho)) \left( \frac{\rho^2 \tau_Z}{T_\varepsilon(\rho)} + \frac{\tau_\varepsilon}{T_\varepsilon(\rho)} \right) - \rho p_Z = 0 \tag{12}$$

and

$$-\rho^{-1} \lambda \frac{\rho^2 \tau_Z}{T_G(\rho)} + \rho^{-1} (1 - \lambda w(\rho)) \frac{\rho^2 \tau_Z}{T_\varepsilon(\rho)} - p_Z + \alpha \left( (1 - \lambda w(\rho))^2 T_\varepsilon(\rho)^{-1} + (\lambda w(\rho))^2 \tau_G^{-1} \right) = 0. \tag{13}$$

Subtracting $\rho$ times (13) from (12) yields

$$(1 - \lambda w(\rho)) \frac{\tau_\varepsilon}{T_\varepsilon(\rho)} - \alpha \rho \left( (1 - \lambda w(\rho))^2 T_\varepsilon(\rho)^{-1} + (\lambda w(\rho))^2 \tau_G^{-1} \right) = 0, \tag{14}$$

an equation of $\rho$ only (observe that this matches equation (10) in the main text). Note that the pair of equations (12) and (13) hold if and only if the pair (12) and (14) hold. So to complete the proof of equilibrium existence, it suffices to show that there exists $\rho$ solving (14), since $p_Z$ can then be chosen freely to solve (12).

Since $(1 - \lambda w)^2 = 1 - \lambda w - \lambda w (1 - \lambda w)$, equation (14) can be rewritten as

$$(\alpha \rho - \tau_\varepsilon)(1 - \lambda w(\rho)) = \alpha \rho \left( \lambda w(\rho)(1 - \lambda w(\rho)) - (\lambda w(\rho))^2 \tau_G^{-1} T_\varepsilon(\rho) \right),$$

and so as

$$1 - \frac{\tau_\varepsilon}{\alpha \rho} - \lambda w(\rho) + \frac{\lambda^2 w(\rho)^2}{1 - \lambda w(\rho)} \frac{T_\varepsilon(\rho)}{\tau_G} = 0$$

and finally as

$$1-\frac{\tau_{\varepsilon}}{\alpha\rho}-\lambda w(\rho)+\frac{\lambda^{2}w(\rho)}{1-\lambda w(\rho)}\frac{T_{\varepsilon}(\rho)}{T_{G}(\rho)}=0. \tag{15}$$

Note that $w$ is decreasing in $\rho$, with $w<1$ for $\rho=0$, and $w\to 0$ as $\rho\to\infty$. So the left hand side of (15) is negative for all $\rho$ sufficiently small, and is positive for all $\rho$ sufficiently large. By continuity, it follows that (14) has a solution, completing the proof of equilibrium existence.

For uniqueness, first note that at $\lambda=0$, the unique solution of (15) is $\rho=\frac{\tau_{\varepsilon}}{\alpha}$, and moreover, the derivative of the left hand side is strictly positive at $\rho=\frac{\tau_{\varepsilon}}{\alpha}$. Uniqueness for $\lambda$ sufficiently small then follows from the uniform convergence (as $\lambda\to 0$) of $-\lambda w+\frac{\lambda^{2}w}{1-\lambda w}\frac{T_{\varepsilon}}{T_{G}}$ to 0. ■

**Proof of Proposition 2:** Let $F(\rho,w)=1-\frac{\tau_{\varepsilon}}{\alpha\rho}-\lambda w+\frac{(\lambda w)^{2}}{1-\lambda w}\tau_{G}^{-1}T_{\varepsilon}(\rho)$, where we write $T_{\varepsilon}(\rho)$ to make clear the dependence of $T_{\varepsilon}$ on $\rho$. Observe that $F_{\rho}>0$ and $F_{w}=-\lambda+\lambda^{2}\tau_{G}^{-1}T_{\varepsilon}(\rho)\frac{2w-\lambda w^{2}}{1-\lambda w}$. The equilibrium condition is $F(\rho,w(\rho))=0$. Given an exogenous shift in $w$, the value of $\rho$ changes according to

$$\frac{d\rho}{dw}=-\frac{F_{w}(\rho,w(\rho))}{F_{\rho}(\rho,w(\rho))}.$$

For $\lambda$ small and positive, $F_{w}(\rho,w)<0$ for all $w\in[0,1]$, implying $\frac{d\rho}{dw}>0$. For $\lambda$ negative, $F_{w}>0$, implying $\frac{d\rho}{dw}<0$. ■

**Proof of Proposition 3:** Immediate from proof of Proposition 2. ■

**Proof of Proposition 4:** See the text following the Proposition. ■

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