On the Social Cost of Transparency in Monetary Economies

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David Andolfatto[†]
andolfatto@stls.frb.org

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Abstract

I study a class of models commonly used to motivate monetary exchange, extended to include a physical asset whose expected short-run return is subject to exogenous news events, but whose expected long-run return is independent of this information. I show that there are circumstances in which the nondisclosure of news by an asset manager is welfare-improving. When nondisclosure is infeasible, the framework admits a role for government debt. The theory is used to interpret the nondisclosure practices of reputable financial agencies and suggests caveats for legislation designed to promote financial market transparency.

1 Introduction

Financial agencies are natural targets of intense scrutiny and criticism during a financial market crisis. One frequent criticism is the charge of a general lack of transparency in financial practices; ranging from vague accounting principles to the outright nondisclosure of pertinent information. Implicit in these charges is the idea that less transparency promotes a lack of accountability; which, in turn, results in misaligned incentives and, ultimately, a misallocation of resources. There is a widespread belief that efficiency is only enhanced when financial market participants are granted access to more information.

It is a matter of fact that financial agencies frequently do depart from the principle of full transparency. Private banks, for example, appear inclined to report the value of their assets based on an internally generated "mark-to-model" algorithm; the market value of assets is not necessarily disclosed. In a similar vein, a money market mutual fund can avoid "breaking the buck" at the discretion of its board members.[1] Many other examples can be drawn from history. During the banking panics of the U.S. National Banking Era (1863-1913), for example, private clearinghouses (coalitions of private banks) would temporarily suspend the publication of individual bank balance sheet information. Moreover, such practices are not relegated to the private sector. The Federal Reserve Bank of the United States, for example, does not disclose the identity of agencies that make use of its discount window facility. Nor do federal regulators make public their internal assessments of the financial soundness of private banks under federal supervision.[2]

What is interesting, of course, is that these (and similar) practices are invariably justified on the grounds of *promoting* economic efficiency. Understandably, public tolerance for apologies of this sort wanes significantly during an economic crisis. A manifestation of this are legislative proposals designed to increase financial market transparency. The Federal Accounting Standards Board (FASB) Rule 157 constitutes one prominent example.[3] Recent Congressional attempts to diminish the powers of the U.S. Federal Reserve Bank may similarly be interpreted in this manner.[4]

The question I ask in this paper is whether legislative attempts to promote the public disclosure of information in financial markets necessarily constitute a worthwhile social objective. This is, of course, a delicate issue. History is replete with examples of private and public sector agencies exploiting informational advantages at the expense of society. Nevertheless, I do not believe that the answer to this question is a foregone conclusion. In particular, reputable agencies risk losing their credibility; and the punishment for this can be severe. The nondisclosure practices of reputable agencies should therefore be examined with an open mind.

In any case, economic theory is not entirely silent on the matter. Since at least Jack Hirschleifer's (1971) famous example, where additional information destroys a desirable risk-sharing arrangement, economists have recognized

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[1] Rule 2a-7 of the Investment Company Act of 1940 stipulates that "The board of directors of the money market fund shall determine, in good faith, that it is in the best interests of the fund and its shareholders to maintain a stable net asset value per share or stable price per share, by virtue of either the Amortized Cost Method or the Penny- Rounding Method, and that the money market fund will continue to use such method only so long as the board of directors believes that it fairly reflects the market-based net asset value per share."

[2] These are the so-called Camels ratings, performed by the Federal Reserve Bank, the Office of the Comptroller of the Currency, and the Federal Deposit Insurance Corporation.

[3] Rule 157 is the *Fair Value Measurements* accounting standard (or "mark-to-market" rule) issued by FASB in September 2006 and implemented in November 2007.

[4] For example, a House panel chaired by Barney Frank (D-Mass) voted in favor of a sweeping congressional audit of the "secretive" Federal Reserve on November 19, 2009.

that more information is not necessarily welfare-improving. Alessandro Citanna and Antonio Villanacci (2000) examine a class of economies where information is communicated through prices; see also Roy Radner (1979). They establish conditions under which increased information revelation through prices has an ambiguous effect on economic welfare; in doing so, they generalize Hirschleifer's (1971) original contribution. Their result is important because it emphasizes that informationally efficient asset prices (say, as postulated by the efficient markets hypothesis) are neither necessary or sufficient to guarantee allocative efficiency. Related arguments are made in the agency literature. Andrea Prat (2005), for example, explains why agency relationships may require more transparency along some dimensions, but less transparency along other dimensions.[5]

These are ideas that I think should be explored further in the context of monetary models. The motivation for this, as I have explained above, is the fact that liquidity providers and regulators are currently at the center of proposed legislative changes designed to promote financial market transparency in one way or another. It would be useful to have a theoretical framework to help organize our thinking on the matter.

A good starting point, I think, is to investigate the properties of models that are commonly used to motivate monetary exchange. I study two such models. The first is a textbook Wicksellian model where the disclosure of private information leads to an economic collapse. While this model is perhaps too simple for practical application, it demonstrates the underlying logic of the basic argument in a simple and coherent (if rather dramatic) manner.

The second model is based on a framework popularized by Ricardo Lagos and Randall Wright (2005); see also Randall Wright and Stephen D. Williamsom (2008). A benefit of this class of models is that it simultaneously takes seriously the frictions that give rise to circulating media of exchange (or of record-keeping) while preserving analytical tractability. I consider a natural extension of this model where the expected short-term return on an asset is permitted to depend on information. I show that there are circumstances in which the nondisclosure of such information by an asset manager can improve social welfare. An implication of this is that high-frequency "mark-to-market" asset valuation methods, contrary to their intended effect, may actually promote allocative inefficiency. When nondisclosure is infeasible, efficiency may be enhanced with the introduction of a fiat money instrument whose return is relatively insensitive to information affecting the expected returns of competing assets; see also David Andolfatto and Fernando Martin (2009). These and related arguments are formalized below.

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[5] There is a sense in which the results cited here should not be surprising. In particular, these and related propositions, may be interpreted as consequences that are known to follow from the general theory of the second best; see Richard G. Lipsey and Kelvin Lancaster (1956).

2   A Wicksellian Model

The economy consists of N individuals and N time periods; where N is an integer, $3 \leq N < \infty$. *Ex ante*, all individuals are identical; *ex post*, they are divided into N types; with each individual having an equal probability of realizing type $j \in \{1, 2, ..., N\}$.

All $j \neq N$ individuals are endowed with $0 < y < \infty$ units of nonstorable output at date j. The type N individual is endowed with a stochastic endowment; it is equal to y/α with probability $0 < \alpha < 1$; and is otherwise equal to zero. Hence, all individuals have an expected endowment equal to y.

Let $c_j(t)$ denote consumption by individual j at date $t \in \{1, 2, ..., N\}$. A type j individual has linear preferences given by

$$U_j = \theta c_j(j) + c_j(j + 1)$$

for $j = 1, 2, ..., N$ (modulo N); where $0 < \theta < 1$. That is, each individual values his own endowment "a little bit;" but attaches greater value to endowment of the person "next" to him on the circle. This pattern of preferences and endowments generates a complete lack of double coincidence of wants.

This much is standard (for $N = 3$, the model reduces to Wicksell's famous "triangle"). But here is the twist: assume that the type N individual receives a private signal at the beginning of date 1 that perfectly reveals the future realization of his endowment. I call this private signal "news," since it constitutes potentially important information pertaining to an impending future event. News, when it arrives in this model, is either "good" or "bad."

2.1   The Efficient Allocation

The *ex ante* efficient allocation is simple to characterize. In particular, each individual j is required to transfer his endowment to individual $j - 1$ (modulo N). Each individual receives an *ex ante* utility payoff equal to y (whereas autarky generates the *ex ante* payoff $\theta y < y$). Note that the efficient allocation is invariant to news.

Ex post, all type $j \neq N - 1$ individuals receive y units of output. The type $N - 1$ individual receives either y/α units of output (with probability α), or zero units of output (with probability $1 - \alpha$).

2.2   Private Information and Full Commitment

Consider now the planner's problem when individuals cannot be relied upon to reveal their private information truthfully. To begin, I assume that all individuals can commit to any feasible allocation recommended by the planner. Of

course, individuals cannot commit to revealing their private information truthfully; the mechanism will have to be incentive compatible. We may, without loss, restrict attention to a direct revelation mechanism.

It should be immediately clear that, in this case, the efficient allocation is incentive compatible. At date 1, the type N individual receives good or bad news concerning the value of his asset. As individual N is unaffected one way or the other whether the news is good or bad, he reports it truthfully to the planner. The planner, in turn, is free to make this information publicly available or not. If the news is bad, individual $N-1$ will suffer (*ex post*). But by assumption, this latter individual is bound to make good on his promise to deliver y to individual $N-2$ (rather than consume it himself, which he would clearly prefer if permitted to do so).

2.3 Private Information and Limited Commitment

Assume now that commitment is limited in the sense that only the type N individual can commit, while all other types cannot. Note that this is an environment where the revelation principle continues to hold. And indeed, the efficient allocation continues to be incentive compatible–*but only if the planner can promise to keep any solicited news from the public domain.*

To see that this is the case, imagine that the planner makes the news public. If the news is good, then the efficient allocation is sequentially rational. But if the news is bad, the efficient allocation is not sequentially rational; at least, not for the type $N-1$ individual. This latter individual would prefer to consume his own endowment rather than exchange it for nothing. Anticipating that this will be the case, the type $N-2$ individual refuses to trade as well. Working backward in this manner, it is evident that the entire "trading chain" will collapse–the economy reverts to autarky in the bad news state.

Economic collapse in the event of bad new is, however, averted if the private information is kept hidden. True, the type $N-1$ individual is made worse off in an *ex post* sense; but *ex ante*, he–along with everyone else in this economy–would insist on the nondisclosure of private information.

2.4 Money and Banking

Assume that all individuals, apart from type N, are anonymous. Then monetary exchange is necessary. In principle, the monetary object may be issued by the type N individual; i.e., in the form of a security representing a (stochastic) claim against date N output (see Nobuhiro Kiyotaki and John Moore, 2002). But I assume here that only the planner can issue noncounterfeitable notes. I interpret the planner as a bank (an asset manager).

Trade proceeds as follows. At date 1, types are realized. The type N individual would like like to purchase output at date 1; but is in no position to

make payment as his security is (by assumption) illiquid. So type N approaches the bank for a money loan; that is, the bank issues a note in exchange for a "deposit" consisting of the type N security (the security serves as collateral for the money loan). As this banknote is universally recognized, it may potentially circulate as currency. Indeed, the asset-transformation activity described here is one of the primary functions of the banking sector.

Having obtained his money loan, type N pays for his date 1 output. Type 1 accepts the banknote, anticipating that he too will be able to use it to make a future purchase. In this manner, efficient exchanges are realized all along the trading chain. At the final date, the type $N-1$ individual redeems the banknote in exchange the security in deposit at the bank (a claim against date N output).

Needless to say, if these *ex ante* efficient exchanges are to be realized, it is imperative that the bank keep the true state of its balance sheet hidden from society. In particular, revealing bad news in the interest of "transparency" would render banknotes worthless (the underlying collateral is worth zero). True, the banknotes would, in this event, be "properly" priced according to their fair market value (an FASB accountant might be pleased). But if these notes constitute the primary source of liquidity in an economy, the consequence of such transparency is an economic collapse in at least some states of the world.

3   A Lagos-Wright Model

There is a unit measure of infinitely-lived individuals, distributed uniformly on $[0, 1]$. Time is discrete; with each time-period $t = 0, 1, ..., \infty$ divided into two subperiods, labeled *day* and *night*.

Output is produced in the day and the night. Let $x_t(i) \in \mathbb{R}$ denote consumption in the day by individual $i \in [0, 1]$ at date t; where $x_t(i) < 0$ is interpreted as production. Utility is linear in $x_t(i)$.

At the beginning of the night, agents experience an idiosyncratic shock that determines their type: *consumer* or *producer*. Consumption at night is denoted $c_t(i) \in \mathbb{R}_+$ and generates (for a consumer) the utility flow $u(c_t(i)) \in \mathbb{R}$; where $u'' < 0 < u'$ and $u(0) = 0$, $u'(0) = \infty$. Production at night is denoted $y_t(i) \in \mathbb{R}_+$ and generates (for a producer) the utility flow $-h(y_t(i)) \in \mathbb{R}$; where $h(0) = h'(0) = 0$, $h' > 0$ for $y > 0$ and $h'' \geq 0$.

For each individual, the stochastic process generating types is *i.i.d.* across time. Assume that the population at night is at all times divided equally between the two types. Preferences for individual i at the beginning of time are represented by

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[x_t(i) + 0.5u(c_t(i)) - 0.5h(y_t(i)) \right] \tag{1}$$

where $0 < \beta < 1$.

There is a durable asset that generates an exogenous and stochastic output flow $z_t \in [\underline{z}, \overline{z}]$ at the beginning of each day; $0 \le \underline{z} \le \overline{z} < \infty$. This aggregate shock follows a Markov process, $\Pr[z_{t+1} \le z^+ \mid \eta_t = \eta] = F(z^+ \mid \eta)$; where F is a cumulative distribution function, conditional on information η_t (news) received at the beginning of the night. Assume that news is either *bad* or *good*; $\eta_t \in \{b, g\}$ and that $\pi \equiv \Pr[\eta_t = b]$. Define

$$z(\eta) \equiv \int z^+ dF(z^+ \mid \eta) \qquad (2)$$

where $0 \le z(b) \le z(g) < \infty$. That is, $z(\eta)$ is a "short-term" conditional forecast made at night over the dividend payment that is to be realized the next day. In contrast, the "long-term" forecast (horizons extending from one day to the next and beyond) is invariant to news; i.e.,

$$z^e \equiv \pi z(b) + (1 - \pi)z(g) \qquad (3)$$

As all output is nonstorable, there are two resource constraints

$$z_t \ge \int x_t(i)di \qquad (4)$$

$$\int y_t(i)di \ge \int c_t(i)di \qquad (5)$$

The first-best allocation maximizes (1) for an *ex ante* representative individual, subject to the resource constraints (4), (5); and assuming that expectations are consistent with (2). The first-best allocation may, without loss, assign $x_t(i) = z_t$; so that each agent receives (in expectation) z^e units of output in the day.[6]

Symmetry implies $c_t(i) = c_t$ and $y_t(i) = y_t$. An equal population of types at night implies $c_t = y_t$; by virtue of (5) holding with equality. Optimality requires $y_t = y^*$; with $0 < y^* < \infty$ satisfying

$$u'(y^*) = h'(y^*) \qquad (6)$$

The first-best allocation delivers *ex ante* utility

$$W^* = (1 - \beta)^{-1} \left[z^e + 0.5u(y^*) - 0.5h(y^*) \right]$$

To motivate the need for record-keeping, I assume that all agents, apart from that agent or agency in control of the durable asset, lack commitment.

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[6] Note that owing to the quasilinear property of preferences, the presence of risk (whether aggregate or idiosyncratic) has no effect on *ex ante* welfare. The first-best allocation here is also consistent with any lottery over $\{x_t(i)\}$ that generates expected utility z^e for the agent.

Although it is not necessary to do so, I also assume that an agent's type (whether consumer or producer) is private information. Only the asset manager (planner) is privy to information η_t; and may choose to reveal it or not. Enforcement is limited; the maximum penalty for noncompliance is perpetual ostracism. This entails foregoing all future gains associated with ownership of the physical asset in addition to the gains associated with risk-sharing at night. Allocations, in short, are restricted to be sequentially rational and incentive compatible. A feasible allocation with these two properties is called *incentive-feasible*.

3.1   Implementation with an Indirect Mechanism

I begin by examining the set of (stationary) allocations implementable with an indirect mechanism. Let $y(\eta)$ denote the level of production required of a producer (delivered to a consumer) at night when $\eta_t = \eta$. Let $x_j(z)$ denote the level of consumption (production, if negative) delivered to an agent in the day, conditional on realization $z_t = z$ and on whether the agent was a consumer or producer the previous evening; i.e., $j \in \{c, p\}$. Note that conditioning the allocation on longer trading histories is unnecessary here, given the quasilinear structure of preferences.

A night allocation $\{y(b), y(g)\}$ generates an *ex ante* lifetime utility $w(y(b), y(g))$ satisfying

$$(1 - \beta)w(y(b), y(g)) \equiv 0.25 \left[u(y(b)) - h(y(b)) + u(y(g)) - h(y(g)) \right]$$

Feasibility in the day requires $x_c(z) + x_p(z) = z$. Hence, the total *ex ante* lifetime utility associated with following the planner's recommendation is $z^e/(1 - \beta) + w(y(b), y(g))$. Noncompliance generates a lifetime utility equal to zero.

Since enforcement is limited, an allocation will have to satisfy a set of sequential rationality (SR) constraints. Anticipating that agents in the day who were producers the previous night are to be rewarded, one can restrict attention to those agents in the day who were consumers the previous night. To induce participation of these latter agents, the following restriction must hold

$$x_c(z) + (1 - \beta)w(y(b), y(g)) + \beta \left[\frac{z^e}{1 - \beta} + w(y(b), y(g)) \right] \geq 0$$

This may be written more compactly as

$$x_c(z) + w(y(b), y(g)) + \left(\frac{\beta}{1 - \beta} \right) z^e \geq 0 \tag{7}$$

Define $\overline{x}_c$ such that the SR constraint (7) holds with equality (notice that $\overline{x}_c$ does not depend on z). By feasibility, one may also define $\overline{x}_p(z) \equiv z - \overline{x}_c$. Observe that $[\overline{x}_p(z^e) - z^e] = [\overline{x}_p(z(\eta)) - z(\eta)] = -\overline{x}_c$ for $\eta \in \{b, g\}$.

At night, the situation is reversed: consumers are rewarded and producers are punished. To induce participation of producers at night, the following

restriction must hold

$$-h(y(\eta))+\beta\left[E[\overline{x}_p(z^+)\mid\eta]+(1-\beta)w(y(b),y(g))+\beta\left[\frac{z^e}{1-\beta}+w(y(b),y(g))\right]\right]\geq 0$$

This may be written more compactly as

$$-h(y(\eta))+\beta\left[E[\overline{x}_p(z^+)\mid\eta]+w(y(b),y(g))+\left(\frac{\beta}{1-\beta}\right)z^e\right]\geq 0 \qquad (8)$$

for $\eta\in\{b,g\}$; where z^+ denotes the realization of z the following day. Notice that the expectation $E[\overline{x}_p(z^+)\mid\eta]$ (the expected future reward) is formed using information η.

Consider next incentive-compatibility (IC). In the proposed mechanism, agents reveal their types at night indirectly via their production decision. Matters are simplified here by the fact that consumers are technologically prevented from misrepresenting themselves as producers. Producers, on the other hand, may misrepresent themselves as consumers. To ensure that this is not the case, the following IC conditions must be satisfied

$$-h(y(\eta))+\beta\left[E[\overline{x}_p(z^+)\mid\eta]+w(y(b),y(g))+\left(\frac{\beta}{1-\beta}\right)z^e\right]$$
$$\geq\quad \beta\left[\overline{x}_c+w(y(b),y(g))+\left(\frac{\beta}{1-\beta}\right)z^e\right] \qquad (9)$$

for $\eta\in\{b,g\}$.

Observe that, by the definition of $\overline{x}_c$, the RHS of condition (9) is equal to zero; see (7). It follows then that the SR constraints for the producer (8) necessarily hold when the IC constraints for the producer (9) are satisfied. The implication is that we can ignore (8) in what follows.[7] Note that one can write (9) more compactly as

$$\beta\left[E[\overline{x}_p(z^+)\mid\eta]-\overline{x}_c\right]\geq h(y(\eta)) \qquad (10)$$

for $\eta\in\{b,g\}$.

Now, imagine for the moment that news is either absent or not disclosed. In this case, the allocation must be invariant to news; so that $y(\eta)=y$. Condition (10) may now be expressed as $\beta\left[\overline{x}_p(z^e)-\overline{x}_c\right]\geq h(y)$. Since $\overline{x}_p(z^e)-z^e=-\overline{x}_c$, this may alternatively be expressed as $\beta\left[z^e-2\overline{x}_c\right]\geq h(y)$. Employing the definition of $\overline{x}_c$ and $w(y,y)$ we have, after rearranging terms

$$\frac{u(y)-h(y)}{1-\beta}\geq\frac{h(y)}{\beta}-z^e \qquad (11)$$

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[7] This is also true if the RHS of (9) is strictly positive; i.e., if (7) holds with strict inequality. That is, the producer IC constraint is more restrictive for any given y than the producer SR constraint.

Restricting attention to levels of output such that $u(y) > h(y)$, the LHS of (11) is monotonically increasing in β and approaches $+\infty$ as $\beta \nearrow 1$ and some finite positive number as $\beta \searrow 0$. The RHS of (11) approaches $-\infty$ as $\beta \searrow 0$ and some bounded number (positive or negative) as $\beta \nearrow 1$. Hence, conditional on some value for z^e, there evidently exists a number $\beta^*(z^e) \in (0, 1)$ satisfying

$$\frac{u(y^*) - h(y^*)}{1 - \beta^*(z^e)} = \frac{h(y^*)}{\beta^*(z^e)} - z^e \tag{12}$$

Proposition 1 *If news is either absent or not disclosed, then the first-best allocation is implementable for any $\beta \in [\beta^*(z^e), 1)$. Moreover, $\beta^*(z^e)$ is strictly decreasing in z^e; so that a higher expected asset return expands the set of economies for which the first-best remains implementable.*

Notice that for a sufficiently patient economy, the first-best allocation is implementable even in the absence of an asset (i.e., if $z \equiv 0$). Evidently, the threat of ostracism from the night market is sufficient to induce participation and truthful revelation. Such a threat may not be sufficient if β is sufficiently low. The presence of an asset, however, endows society with an added threat; namely, the disentitlement from any claim to asset income. The force of this added threat is greater, the larger the expected asset return. When $z^e > 0$, there are economies $\beta \in [\beta^*(z^e), \beta^*(0))$ for which first-best implementation is possible with an asset, but not without.

With these preliminaries out of the way, let me develop the main point of the paper. Consider an economy for which $z^e > 0$ and $\beta = \beta^*(z^e)$. By Proposition 1 then, the first-best allocation is (just) implementable if news is either absent or not disclosed. In terms of condition (10) we have $\beta \left[\overline{x}_p(z^e) - \overline{x}_c \right] = h(y^*)$.

Imagine now that information η is available and that it is disclosed to the public. The availability of this information does not, of course, affect z^e. It does, however, influence the conditional forecasts that agents make at night; i.e., $z(b) < z^e < z(g)$. As a result, we have $\overline{x}_p(z(b)) < \overline{x}_p(z^e) < \overline{x}_p(z(g))$; which, in turn, implies

$$\beta \left[\overline{x}_p(z(b)) - \overline{x}_c \right] < h(y^*) < \beta \left[\overline{x}_p(z(g)) - \overline{x}_c \right]$$

That is, the IC constraint (10) is violated in the bad news state, but not in the good news state.

When the news is bad, the expected promised reward for producers at night cannot be made large enough to induce truthful revelation (given that consumer participation in the day must be respected as well); at least, not if producers are asked to produce the first-best level of output y^*. Truthful revelation requires that producers be asked to produce less than the first-best level of output in the bad news state; in particular, a level $\hat{y}(b)$ that satisfies

$$\beta \left[\overline{x}_p(z(b)) - \overline{x}_c \right] = h(\hat{y}(b)) \tag{13}$$

The constrained-efficient allocation is therefore characterized by $\{y(b), y(g)\} = \{\hat{y}(b), y^*\}$ with $\hat{y}(b) < y^*$ (since h is strictly increasing in y). It follows that welfare is higher (the first-best is implementable) when information η is not disclosed.

Proposition 2 *If $0 < z(b) < z^e < z(g)$ and $\beta = \beta^*(z^e)$, then the disclosure of information $\eta \in \{b, g\}$ is welfare reducing.*

Proposition 2 holds more generally for β in a neighborhood above $\beta^*(z^e)$; all that is required is that the IC constraint (10) bind in the bad news state and remain slack in the good news state. The opposite may hold true for $\beta < \beta^*(z^e)$; but of course, this is beside the point.

3.2 Competitive Equilibrium

In this section, I restrict attention to a linear mechanism and study the implications of information disclosure on asset prices.

I have already assumed that agents lack commitment. In addition to this, assume that they are anonymous in the sense that it is impossible for society (the planner) to monitor individual trading histories directly. The implication of this is that private credit is infeasible, so that payment for goods and services must be made up-front with a tangible asset. A natural candidate for this tangible asset are claims against the economy's durable asset. In this way, equity shares can serve as the economy's payment instrument.

Each individual is initially endowed with one unit of the physical asset. The planner (asset manager) offers to take control of the asset in exchange for one token; henceforth called a *share*. The asset manager promises to remit dividends at the beginning of each day to each individual in proportion to their revealed shareholdings. Individuals will voluntarily take up this offer; as they anticipate the possibility of using of shares as a medium of exchange.[8]

Apart from the initial period, I anticipate that the equilibrium distribution of shares at the beginning of each day will fall on a two-point set $\{s_c, s_p\}$; where $s_j \geq 0$ and j denotes the individual's type in the previous night (consumer or producer). Let (ϕ_1, ϕ_2) denote the price of a share measured in units of output; in the day and night, respectively. In what follows, ϕ_1 denotes the ex-dividend price.

3.2.1 Decision Making in the Day

Let $s \geq 0$ denote shares carried forward into the night. The day budget constraint is then given by

$$x = (z + \phi_1) s_j - \phi_1 s \tag{14}$$

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[8] Note that the alternative is autarky.

Let $D(s_j, z)$ denote the value of entering the day with shares s_j and with realized dividend income z. Let $N(s, \eta)$ denote the *ex ante* (before type is known) value of entering the night-market with share-holdings s when the news is η. The value functions D and N must satisfy the following recursion

$$D(s_j, z) \equiv \max_{s \geq 0} \{(z + \phi_1) s_j - \phi_1 s + E_\eta [N(s, \eta)]\} \tag{15}$$

where here, I have substituted in the budget constraint (14).

Assume that the value function N is increasing and at least weakly concave in s; i.e., $N_{11} \leq 0 < N_1$. In fact, these are properties that will hold in equilibrium. If $N_{11} < 0$, then each individual leaves the day-market with identical share-holdings s characterized by

$$\phi_1 = E_\eta [N_1(s, \eta)] \tag{16}$$

As in Lagos and Wright (2005), the distribution of wealth at the end of the day is degenerate. If $N_{11} = 0$, then desired individual share-holdings are indeterminate; at least, beyond some strictly positive lower bound. Even in this case, however, condition (16) will continue to hold in any equilibrium.[9]

By the envelope theorem, $D_1(s_j, z) = z + \phi_1$; so that $D_1(s_j^+, z^+) = z^+ + \phi_1^+$. Given that the stochastic dividend flow is an *i.i.d.* process from one day to the next, and given quasi-linearity, the ex-dividend price of equity in the day will remain constant over time. In this case,

$$\int D_1(s_j^+, z^+) dF(z^+ \mid \eta) = z(\eta) + \phi_1 \tag{17}$$

3.2.2   Decision Making at Night

Let $C(s, \eta)$ denote the value of being a consumer at night, with shares s and when news is η. Using $c \equiv \phi_2(s - s_c^+)$, the choice problem may be stated as

$$C(s, \eta) \equiv \max_{s_c^+ \geq 0} \left\{ u(\phi_2(s - s_c^+)) + \beta \int D(s_c^+, z^+) dF(z^+ \mid \eta) \right\} \tag{18}$$

The consumer's debt-constraint $s_c^+ \geq 0$ plays an important role in what follows.[10] Utilizing (17), desired consumption is characterized by

$$\begin{array}{ll} \phi_2(\eta)u'(c(\eta)) = \beta[z(\eta) + \phi_1] & \text{if} \quad \phi_2(\eta)s > c(\eta) \\ c(\eta) = \phi_2(\eta)s & \text{otherwise} \end{array} \tag{19}$$

Let $P(s, \eta)$ denote the value of being a producer at night, with money s and when news is η. Using $y \equiv \phi_2(s_p^+ - s)$, the choice problem may be stated as

$$P(s, \eta) \equiv \max_{s_p^+ \geq 0} \left\{ -h(\phi_2(s_p^+ - s)) + \beta \int D(s_p^+, z^+) dF(z^+ \mid \eta) \right\} \tag{20}$$

---

[9]If it did not hold, then the demand for shares would either be zero or infinity.
[10]That is, consumers may wish to short equity, but are prevented from borrowing because they are anonymous.

Note that as a producer has no desire to consume, his debt-constraint is necessarily slack. Utilizing (17), desired production is characterized by

$$\phi_2(\eta)h'(y(\eta)) = \beta\left[z(\eta) + \phi_1\right] \tag{21}$$

3.2.3 Market Clearing

The market-clearing conditions are given by

$$s = 1 \text{ and } c(\eta) = y(\eta) \tag{22}$$

which will, of course, imply $0.5s_c^+(\eta) + 0.5s_p^+(\eta) = 1$.

The object of interest here is the equilibrium allocation at night $y(\eta)$, together with the corresponding price system ϕ_1 and $\phi_2(\eta)$. To begin, consider (16). Note that $N_1(s,\eta) \equiv 0.5C_1(s,\eta) + 0.5P_1(s,\eta)$. Applying the envelope theorem to (18) and (20), $N_1(s,\eta) \equiv 0.5\phi_2(\eta)u'(y(\eta)) + 0.5\phi_2(\eta)h'(y(\eta))$. Condition (16) may therefore be expressed as

$$\phi_1 = 0.5\pi\phi_2(b)\left[u'(y(b)) + h'(y(b))\right] + 0.5(1 - \pi)\phi_2(g)\left[u'(y(g)) + h'(y(g))\right] \tag{23}$$

Next, note that condition (21) implies the asset-price function

$$\phi_2(\eta) = \beta\left[\frac{z(\eta) + \phi_1}{h'(y(\eta))}\right] \tag{24}$$

Finally, note that (19) and (21), together with market-clearing, imply

$$\begin{array}{ll} y(\eta) = y^* & \text{if} \quad \phi_2(\eta) > y^* \\ \phi_2(\eta) = y(\eta) < y^* & \text{otherwise} \end{array} \tag{25}$$

Conditions (23), (24) and (25) constitute the key restrictions that characterize the general equilibrium allocation and price-system for this competitive economy.

3.2.4 A No-News Economy

I begin with a useful benchmark that I call a *no-news economy*; i.e., assume that $z(\eta) = z^e$ for $\eta \in \{b, g\}$. It follows that $\phi_2(\eta) = \phi_2$ and $y(\eta) = y$.

Now, conjecture that the debt-constraint remains slack. Then (25) implies that $y = y^*$ and (24) implies $\phi_2 = \beta\left[z^e + \phi_1\right]/h'(y^*)$. This pricing function, together with $y(\eta) = y^*$ and (23) delivers

$$\phi_1 = \left(\frac{\beta}{1 - \beta}\right)z^e; \tag{26}$$

which appears to be the standard asset-pricing formula that one would expect for risk-neutral agents.

I need to confirm that the conjecture I made with respect to (25) holds in equilibrium; i.e., that $\phi_2 > y^*$. Using the ϕ_1 and ϕ_2 derived above, this latter condition can be expressed as

$$\left(\frac{\beta}{1-\beta}\right) z^e > h'(y^*)y^*$$

Whether this condition holds or not depends on parameters. The following result is immediately apparent.

Proposition 3 *A competitive equilibrium implements the first-best allocation for any $\beta \geq \hat{\beta}(z^e) \in (0,1)$; where $\hat{\beta}$ satisfies $\hat{\beta}z^e \equiv (1-\hat{\beta})h'(y^*)y^*$.*

Proposition 3 is the analog to Proposition 1; the latter which holds for the nonlinear mechanism studied there. As in Proposition 1, we see that $\hat{\beta}(z^e)$ is strictly decreasing in z^e; so that a higher expected asset return expands the set of economies for which the first-best is implementable.

It is instructive to examine a case for which $\beta < \hat{\beta}(z^e)$. In this case, the debt-constraint binds tightly; so that (25) implies $\phi_2 = y < y^*$. Define the following object

$$A(y) \equiv 0.5 \left[\frac{u'(y)}{h'(y)} + 1\right]$$

Clearly, $A(y^*) = 1$ and $A'(y) < 0$.

Now, express condition (23) as $\phi_1 = \phi_2 h'(y)A(y)$. Note that this implies $\beta[z^e + \phi_1] = \beta[z^e + \phi_2 h'(y)A(y)]$; or, using condition (24),

$$\phi_2 h'(y) = \beta[z^e + \phi_2 h'(y)A(y)]$$

As $\phi_2 = y$ when the debt-constraint binds, the latter expression can be written as

$$yh'(y)[1 - \beta A(y)] = \beta z^e$$

With $y < y^*$ so determined, the equilibrium price of equity in the day is $\phi_1 = yh'(y)A(y)$; or

$$\phi_1 = \left[\frac{\beta A(y)}{1 - \beta A(y)}\right] z^e \tag{27}$$

In comparing the asset price functions (26) and (27), it appears that equity is "over-valued" in the debt-constrained equilibrium relative to its "fundamental" value. That is, people would like to borrow (or short equity) at night, but cannot. In terms of the expected rate of return on equity (from one day to the next)

$$1 < \left[\frac{z^e + \phi_1}{\phi_1}\right] < \frac{1}{\beta}$$

14

That is, the effect of the binding debt constraint is to confer a "liquidity premium" on the price of equity; so that equity earns a lower expected rate of return.[11]

3.2.5 A News Economy

By a *news economy*, I mean $0 \leq z(b) < z^e < z(g)$.

If the debt-constraint never binds, then by (25), the competitive equilibrium implements the efficient allocation $y(\eta) = y^*$. As a consequence, the equilibrium asset price in the day is given by (26). Condition (24) then delivers an expression for the price of equity at night

$$\phi_2(\eta) = \beta \left[\frac{z(\eta) + \phi_1}{h'(y^*)} \right]$$

That is, the equilibrium share price at night responds to news in the way one would expect; i.e., $\phi_2(b) < \phi_2(g)$.

Thus, it is conceivable here that equity will serve as an efficient payments instrument. While the price of this monetary instrument fluctuates randomly at night in response to new information, this price volatility in no way inhibits *ex ante* efficiency. This is true as long as share price movements do not leave consumers debt-constrained in some states of the world; a possibility that I now consider.

Proposition 4 *If $0 \leq z(b) < z^e < z(g)$ and $\beta = \hat{\beta}(z^e)$, then the consumer debt constraint will bind tightly in the bad news state and remain slack in the good news state.*

I relegate the formal proof of Proposition 4 to the appendix as the intuition should be clear enough; especially in light of the discussion surrounding Proposition 2.

Proposition 3 and condition (25) imply that $\phi_2(b) = y(b) < y(g) = y^*$. Appealing to (23) and (24), the equilibrium $(\phi_1, y(b))$ is characterized by

$$\phi_1 = \pi \beta [z(b) + \phi_1] A(y(b)) + (1 - \pi) \beta [z(g) + \phi_1]$$
$$h'(y(b)) y(b) = \beta [z(b) + \phi_1]$$

Solving for the ex-dividend price of equity in the day

$$\phi_1 = \beta \left[\frac{\pi z(b) A(y(b)) + (1 - \pi) z(g)}{1 - \beta(\pi A(y(b)) + 1 - \pi)} \right] \tag{28}$$

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[11]In a model with endogenous capital accumulation, the analogous result is an over-accumulation of capital; see Ricardo Lagos and Guillaume Rocheteau (2008).

Note that (28) reduces to (26) when $y(b) = y^*$. Hence, as long as $y(b) < y^*$, equity commands a "liquidity premium."

As for the equilibrium price of equity at night, refer to condition (24)

$$\phi_2(b) = \frac{\beta\left[z(b) + \phi_1\right]}{h'(y(b))} \text{ and } \phi_2(g) = \frac{\beta\left[z(g) + \phi_1\right]}{h'(y^*)}$$

It is curious to note that $\phi_2(b) > \phi_2(g)$ appears possible here (unless h is linear). If this is so, then the debt constraint would bind in the good news state and remain slack in the bad news state; a possibility ruled out by Proposition 3. Hence, $\phi_2(b) < \phi_2(g)$; a result that is immediately apparent for the case $h'' = 0$.

A few points are worth stressing here. First, it follows as a direct corollary to Proposition 3 that the first-best allocation can be implemented if information η is not disclosed by the asset manager. Bad news has the effect of (temporarily) depressing asset prices at night; an effect that here renders consumers with insufficient money balances to purchase the first-best level of output (their debt constraint binds). In light of Proposition 2, this is tantamount to the planner being unable to credibly promise producers a sufficiently large future reward to induce truthful revelation.

Second, under the conditions stated in Proposition 3, informationally-efficient asset prices are inconsistent with allocative efficiency. There is a sense here in which informationally-efficient asset prices display "excess volatility" at high frequency; the allocation is improved (the debt constraint will not bind) if asset prices could somehow be rendered insensitive to high-frequency news events. Moreover, this excess volatility results in a "liquidity premium" for asset prices (assets are valued for their medium of exchange properties).

As in the Wicksellian model studied earlier, the public revelation of news would not be socially detrimental if people were not anonymous and/or had the power to commit to their promises. But as Narayana Kocherlakota (1998) has emphasized, it is precisely the limitations along these dimensions that make monetary exchange (record-keeping) necessary. When this is so, individuals may find themselves debt-constrained by a temporary decline in the value of their liquid assets (a price decline that bears little, if any, relation to the fundamental long-run value of their monetary asset). Welfare is enhanced here by suppressing the high-frequency information flow that generates excess volatility in the value of the economy's payment instrument. Suppressing this high-frequency information flow stabilizes the short-run expected return of a monetary instrument (around its long-run fundamentals), so that consumers are never caught short of "cash" in bad news events.

3.3   A Role for Government Debt

Circumstances may dictate that privately-valued information cannot be kept secret from society. If nondisclosure is infeasible (or prohibited by legislation),

then it would appear that first-best implementation in the environment studied here may not be possible for impatient economies. In fact, this need not be the case. The following discussion draws heavily on David Andolfatto (in press); the reader is referred there for details.

Andolfatto (in press) studies the properties of an environment identical to the Lagos and Wright (2005) model studied above; except absent any asset. He restricts trade among agents to be competitive. It is well-known for this environment that the introduction of a fiat money instrument, along with a deflation financed by a lump-sum tax, can implement the first-best allocation (this is the celebrated Friedman rule). This is a result that holds for all $0 < \beta < 1$. Andolfatto (in press), demonstrates that first-best implementation is still possible when lump-sum taxation is infeasible (that is, if all trade is restricted to be voluntary); this is also shown to be the case for all $0 < \beta < 1$. The added restriction of voluntary trade rules out deflationary policies. Efficient implementation requires the use of interest-bearing government debt; with interest financed in part by inflation and in part by a voluntary "redemption fee" on government debt.

What these results suggest is the following. If the Friedman rule (or its variant considered in Andolfatto, in press) is a feasible policy, then efficient implementation is independent of the existence of a physical asset. This suggests that the introduction of a government asset may be necessary to improve efficiency when: [1] in the absence of the government asset, claims to a physical asset are used as a medium of exchange; and when [2] information relating to the physical asset's short-term returns cannot be kept hidden from traders.

The theme that emerges from this discussion is that society may find it desirable to create media of exchange whose expected returns are independent of the high-frequency information flow that is unavoidably capitalized in other asset prices. The construction of such "informationally-insensitive" assets is also a theme pursued (albeit in a somewhat different context) by Gary Gorton and George Pennacchi (1990).[12]

I have limited attention here to the role that government debt may play as a medium of exchange. Alternatively, one might explore the extent to which private sector debt with similar attributes may be created to fulfill this role. In fact, private banks do go to some length in creating "informationally-insensitive" debt for this purpose. Such an activity would appear to extend to the so-called "shadow-banking" sector; which oversaw the creation of "low-risk" securities (e.g., AAA rated tranches of asset-backed securities) used extensively as collateral in the repo market; see Gary Gorton (2009).

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[12] Gorton and Pennacchi (1990) develop a model that it relies on the presence of asymmetric information between "informed" and "uninformed" traders. In their environment, one solution to this problem is for a firm to split the cash flow of their asset portfolio between risky equity and risk-free debt. The debt instrument here is "informationally insensitive" in that its value is independent of any news received by informed traders. In this manner, uninformed agents can be induced to acquire and use debt for transaction purposes.

4   Conclusions

Some form of record-keeping is necessary to support desirable allocations when agents lack commitment and enforcement is limited. The presence of a physical asset generally expands the set of implementable allocations because promised rewards and punishments are enhanced with entitlements to asset returns. If agents are in addition anonymous so that "memory" is absent, durable and non-counterfeitable physical tokens representing claims to the asset can substitute for the missing memory.[13] In a competitive economy, these tokens take the form of equity shares that circulate as a medium of exchange.

In an asset economy, the short-run expected return to an asset may depend on high-frequency news events. The dividend return of capital, for example, may occur quarterly; while news concerning this expected return may arrive daily. When asset markets are informationally efficient, this high-frequency news is embedded immediately into the market price of the security. This poses a potential problem for the use of securities as a means of financing high-frequency payments. On any given day, a consumer holding equity as a means of payment may find the value of his current holdings insufficient to finance a planned expenditure.

For an asset economy then, the prescription of "full transparency" is not generally warranted. In competitive economies, the disclosure of high-frequency information unrelated to an asset's "long-run fundamentals" may be detrimental to economic welfare when claims to such assets serve as high-velocity payment instruments. The equilibrium price of a liquid asset is excessively volatile when asset prices capitalize all information. This general result appears not to be an artifact of competitive exchange; it is more fundamental than this. In particular, I have also shown that it holds for non-competitive (nonlinear) constrained-efficient allocations.

The basic idea developed here may be of some use in interpreting the nondisclosure practices used by banks (issuers of high-velocity payment instruments) in the past. It may even go some way to explaining the apparently "opaque" properties of the asset-backed securities that, until recently, circulated extensively in the shadow banking sector. Unfortunately, these highly rated securities (as with the demandable bank liabilities issued prior to the establishment of the FDIC) turned out to be more "informationally sensitive" than previously imagined. The implications of this have yet to be worked out.

It may be the case, as in the model considered above, that the government has a comparative advantage in creating informationally-insensitive debt. To the extent that this is true, society may stand to benefit from its use. It may even be desirable to prohibit the use of private securities in some segments of an economy's payments system (insisting, for example, on the use of govern-

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[13]The idea that physical tokens may constitute a substitute form of record-keeping is emphasized by Narayana Kocherlakota (1998); see also Robert M. Townsend (1987) and Joseph M. Ostroy (1973).

ment treasuries as collateral in repo). This, as well as other legislative changes designed to enhance financial market transparency, deserve careful study before they are implemented. Approaching the problem under the premise that fuller transparency is always desirable may not be the right place to start.

5 References

1. **Andolfatto, David** (in press). "Essential Interest-Bearing Money," forthcoming: *Journal of Economic Theory*.

2. **Andolfatto, David and Fernando Martin** (2009). "Money and Capital as Competing Media of Exchange in a News Economy," Manuscript dated September 11, 2009.

3. **Citanna, Alessandro and Antonio Villanacci** (2000). "Incomplete Markets, Allocative Efficiency, and the Information Revealed by Prices," *Journal of Economic Theory*, 90: 222-253.

4. **Gorton, Gary and George Pennacchi** (1990). "Financial Intermediaries and Liquidity Creation," *Journal of Finance*, XLV(1): 49–71.

5. **Gorton, Gary** (2009). "Slapped in the Face by the Invisible Hand: Banking and the Panic of 2007," Manuscript dated April 01, 2009.

6. **Hirschleifer, Jack** (1971). "The Private and Social Value of Information and the Reward to Inventive Activity," *American Economic Review*, 61(4): 561–574.

7. **Kiyotaki, Nobuhiro and John Moore** (2002). "Evil is the Root of All Money," *American Economic Review*, 92: 62-66.

8. **Kocherlakota, Narayana** (1998). "Money is Memory," *Journal of Economic Theory*, 81(2): 232–251.

9. **Lagos, Ricardo and Randall Wright** (2005). "A Unified Framework for Monetary Theory and Policy Analysis," *Journal of Political Economy*, 113: 463–484.

10. **Lagos, Ricardo and Guillaume Rocheteau** (2008). "Money and Capital as Competing Media of Exchange," *Journal of Economic Theory*, 142(1): 247-258.

11. **Lipsey, Richard G. and Kelvin Lancaster** (1956). "The General Theory of the Second Best," *Review of Economic Studies*, 24(1): 11-32.

12. **Ostroy, Joseph M.** (1973). "The Informational Efficiency of Monetary Exchange," *American Economic Review*, 63(4): 597-610.

13. **Prat, Andrea** (2005). "The Wrong Kind of Transparency," *American Economic Review*, 95(3): 862-877.

14. **Radner, Roy** (1979). "Rational Expectations Equilibrium: Generic Existence, and the Information Revealed by Prices," *Econometrica*, 47: 655-678.

15. **Townsend, Robert M.** (1987). "Economic Organization with Limited Communication," *American Economic Review*, 77(5): 954-971.

16. **Williamson, Stephen D. and Randall Wright** (2008). "The New Monetarist Economics," Manuscript dated September 17, 2008.

Appendix

Proof to Proposition 3

Proposition 3 asserts that if $0 \leq z(b) < z^e < z(g)$ and $\beta = \hat{\beta}(z^e)$, then the consumer debt constraint will bind tightly in the bad news state and remain slack in the good news state. This can be demonstrated as follows.

Lemma 1 *The debt-constraint cannot remain slack in both news states.*

Proof. Assume that the debt-constraint remains slack in both news states. Then $y(b) = y(g) = y^*$, so that (23) implies

$$\phi_1 = \beta(z^e + \phi_1)$$

Moreover, conditions (24) and (25) imply

$$\phi_2(\eta) = \beta \left[\frac{z(\eta) + \phi_1}{h'(y^*)} \right] \geq y^* \text{ for } \eta \in \{b, g\}$$

This latter condition implies $\beta \left[z(b) + \phi_1 \right] \geq y^* h'(y^*)$. Since $z(b) < z^e < z(g)$, it follows that

$$\phi_1 = \beta(z^e + \phi_1) > \beta \left[z(b) + \phi_1 \right] \geq y^* h'(y^*) = \left(\frac{\beta}{1 - \beta} \right) z^e = \phi_1;$$

which is a contradiction. ∎

Lemma 2 *The debt-constraint cannot bind tightly in both news states.*

Proof. Assume that the debt-constraint binds tightly in both news states. Then (23) and (24) imply

$$\phi_1 = \pi\beta[z(b) + \phi_1]A(y(b)) + (1 - \pi)\beta[z(g) + \phi_1]A(y(g))$$

or, by collecting terms,

$$\phi_1 \left[1 - \pi\beta A(y(b)) - (1 - \pi)\beta A(y(g)) \right] = \pi\beta z(b) A(y(b)) + (1 - \pi)\beta z(g) A(y(g))$$

As both debt-constraints bind, (25) implies that $y(\eta) < y^*$ for $\eta \in \{b, g\}$; so that $A(y(\eta)) > 1$ for $\eta \in \{b, g\}$. Combining this information with the equation above, we see that the asset commands a liquidity premium; i.e.,

$$\phi_1 > \left(\frac{\beta}{1 - \beta} \right) z^e = y^* h'(y^*)$$

The expression above implies

$$\beta \left[z^e + \phi_1 \right] > \beta[z^e + y^* h'(y^*)] > y^* h'(y^*) \tag{29}$$

22

Condition (25) implies $\phi_2(\eta) = y(\eta) < y^*$ for $\eta \in \{b, g\}$, so that by condition (24)

$$
\begin{aligned}
y(b)h'(y(b)) &= \beta\left[z(b) + \phi_1\right] \\
y(g)h'(y(g)) &= \beta\left[z(g) + \phi_1\right]
\end{aligned}
$$

Since $z^e = \pi z(b) + (1 - \pi)z(g)$, it follows from these latter two restriction that

$$
\pi y_2(b)h'(y(b)) + (1 - \pi)y_2(g)h'(y(g)) = \beta\left[z^e + \phi_1\right] \tag{30}
$$

Conditions (29) and (30) imply

$$
\pi y_2(b)h'(y(b)) + (1 - \pi)y_2(g)h'(y(g)) > y^*h'(y^*) \tag{31}
$$

But as $yh'(y)$ is strictly increasing in y, and as $y(\eta) < y^*$, the inequality in (31) is impossible. ∎

Lemma 3 *The debt-constraint cannot bind in the good-news state and remain slack in the bad-news state.*

Proof. Assume that the debt-constraint binds in the good-news state and remains slack in the bad-news state. Then (25) implies $\phi_2(b) > y^*$ and $\phi_2(g) = y(g) < y^*$. Moreover, by condition (24)

$$
\begin{aligned}
\phi_2(b)h'(y^*) &= \beta\left[z(b) + \phi_1\right] \\
y(g)h'(y(g)) &= \beta\left[z(g) + \phi_1\right]
\end{aligned}
$$

As $z(g) > z(b)$, these latter equations imply

$$
y(g)h'(y(g)) > \phi_2(b)h'(y^*) > y^*h'(y^*)
$$

But this is impossible; as $yh'(y)$ is strictly increasing in y and as $y(g) < y^*$. ∎

The three lemmas above rule out three out of the four possible configurations. The only remaining configuration is as characterized in the text; where the debt-constraint binds in the bad-news state and remains slack in the good-news state.