Central bank transparency and the crowding out of private information in financial markets

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Abstract

We use an asset market model based on Diamond (1985) to demonstrate that increased central bank transparency may lead to crowding out of costly private information, which can result in a market that is less able to predict monetary policy. Consequently, for intermediate levels of public information precision, it is optimal for the central bank to actually disclose less than it knows. We show that such crowding out can occur, even in the likely scenario that public information is more precise than private information, under the plausible assumption that traders are nearly risk-neutral. Central banks should be aware of possible adverse effects of transparency and take note if market participants reduce investment in information.

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1 Introduction

Bernanke (2004) states, that "clear communication helps to increase the near-term predictability of [central bank] rate decisions, which reduces risk and volatility in financial markets and allows for smoother adjustment of the economy to rate changes." This statement is generally supported by empirical research on the impact of communication on the predictability of monetary policy.

We, however, tell a cautionary tale of the potential adverse effects of central bank communication. We follow Diamond (1985) and use a rational expectations asset market model with a public signal and costly private information acquisition. An increasingly precise public signal is found to improve predictability only as long as it does not crowd out private information. Once this happens the market price becomes less informative. We find that crowding out occurs for plausible parameters. Unlike the work of Morris and Shin (2002), which is also critical of transparency, our results do not rely on higher order expectations.

2 Literature review

Standard theory hypothesizes that a switch to more transparent communication by central banks should improve the predictability of monetary policy in financial markets. Generally, the empirical literature supports such a positive link between transparency and predictability. Most of the empirical work in the field shares a common setup in selecting a watershed communication reform such as the introduction of FOMC interest rate announcements in the U.S. in 1994 and the start of inflation targeting in some other countries. Subsequently, two different approaches are dominantly employed to test the difference in interest rate predictability before and afterwards.

The first approach examines market movements after an interest rate announcement. The sharper the subsequent price move, the less the market was evidently able to predict the outcome. Examples are Swanson (2006), Murdzhev and Tomlanjanovich (2006) and Coppel and Connolly (2003).

The second approach extracts market expectations of monetary policy from the yield curve or futures contracts and then examines their accuracy. See, for instance, Rafferty and Tomljanovich (2002), Lange, Sack and Whitesell (2003), Lildholdt and Wetherilt (2004), Tomljanovich (2004), Swanson (2006), Carlson, Craig, Higgins and Melick (2006) and Kwan (2007).

Morris and Shin (2002) develop a theoretical model with higher order expectations to show that a public signal can coordinate prices away from fundamentals. In reply, Svensson (2005) argues that this conclusion is only valid for the unlikely situation where public signals are less precise than private information. Demertzis and Hoeberichts (2007), on the other hand, add costly information acquisition to the Morris and Shin model and find that this strengthens the original result. Dale, Orphanides and Osterholm (2008) demonstrate that the private sector may become overly reliant on central bank information if it overestimates its precision.

In this paper, we extend this strand of the theoretical literature, using a model based on Diamond (1985). We show that even without higher order ex-

pectations and with full knowledge of the precision of the public and private signal, central bank communication can have an adverse impact on predictability.

3 The model

Rational expectations asset market models are widely used in the finance literature to provide a general model of a financial market. A core feature is that traders use market prices to learn about other traders' private information. Grossman and Stiglitz (1980) establish there is no point in trading on private information, if prices are perfectly informative. Consequently, there is no incentive to bring information into the market in the first place. They resolve the paradox by introducing supply uncertainty, which obfuscates private information. Hellwig (1980) adds diversely informed traders to the model to illustrate how the market acts as an aggregator of diffuse private information.

Here, we briefly introduce the Diamond (1985) rational expectations model. Tildes represent normally distributed random variables. To keep the model tractable we assume that traders have an exponential utility function with constant absolute risk tolerance r. The number of agents is infinite, so individual traders are atomistic and cannot observe their impact on prices. Agents are endowed with a risky and a riskless asset. The random average supply of the former is denoted by $\widetilde{X}$, with variance V. A unit of the risky asset provides a random payout of $\widetilde{u}$ after a single period. All agents know prior to trading that the average payout on the risky asset is Y with a precision of h. Each trader also receives a unique private noisy signal of $\widetilde{u}$ with a precision of s. Before the payout of the assets is realized, trading is allowed.

Following Verrecchia (1982), Diamond (1985) adds costly private information acquisition. Traders only receive a private signal if they pay a fixed amount c. They make this decision based on the expected utility of becoming informed. Diamond (1985) derives the equilibrium fraction of informed traders, λ, and shows that it rises as the private signal becomes either cheaper or more precise, but declines as prior information improves or prices become more informative. Finally, Diamond (1985) also adds a public signal of $\widetilde{u}$ to the model. It is released before the purchase of private information and has an error, $\widetilde{\zeta}$, with a precision of Δ. Diamond shows that the public signal has essentially the same role as prior information. To reflect this we refer to prior information and the public signal together as "public information".

Following the analysis of Diamond (1985), the equilibrium market price of the risky asset can be represented by the following relationship:

$$(1)\ \widetilde{P} = \frac{h}{h+\Delta+\lambda s+\frac{(r\lambda s)^2}{V}}Y + \frac{\Delta}{h+\Delta+\lambda s+\frac{(r\lambda s)^2}{V}}\left(\widetilde{u}+\widetilde{\zeta}\right) + \frac{\left(\lambda s+\frac{(r\lambda s)^2}{V}\right)}{h+\Delta+\lambda s+\frac{(r\lambda s)^2}{V}}\widetilde{u} - \frac{\left(\frac{1}{r}+\frac{r\lambda s}{V}\right)}{h+\Delta+\lambda s+\frac{(r\lambda s)^2}{V}}\widetilde{X}$$

Where

P	price
Y	average (unconditionally expected) payout, $E(\widetilde{u})$
$\widetilde{\zeta}$	error of public signal
$\widetilde{u}$	payout of the risky asset, $\mathrm{N}(Y, \frac{1}{h})$
X	average supply per trader, $\mathrm{N}(0, V)$
h	precision of payout / prior information, $h > 0$
Δ	precision of public signal, $\Delta > 0$
s	precision of private signal, $s > 0$
V	variance of average supply, $V > 0$
r	risk tolerance (inverse of risk aversion), $r > 0$
λ	fraction of informed traders

$$(2)\quad \begin{array}{lll} \lambda = 1 & \text{if} & h+\Delta \leq \Delta_1 \\ & \text{where} & \Delta_1 = \frac{s}{e^{\frac{2c}{r}}-1} - \frac{(rs)^2}{V} \\ \lambda = \frac{\sqrt{V}}{rs}\sqrt{\frac{s}{e^{\frac{2c}{r}}-1} - h - \Delta} & \text{if} & \Delta_1 < h+\Delta < \Delta_2 \\ \lambda = 0 & \text{if} & h+\Delta \geq \Delta_2 \\ & \text{where} & \Delta_2 = \frac{s}{e^{\frac{2c}{r}}-1} \end{array}$$

The first three terms on the right hand side of Equation (1) represent the expected value of the risky asset as a weighted average of public and private information. The weights represent the relative precisions and sum to one. The denominator of each coefficient (weight) equals the precision of the average overall information of traders. It is the sum of the precisions of public information $(h+\Delta)$, the average private signal (λs) and of the informativeness of the price $(\frac{(r\lambda s)^2}{V})$. The last of these is the precision of a signal that traders can extract from prices. Traders will learn more from prices if everyone's private information is more precise or if there is less interference from supply, either because its variance goes down or because traders are more risk tolerant and thus react less strongly to their endowment. The final right hand side term has two parts that reflect the two ways in which supply influences prices. First, the more risk averse traders are $(\frac{1}{r})$ the more reluctant they are to hold risky assets and the more supply pushes down prices. The second term $(\frac{r\lambda s}{V})$ reflects the forecast error caused by supply shocks being mistaken for information about $\widetilde{u}$.

We use the Diamond model because its structure matches that of the markets that are actually used to predict monetary policy. Federal funds futures contracts are traded for a fixed number of months after which they are liquidated at a rate that is the direct result of the level of the Fed funds rate. The risky asset in the Diamond (1985) model corresponds to this futures contract, where the payout $\widetilde{u}$ represents the liquidation rate and $\widetilde{P}$ is the contract's trading price. The public signal is information released by the central bank that is

relevant for the future of interest rates. Clear examples include the qualitative "guidance" and hints about the future directions of policy rates provided by the Fed and the ECB and the quantitative forecasts of policy rates provided by New Zealand and some Nordic countries. Finally, the costly private signal is any investment in time or resources to forecast monetary policy, such as a trader spending time on his own analysis or a bank hiring an economist.[1]

4 Transparency and predictability

We are interested in how more precise central bank communication affects the ability of financial markets to predict monetary policy. An appropriate measure of predictability is the variance of the difference between the market price, $\widetilde{P}$, and the policy interest rate, $\widetilde{u}$. From Equation (1) we can derive the following expression for this variance:[2]

$$(3)\ E\left(\widetilde{P}-\widetilde{u}\right)^2 = E\left(\frac{hY+\Delta\left(\widetilde{u}+\widetilde{\zeta}\right)+\left(\lambda s+\frac{(r\lambda s)^2}{V}\right)\widetilde{u}-\left(\frac{1}{r}+\frac{r\lambda s}{V}\right)\widetilde{X}}{h+\Delta+\lambda s+\frac{(r\lambda s)^2}{V}}-\widetilde{u}\right)^2$$

Equation (3) is equivalent to the variance of market prices not caused by changes in the policy rate, indicating that improved predictability lowers market volatility, as the opening quote from Bernanke (2004) states.

Equation (3) can be further simplified to Equation (4)

$$(4)\ E\left(\widetilde{P}-\widetilde{u}\right)^2 = \frac{1}{h+\Delta+\lambda s+\frac{(r\lambda s)^2}{V}} + \frac{\frac{V}{r^2}+\lambda s}{\left(h+\Delta+\lambda s+\frac{(r\lambda s)^2}{V}\right)^2}$$

The denominator of Equation (4) shows that as overall information improves, the variance of the error declines. However, the variance of the price error is always greater than the inverse of the quality of overall information. This is due to the price variance caused by supply and would be true even in a market where there is no public information. Equation (4) also shows that if the fraction of informed traders, λ, is constant then better public information, $h+\Delta$, always lowers the variance of the price error.[3] The fraction of informed traders is, however, a function of public information. So, to see what happens when the precision of public communication (Δ) increases, we substitute Equation (2) for λ and take the first derivative of Equation (4) with respect to Δ and check its

[1] More generally, our results are conceptually applicable whenever we can plausibly argue that a market payout, $\widetilde{u}$, is dependent on monetary policy.

[2] Complete calculations for all steps are available on request.

[3] In the analysis we assume an unconditional distribution for $\widetilde{u}$ with constant mean. There is no loss of generality, however, as the threshold solutions in Equations (5) and (6) and Figure 1 are independent of the interest rate level.

sign for $\lambda = 0$, $0 < \lambda < 1$ and $\lambda = 1$. Given that h, Δ, s, c, r and V are all positive, the following can be shown.

When either all traders are informed ($\lambda = 1$) or none ($\lambda = 0$) are, $\mathrm{E}\left(\widetilde{P} - \widetilde{u}\right)^2$ is strictly decreasing in Δ, meaning that the predictability of monetary policy is strictly increasing in the precision of the public signal. This is not surprising as it is equivalent to holding λ constant in Equation (4). However, the opposite is true when the public signal crowds out some but not all private information acquisition ($0 < \lambda < 1$). In that case $\mathrm{E}\left(\widetilde{P} - \widetilde{u}\right)^2$ is strictly increasing in Δ and the predictability of monetary policy is strictly decreasing.

(5) $\frac{\partial E\left(\widetilde{P}-\widetilde{u}\right)^2}{\partial \Delta} < 0$ if $h + \Delta \leq \Delta_1$ or $h + \Delta \geq \Delta_2$

(6) $\frac{\partial E\left(\widetilde{P}-\widetilde{u}\right)^2}{\partial \Delta} > 0$ if $\Delta_1 < h + \Delta < \Delta_2$

Figure 1 illustrates this process for parameter values $\frac{1}{2}$ for $1/r$, s, c and $\frac{1}{V}$. The shaded areas in the upper frame represent the precisions of public information, $\Delta + h$, the average private signal, λs, and the informativeness of the price, $\frac{(r\lambda s)^2}{V}$, charted against the precision of public information, $\Delta + h$. The shaded areas stack and together represent the average overall precision of information available to traders, $h+\Delta+\lambda s+\frac{(r\lambda s)^2}{V}$. Up to point Δ_1 the precision of the private signal and the information of the price are constant because all traders are informed, $\lambda = 1$. Beyond Δ_1, with a higher public precision, some crowding out occurs and as a result the precisions of the private and price signals decline up to Δ_2 where all private information has been crowded out. The thick black line in the upper frame represents the precision of the error. Corresponding to the inverses of Equation (5) and (6) respectively, it rises until crowding out of private information begins (Δ_1) and then declines until all private information has been crowded out (Δ_2). As shown in Equation (4), the error precision is everywhere below the precision of overall information. In the lower frame, we correspondingly present the fraction of informed traders, λ, and the weight on public information.

Figure 1 can be used to make inferences about communication policy by the monetary authorities. We define optimal policy as one that minimizes the ex ante variance of prediction errors about future interest rates in the market. It is immediately clear from Figure 1 that it is not always optimal for the central bank to be as transparent as it can be. Assume the highest precision the central bank can achieve for its (public) forecast is Δ_{max} while its actual choice of precision (transparency) is Δ^*. First consider the case where Δ_{max}, is so low that $h + \Delta_{max}$ remains below Δ_1. Then, full transparency, $\Delta^* = \Delta_{max}$, is optimal; the market benefits from everything the central bank has to signal without crowding out private information. Now consider the case where the central bank's forecast is precise enough so that if it were fully disclosed it

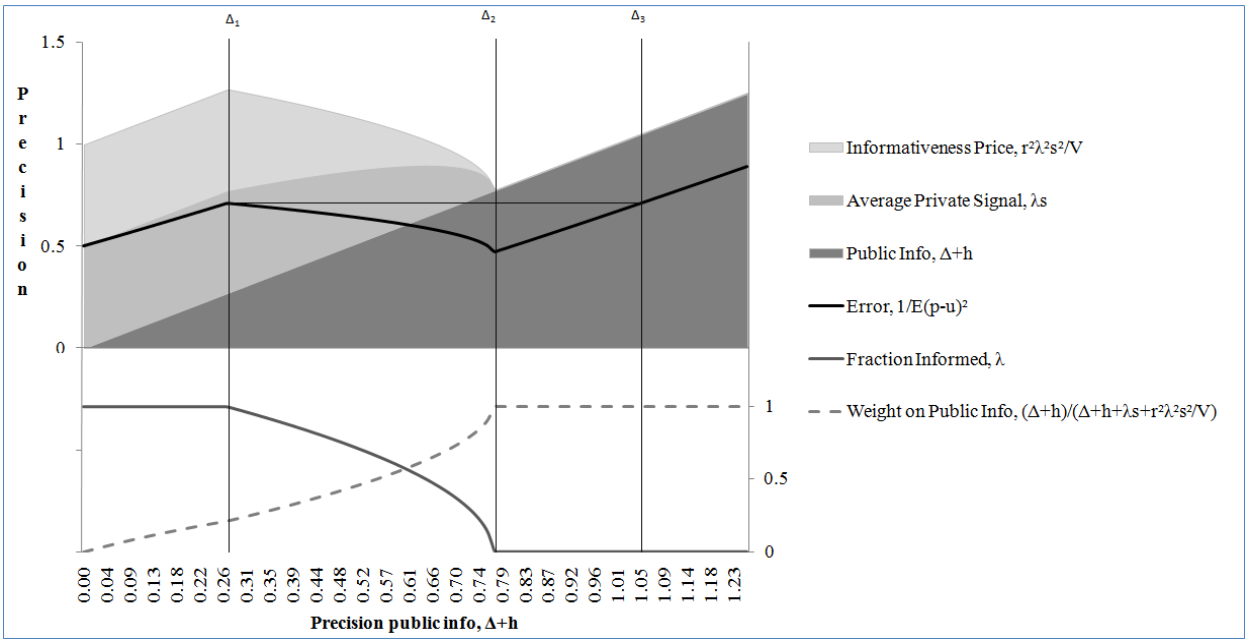

Figure 1: Consequences of rising precision of public signal, Δ

would create some crowding out, $\Delta_1 < h + \Delta_{max} < \Delta_2$; then the best policy is to avoid any crowding out by setting Δ^* such that $h + \Delta^* = \Delta_1$, where clearly $\Delta^* < \Delta_{max}$. The same holds when $\Delta_2 < h + \Delta_{max} < \Delta_3$; even though all private information has been crowded out and every subsequent increase in $h + \Delta$ improves the precision of the error, this precision is still lower than at Δ_1. Only for the case where $h + \Delta_{max} > \Delta_3$ is maximum transparency again optimal and the central bank should set $\Delta^* = \Delta_{max}$.[4] Central banks will probably be unable to exactly define the turning points on Figure 1. Therefore, the practical policy conclusion from this paper is that central banks should be aware that transparency may undermine the goal of more predictable and less volatile financial markets. This is particularly true if there are signs that market participants are scaling back investment in information and research.

Equations (5) and (6) as well as Figure 1 unambiguously show that at Δ_2 overall precision is lower than at Δ_1 despite higher public precision $\Delta + h$ .The result is due to crowding out of private information acquisition and is independent of the chosen parameter values in the model. The remaining issue is whether this crowding will be a plausible outcome in reality. More particularly, since Svensson (2005) argues that public information typically is more precise

[4] The analytical expression for Δ_3 is unreported because it is long and provides no additional intuition, calculations are available on request.

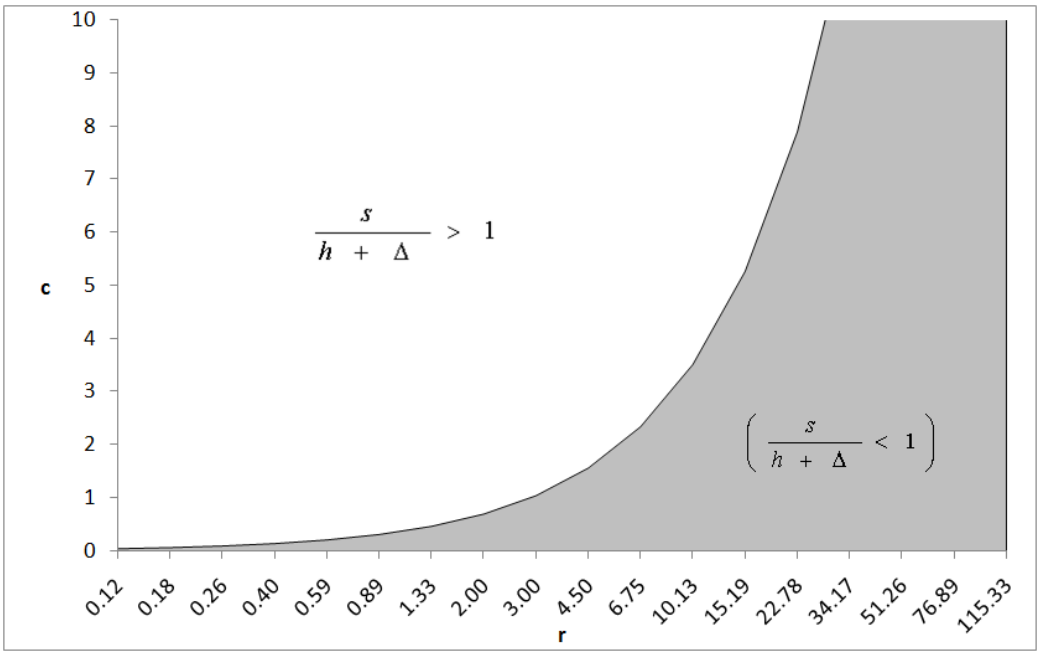

Figure 2: Area in c-r space at Δ_1 where $s < \Delta + h$

than private information ($s < \Delta + h$), we need to establish whether this latter condition is fulfilled in the range of public precision values where partial crowding out occurs ($\lambda > 0$) according to the model. We proceed as follows. First, we use Equation (2) to evaluate $\frac{s}{\Delta+h}$ at point Δ_2. If $\frac{s}{\Delta+h} < 1$ at Δ_2, there is a range of public information precision to the left of Δ_2 for which the same holds and for which partial crowding out occurs under the Svensson plausibility requirement.

At point Δ_2 it is true that $h + \Delta = \frac{s}{e^{\frac{2c}{r}}-1}$ so it directly follows that the condition $\frac{s}{\Delta+h} < 1$ is equivalent to the condition $\frac{c}{r} < \frac{\ln 2}{2}$. The shaded area in Figure 2 shows combinations of c and r where the last informed trader has just been crowded out (i.e. Δ_2 in Figure 1) and the precision of public information has already surpassed that of the private signal, $\left(\frac{s}{\Delta+h} < 1\right)$. The frontier represents c-r combinations where the precision of private and public information are equal, $\left(\frac{s}{\Delta+h} = 1\right)$. The figure illustrates that as traders approach risk neutrality (infinite risk tolerance, r) crowding out will occur for $\frac{s}{\Delta+h} < 1$ at practically any cost of the private signal. If professional market participants are approximately risk neutral, as is often assumed in financial market modeling, some crowding out for $s < h+\Delta$ is likely for a broad range of private signal costs c. Less risk tolerance, however, would require sharply lower levels of private sig-

nal costs for crowding out to be plausible, reducing the practical relevance of the model. [5] Further empirical research is required to make progress in this direction and to validate the model. Figure 2 does suggest the phenomenon of partial crowding out and decreasing precision can plausibly occur in reality.

5 Conclusions

Bernanke (2004) argues that central bankers care about the predictability of monetary policy because lower predictability produces higher interest rate volatility, which in turn creates additional volatility in the real economy. In this paper, we use the Diamond (1985) model with costly information acquisition. We argue that the model can be appropriately applied to the Fed funds futures market. Our results show that for intermediate levels of public signal precision private information is crowded out, resulting in higher forecast error variance. If the maximum level of public signal precision the central bank can provide lies within this intermediate range, it is actually optimal for the central bank to disclose less than it knows. Only when public signal precision is either very high or very low, should the central bank be completely transparent. Furthermore, we demonstrate crowding out can occur when public information is more precise than private information, especially under the plausible circumstance that traders are nearly risk neutral. Central banks may be unable to exactly determine the relevant thresholds. However, they should be aware of the possibilities of adverse effects of increased transparency and heed signals that market participants are scaling back investment in information and research.

References

Bernanke, B.: 2004, Central bank talk and monetary policy. Speech, 7 October.

Carlson, J., Craig, B., Higgins, P. and Melick, W.: 2006, FOMC communications and the predictability of near-term policy decisions. Federal Reserve of Cleveland Review.

Coppel, J. and Connolly, E.: 2003, What do financial market data tell us about monetary policy transparency? Reserve Bank of Australia Working Paper.

Dale, S., Orphanides, A. and Osterholm, P.: 2008, Imperfect central bank communication - information vs. distraction. IMF Working Paper 08/60.

Demertzis, M. and Hoeberichts, M.: 2007, The costs of increasing transparency, *Open Economies Review* **18**, 263–280.

[5] Literal interpretation of the dollar amount c needed for crowding is hampered by the assumptions – in particular absolute risk aversion - made to keep the model tractable.

Diamond, D. W.: 1985, Optimal release of information by firms, *The Journal of Finance* **40**(4), 1071–1094.

Grossman, S. and Stiglitz, J.: 1980, On the impossibility of informationally efficient markets, *The American Economic Review* **70**(1), 393–408.

Hellwig, M. F.: 1980, On the aggregation of information in competetive markets, *Journal of Economic Theory* **22**, 477–498.

Kwan, S.: 2007, On forecasting future monetary policy: Has forward-looking language mattered? Federal Reserve Bank of San Francisco Economic Letter 2007-15.

Lange, J., Sack, B. and Whitesell, W.: 2003, Anticipations of monetary policy in financial markets, *Journal of Money, Credit and Banking* **35**(6), 889–909.

Lildholdt, P. and Wetherilt, A. V.: 2004, Anticipation of monetary policy in UK financial markets. Bank of England Working Paper 241.

Morris, S. and Shin, H. S.: 2002, Social value of public information, *The American Economic Review* **92**(5), 1521–1534.

Murdzhev, A. and Tomlanjanovich, M.: 2006, What is the color of Alan Greenspan's tie? how central bank policy announcements have changed financial markets, *Eastern Economic Journal* **32**(4).

Rafferty, M. and Tomljanovich, M.: 2002, Central bank transparency and market efficiency: An econometric analysis, *Journal of Economics and Finance* **26**(2), 150–161.

Svensson, L. E.: 2005, Social value of public information: Morris and Shin (2002) is actually pro transparency, not con. Working Paper, Forthcoming in the American Economic Review.

Swanson, E.: 2006, Have increases in Federal Reserve transparency improved private sector interest rate forecasts, *Journal of Money, Credit and Banking* **38**, 792–819.

Tomljanovich, M.: 2004, Does central bank transparency impact markets? a cross-country econometric analysis. Working Paper.

Verrecchia, R. E.: 1982, Information acquisition in a noisy rational expectations economy, *Econometrica* **50**(6), 1415–1430.