Government Information Transparency*

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Abstract

This paper studies a model of announcements by a privately informed government about the future state of the economic activity in an economy subject to recurrent shocks and with distortions due to income taxes chosen by majority voting. Although transparent communication would ex ante be desirable, we find that even a benevolent government may ex-post be non-informative, in an attempt to counterveil the tax distortion with a ‘second best’ compensating distortion in information. This result provides a rationale for independent national statistical offices, committed to truthful communication. We also establish a novel link between transparency and inequality, mediated by the shape of labor supply and by the effect of inequality on tax distortions.

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1 Introduction

Many governments are better informed than the private sector about future realizations of macroeconomic variables. Often they transparently convey this information to the public, but at other times they do not. For instance, the US government's announcements on current or future activity have a positive real effect on the economy, confirming the fact that individuals find them informative (Oh and Waldman, 1990; Rodríguez Mora and Schulstald, 2007).¹ In contrast, the widespread skepticism on contemporary Argentinean official statistics provides an example of non transparent and non credible government announcements. While there may be different opportunistic reasons for governments not to be transparent, in the present paper we investigate whether a benevolent government would always reveal its private information on real macroeconomic variables. For the sake of concreteness, we focus on the case in which the government has prior information on exogenous aggregate productivity shocks that produce uniform positive (in booms) or negative (in recessions) shifts in individual productivities. Should the government always fully reveal this information? Is it efficient to do so? Are there circumstances in which it is welfare efficient not to disclose information?

In an otherwise perfectly competitive, first best economy a benevolent government would always reveal its private information. But, in a second best world with unavoidable distortions, a benevolent government might hope to increase social welfare by appropriately distorting information communication. For instance, suppose that income taxes make labor supply sub-optimal. If the government knows that the economy is hitting a recession and does not reveal such information, it may hope that the increase in labor supply caused by ignorance compensates the under-supply of labor caused by taxation.

Indeed, if individuals mechanically believe its announcements (if they are

¹Interestingly, such announcements are believed even when based on false information.

credulous), the government may even be able to restore the first best outcome through an appropriately over-optimistic communication strategy. However, if individuals are rational, this misleading information about a recession will make the government lose credibility. In particular, when the economy is hitting a boom and the government announces it, individuals will discount such announcement. This, in turn, will further worsen the under-supply of labor in booms, and thus reduce social welfare in good times.

In recessions, by hiding information, the government raises labor supply, relative to what it would be under perfect information, so that it may (at least partially) compensate for the welfare loss caused by taxation. Yet, it may also raise labor supply so much, that it indeed causes an over-supply of labor (relative to the first best), whose welfare costs are higher than those due to taxation under perfect information. The higher the tax distortion, the less likely it is that this happens. Thus, roughly, the higher the tax distortion, the higher the incentive to hide negative information. In this framework, we investigate the emergence of informative and non-informative government communication regimes. We first take tax distortions as given and characterize whether the government in equilibrium is transparent or not, and then endogenize the income tax rate and make it the result of majority voting.

Formally, given tax distortions, we represent the government's announcement game as a cheap talk game (Crawford and Sobel, 1982) with multiple and heterogenous receivers. We characterize its pure strategy equilibria and find that non informative equilibria always exist, whereas an informative equilibrium exists if and only if tax distortions are relatively small.² In non informative equilibria, government announcements convey no information (if they have a literal meaning, we may say that the government is over-

²In the working paper version of this article (Albornoz et al., 2009) we also characterize mixed strategy equilibria. There we show that the restriction to pure strategies, made here for expositional purposes, does not drive any important result. We make explicit reference to the complete analysis whenever mixed strategies are of any importance.

optimistic in recessions). In an informative equilibrium, the government is transparent (i.e., its announcements fully reveal its private information) and credible (in the sense that, if announcements have a literal meaning, this naturally coincides with their equilibrium interpretation).

We find that transparency is desirable *ex ante*, but it may turn out not to be feasible *ex-post*, as even a benevolent government may want to hide negative information. The policy implication is then straightforward: when distortions are substantial in magnitude and difficult to remove, the government should find some commitment device to transparency. For instance, announcements over the economic outlook might be delegated to an independent statistical office committed to transparency.

An appropriate equilibrium refinement uniquely selects the informative equilibrium whenever it exists, so that our comparative statics is conducted on the tax distortion threshold, below which it exists. The most interesting result in this context is that we establish a novel link between transparency and inequality, mediated by the shape of labor supply: the range of tax rates for which transparency is the equilibrium strategy broadens or shrinks with inequality depending on whether labor supply is rigid or elastic.

We next complete the model by obtaining the tax rate that would result from majority voting. We examine the existence and properties of the *politico-economic* equilibria, defined so that information policies and majoritarian tax rates are mutually consistent. We obtain that the ideal tax rate is strictly decreasing in individual income and that preferences over tax rates are single peaked, so the pivotal voter for a majority is the individual with median productivity. We find that shock magnitude and inequality have opposite effects on transparency, since the former reduces and the latter widens tax distortions.

Our analysis is related to a number of literatures and open discussions. First, transparency and provision of accurate information have indeed been very prominent in recent debates on institutional and policy reform; to the

point of becoming a typical leitmotif in the discussions. For example, the Federal Open Market Committee (FOMC) announced in November 2007 that, consistently with its greater commitment to improving accountability, it will increase the frequency and expand the content of the economic projections released to the public.³ In other countries, central banks and Statistics Offices have adopted a range of methods aimed at improving their communication.⁴

The policy emphasis on transparency and credibility has been accompanied by a huge economic literature, which, at least since Kydland and Prescott (1977), has mostly focused on their importance for central banks (a recent assesment can be found in Blinder et al., 2008).⁵ Many of these contributions emphasize monetary channels and assume private information on at least two contradictory policy goals.⁶ Two prominent examples, among others, are Cukierman and Meltzer (1986) and Stein (1989).⁷ We differ from

³Projections on consumption will be included for the first time together with forecasts on gross domestic product (GDP) growth, the unemployment rate, and inflation. In addition, the projection horizon will be extended to three years, from two.

⁴These include timely announcements of policy actions, frequent public speeches at meetings with legislature, and the regular publication of reports about the real economy and monetary policy. The Reserve Bank of New Zealand and the Bank of England were early and enthusiastic leaders in this process towards greater transparency, together with the Norges Bank (the central bank of Norway) and Sveriges Riksbank (the central bank of Sweden). Finally, The European Central Bank has adopted a fully transparent communication strategy since it was created in 1998. Geraats (2008) shows that there has been a notable increase in economic transparency between 1998 and 2002, although the intensity varied across countries.

⁵In Faust and Svensson (2001), transparency takes the form of making public announcements more precise. Governments are credible if their announcements are believed to be true. Transparency builds credibility and, as a consequence, it has become an ingredient in the common wisdom of policy making (Faust and Svensson, 2002). This consensus is absolute among central bank authorities. As reported by Blinder (2000), central bankers consider transparency a “fine way to build credibility”. Interestingly, when asked the same questions, non-central bank economists are not that enthusiastic about the importance of transparency.

⁶A smaller literature (see, e.g., Sleet, 2001) posits private government information about productivity shocks, as we do here, and investigates its consequences for time consistency of optimal monetary policy.

⁷The former paper investigates the central bank’s incentive to maintain ambiguous procedures of monetary control, in order to be able to surprise rational agents whenever its

this line of research in that we emphasize real rather than monetary channels and assume private information about the macroeconomic outlook rather than about policy goals. As argued above, both aspects appear to be relevant and worthy of analysis.⁸ Interestingly, we do not require the assumption of contradictory policy goals to generate situations where government cannot commit to transparent information.

A recent and important strand of the literature looks at how economic policy depends on transparency and informational asymmetries, finding that transparency may generate economic distortions. We tackle the complementary question and show how transparency is endogenously determined by pre-existing distortions.⁹

While an interesting literature investigates the government's opportunistic incentives to distort the economy in one way or another, we have nothing to add to this discussion. Rather, we investigate the complementary question of why a benevolent government would impose further distortions to an already distorted economy. We are thus closer to the literature on second best,

policy goals shift. The latter uses a cheap talk framework to emphasize the central bank's incentive to make imprecise announcements about its goals, exactly because precise announcements would induce it to lie (in order to manipulate expectations). More recently, Moscarini (2007) shows that monetary policy is more likely to be transparent the greater the competence of the central bank.

⁸The fact that central authorities have an informational advantage over the private sector has been widely documented and has been mainly attributed to the fact that they devote substantially more resources to forecasting than private forecasters, and possibly use better forecasting methods (Romer and Romer, 2000; Kurz, 2005; Kohn and Sack, 2004; Athey et al., 2005). The fact that central authorities' announcements influence private behavior is also well documented (Oh and Waldman, 1990, 2005; Blinder et al., 2008).

⁹Several papers are concerned with the political economy of budget deficits and find that higher transparency reduces public debt (Milesi-Ferreti, 2004; Shi and Svensson, 2006). More recently, Gavazza and Lizzeri (2008, 2009) concentrate on the effects of different types of transparency in presence of political competition, where voters are misinformed about aggregate government spending and either revenues (Gavazza and Lizzeri, 2009) or the incumbent government's ability (Gavazza and Lizzeri, 2008). These papers show that, although transparency of spending is beneficial, higher transparency of either revenues or incumbent's ability may lead to wasteful spending and higher public debt. See also Barigozzi and Villeneuve (2006), where taxes have a signaling value.

in the sense that in our model it is precisely the existence of a first distortion what disrupts transparency and credibility. In particular, the mechanism we explore is related to the idea that random taxes may raise welfare, compared to certain taxes, because randomness may reduce the deadweight loss associated with income taxes.¹⁰ The main difference is that in our case uncertainty is not associated to random tax rates, but rather to uninformative announcements.

We do not investigate here any reputational incentives for transparency. Yet, the literature on this topic (e.g., Morris, 2001; Ottaviani and Sorensen, 2006) finds that in many cases reputation provides an incentive to hide rather than to reveal information.

A recent line of research investigates the interaction between the disclosure of noisy public information and the use (and quality) of private information. In an influential paper, Morris and Shin (2002) show that noisy public information, if used to coordinate actions, may lead individuals to disregard alternative valuable private information.¹¹ More recently, Amador and Weill (2008) emphasize that releasing public information would jeopardize the price system's ability to aggregate and transmit private information, which could result in welfare losses. We differ from this literature because, rather than investigating the interaction between public and private information, we study how public information disclosure depends on pre-existing distortions. In this sense, our paper is more related to Angeletos and Pavan (2009), who investigate the complementary question of how optimal taxation should take into account the information structure.¹²

¹⁰Weiss (1976) shows this result under the assumption, which we maintain, that utility is separable in consumption and leisure. See Arnott and Stiglitz (1988) and Sleet (2004), among others, for extensions of this literature.

¹¹This reasoning has been used to warn against Central Bank transparency (Amato et al., 2002). Interestingly, Svensson (2006) argues that the result of Morris and Shin (2002) suggests that transparency increases welfare when public information is more precise than private information. We find an analogous result.

¹²They propose a tax scheme that guarantees that individuals make a better use of both private and public information with the additional effect that the provision of public signal

A main contribution of our paper is to reveal a connection between inequality and transparency. In this sense, our work also relates to the literature on the effects of inequality on resource allocation (and growth).¹³ An important message of this literature is that in the presence of distortions (capital market imperfections in most papers), inequality aggravates the misallocation of resources. In our case too, an existing distortion such as income taxation induces a benevolent government to create an additional (compensating) distortion in the transmission of information. The magnitude of this effect depends on the elasticity of labor supply. At the same time, inequality raises tax distortions as determined by the median voter. This result is in line with Esteban and Ray (2006) where the misallocation of resources created by an efficiency seeking government is positively associated with inequality.

The remainder of this paper is organized as follows. Section 2 displays the government's announcement game and the determination of tax rates by majority voting. Section 3 characterizes the equilibria of the announcements game and studies their properties. Section 4 investigates the politico-economic equilibria and Section 5 concludes. In the Appendix we present some analytical details and derive a technical result.

2 The model

2.1 The economy

There is a mass one of individuals, who have the same preferences but differ in productivity. Utility depends on consumption and labor: $u(c, \ell) = c - \frac{\ell^\delta}{\delta}$. The parameter $\delta > 1$ captures the degree of convexity of labor supply, which is linear in the wage for $\delta = 2$, strictly convex for $\delta \in (1, 2)$ and strictly concave for $\delta > 2$.

Individuals earn competitive wages, so that labor income y (equivalently,

would increase welfare.

¹³See the survey by Bénabou (1996).

production, taken as numeraire) is simply equal to individual supply of efficiency units of labor. Individual productivity depends on two factors: an idiosyncratic observable component (ability or human capital), denoted β and distributed according to the cumulative distribution function F , with support on the non empty interval $[b, B) \subset \mathbb{R}_+$; and an aggregate ex-ante unobservable component (say, being in a boom or in recession), denoted θ and distributed according to

$$\theta = \begin{cases} \vartheta & , \text{ with probability } p \\ -\vartheta & , \text{ with probability } (1 - p) \end{cases} ,$$

with $p \in (0, 1)$. We assume $\vartheta \in (0, b)$ to assure that individual productivity is always positive.

Individual labor income therefore depends on effort, ability and aggregate conditions, $y_\beta = (\beta + \theta)\ell_\beta$. Labor income is taxed at a constant marginal rate $t \in (0, 1)$ and tax revenues $T = \int_b^B ty_\beta dF(\beta)$ are equally redistributed, so that individual consumption is equal to $c_\beta = (1 - t)y_\beta + T$. Since the population is continuous, each individual takes T as given.¹⁴ We momentarily take t as also given. In Section 4 we study the choice of taxation by majority voting.

From our assumption on preferences it is immediate to obtain that, if individuals could observe the realization of θ before choosing their effort level, they would choose $\ell_\beta = [(1 - t)(\beta + \theta)]^{\frac{1}{\delta-1}}$ and produce $y_\beta = (1 - t)^{\frac{1}{\delta-1}}(\beta + \theta)^{\frac{\delta}{\delta-1}}$. Taxes impose a downward distortion in individual effort supply, relative to the social optimum, which would require $\ell_\beta = (\beta + \theta)^{\frac{1}{\delta-1}}$.

¹⁴The tax collection per capita T will depend on the realization of θ . Therefore, individuals will entertain conjectures about their value. As we shall see, because of our assumption on individual preferences these conjectures are immaterial because they have no effect on labor supply.

2.2 The Announcements Game

We investigate what happens when individuals are not perfectly informed on the true value of θ , but instead have to decide on the basis of beliefs, which in turn may be influenced by the government's announcements. Specifically, we assume that information is as follows. First Nature draws θ from the above distribution. Both F and the distribution of θ are common knowledge. The government observes the realization of θ and then chooses a (payoff irrelevant) message m from a set of feasible messages $M = \{L, H\}$. Individuals observe m , but not θ , and then simultaneously choose their labor effort to maximise utility. Ex-post the realization of θ is observed by all individuals, who are paid accordingly. The aim of the government is to maximise social welfare $W = \int_b^B u_\beta dF(\beta)$, where u_β denotes the utility of an individual with ability β and depends on t , on θ , on individual labor effort ℓ_β , and on the labor effort chosen by the entire population (since T depends on it).

In this cheap talk game an equilibrium consists of a government's strategy $m(\theta)$, of individual strategies $\ell_\beta(m)$ for all $\beta \in [b, B)$, and of posterior beliefs $\mu = \Pr(\theta = \vartheta | m = L)$ and $\nu = \Pr(\theta = \vartheta | m = H)$, such that: $m(\theta)$ is a best response to individual strategies; for all β , $\ell_\beta(m)$ is a best response to $m(\theta)$ (and to every other individuals' strategies); and along the equilibrium path of play μ and ν are obtained from $m(\theta)$ through Bayes' Rule. We also require that out of equilibrium beliefs are the same for everybody.

As mentioned above, for expositional purposes we restrict attention to pure strategy equilibria. These can be of two kinds: either the government sends the same signal both in booms and in recessions, or it sends different signals. Without loss of generality, let H be the message sent in booms. We then call an equilibrium pooling or non-informative if $m(\vartheta) = m(-\vartheta) = H$, and separating or informative (or transparent) if $m(\vartheta) = H$ and $m(-\vartheta) = L$.

The complete characterization of all equilibria, both in pure and mixed strategies, is done in Alborno et al. (2009). The only additional insights are that mixed strategy babbling equilibria always exist and that a semi-

separating (i.e., partially informative) equilibrium may exist, but only when a separating one also exists. In this case, the semi-separating is not only ex-ante welfare dominated by the separating equilibrium, but it is also discarded by an appropriate refinement, which univocally selects the latter.¹⁵

2.3 Voting over Taxes

In the announcement game the tax rate is taken as given. In order to endogenize taxes we assume that the tax rate is chosen by majority voting along the lines of Romer (1975), Roberts (1977) and Meltzer and Richard (1981). Implicitly in this standard voting model there are two political parties that have to choose a tax rate garnering a majoritarian support. The proposed tax rate critically depends on the preferences of the pivotal voter, who is the individual with median income. His preferred tax rate depends on whether the government transparently communicates its private information or rather hides it.

A *Politico-Economic Equilibrium* is an informational policy and a tax rate such that, given the informational policy, this tax rate is the one preferred by the median voter and, given this tax rate, that informational policy is an equilibrium of the announcements game.

3 Equilibrium of the Announcements Game

3.1 Existence

We first establish existence and characterize the set of all pure strategy equilibria of the cheap talk game. The main result is that a non-informative equilibrium always exists, whereas an informative one exists if and only if the tax

¹⁵A mixed strategy babbling equilibrium is an equilibrium in which individuals disregard announcements and the government randomizes with the same probability in booms as in recessions. At a semi-separating equilibrium the government randomizes in recessions, but not in booms. Such equilibrium is not Neologism Proof, in the sense of Farrell (1993).

rate is below a given threshold, for which we provide a closed form expression. In case of multiple equilibria, appropriate equilibrium refinements select the informative equilibrium whenever it exists. Yet, whenever the tax distortions are sufficiently high, the government is necessarily non-informative in equilibrium. We then use the critical threshold for comparative statics.

As mentioned above, let $\mu = \Pr(\theta = \vartheta|m = L)$ and $\nu = \Pr(\theta = \vartheta|m = H)$ describe individual posterior beliefs; let $E(\theta|L) = \mu\vartheta - (1 - \mu)\vartheta = (2\mu - 1)\vartheta$ and $E(\theta|H) = \nu\vartheta - (1 - \nu)\vartheta = (2\nu - 1)\vartheta$ denote the expected value of the aggregate shock, when expectations are based on posterior beliefs; and let $\bar{\theta} = p\vartheta + (1 - p)(-\vartheta) = (2p - 1)\vartheta$ denote the ex ante expected value of the aggregate shock, when expectations are based on prior beliefs.

Given posterior beliefs, individuals' best response to government's announcements is described by the following labor supply strategy:

$$\ell_{\beta}^*(m) = \{(1 - t) [\beta + E(\theta|m)]\}^{\frac{1}{\delta-1}}. \quad (1)$$

Individuals base labor supply choices on expected net wage, with an elasticity equal to $\gamma \equiv \frac{1}{\delta-1}$. Notice that most microeconomic estimates suggest a value of γ between zero and one, implying $\delta \geq 2$.

Lemmas 1 and 2 in the Appendix formally describe the government's best response to (1) in booms and in recessions, for given posterior beliefs. In booms, the government announces H if and only if $\nu \geq \mu$, since it wants to induce the highest expected value of θ and therefore the highest level of labor supply. So if H is the signal sent in booms, then it is necessarily the case that in equilibrium $\mu \leq \nu$.

We then have two cases in recessions. If $\mu = \nu$, labor supply is unresponsive to announcements, so the government is indifferent between announcing L or H . If $\mu < \nu$, the relative welfare advantage of announcing L (over announcing H) can be expressed as $\Delta W = (1 - t)^{\frac{1}{\delta-1}} Z(t)$, where

$$Z(t) = \frac{1-t}{\delta} \int_b^B (x_\nu^\delta - x_\mu^\delta) dF(\beta) - \int_b^B (\beta - \vartheta) (x_\nu - x_\mu) dF(\beta), \quad (2)$$

with

$$\begin{aligned} x_\mu &= [\beta + E(\theta|L)]^{\frac{1}{\delta-1}} = [\beta + (2\mu - 1)\vartheta]^{\frac{1}{\delta-1}}, \\ x_\nu &= [\beta + E(\theta|H)]^{\frac{1}{\delta-1}} = [\beta + (2\nu - 1)\vartheta]^{\frac{1}{\delta-1}}. \end{aligned}$$

$Z(t)$ is a decreasing function of t , capturing the fact that, given the way in which individuals map announcements to beliefs, the government, by cheating and announcing a boom, is able to raise individual expectations on wages, and therefore to stimulate labor supply.¹⁶ When taxes are zero, this is inefficient, since it induces workers to supply effort in excess of what is optimal. With positive tax rates, if the government reveals information on the recession (announces L), it induces a suboptimal level of labor supply, the further below the social optimum the higher the tax rate. By contrast, the overwork induced by cheating (announcing H) gets lower and lower the higher the tax rate (eventually becoming underwork). The government therefore prefers to announce L in recessions as long as the tax rate is below a given threshold,

$$t^*(\mu, \nu) = 1 - \frac{\int_b^B (\beta - \vartheta)(x_\nu - x_\mu) dF(\beta)}{\int_b^B \frac{1}{\delta} (x_\nu^\delta - x_\mu^\delta) dF(\beta)}, \quad (3)$$

at which the welfare cost of the overwork induced by cheating is exactly equal to the welfare cost of underwork induced by revelation.¹⁷ At higher tax rates, it announces H .

The effect of $Z(t)$ on ΔW is scaled by $(1-t)^{\frac{1}{\delta-1}}$. This term captures the

¹⁶The first and second term of $Z(t)$ reflect welfare differences due to leisure and to consumption, respectively. The terms x_μ and x_ν are defined so that (1) can be written in short as $\ell_\beta^*(L) = (1-t)^{\frac{1}{\delta-1}} x_\mu$ and $\ell_\beta^*(H) = (1-t)^{\frac{1}{\delta-1}} x_\nu$.

¹⁷Formally, at $t = t^*(\mu, \nu)$, we have $Z(t) = 0$.

fact that, by reducing labor supply after any announcement, taxes also reduce the welfare difference between revealing and hiding information. Eventually, as t approaches 1, labor supply converges to zero whatever the announcement, and the welfare difference between revealing and hiding information completely vanishes. Figure 1 plots ΔW against t for different values of ν , given $\mu = 0, \vartheta = 0.5, \delta = 3$ and a Pareto distribution of β with scale parameter $b = 1$, i.e., with support on $[b, B) = [1, \infty)$, and shape parameter $\alpha = 3$. The qualitative pattern is analogous for different parametric and distributional assumptions.

Figure 1: The incentive to reveal information on a recession as a function of tax distortion, for $\mu = 0$ and different values of ν .

In equilibrium, posterior beliefs have to be derived from government's strategy via Bayes' rule along the equilibrium path of play.

Proposition 1 (Equilibrium of the announcements game)

Given μ and ν , equilibrium labor supply strategies are described by (1).

- At a pooling equilibrium $m(\vartheta) = m(-\vartheta) = H$ and $\mu \leq \nu = p$. A pooling equilibrium always exists.
- At a separating equilibrium $m(-\vartheta) = L$, $m(\vartheta) = H$, $\mu = 0$ and $\nu = 1$. A separating equilibrium exists if and only if $t \leq t^*(0, 1)$.

Proof Consider a candidate pooling equilibrium. The government sends the same message H both in booms and in recessions. Along the equilibrium path of play, i.e., upon receiving H , individuals do not learn anything and have to base decisions on their prior beliefs: Bayes' rule implies $\nu = p$. Then by Lemma 1, the government does not deviate in booms if and only if $\mu \leq p$. The pooling equilibrium is babbling if $\mu = \nu$ and non babbling if $\mu < \nu$.¹⁸ If $\mu < p$, by Lemma 2, the government does not deviate in recessions if and only if $t \geq t^*(\mu, p)$. In turn, if $\mu = \nu$, the government never deviates in recessions. So a babbling equilibrium always exists.

Now consider a candidate separating equilibrium. The government announces H in booms and L in recessions. Bayes' rule then implies $\mu = 0$ and $\nu = 1$. Given this, by Lemma 1, the government does not deviate in booms. By Lemma 2, it does not deviate in recessions either if and only if $t \leq t^*(0, 1)$. ■

At a separating equilibrium the government sends different signals in different states of the world, so that workers can fully infer its private information. This implies that they respond to government's announcements by changing labor supply.

¹⁸A babbling equilibrium is an equilibrium in which individual labor supply strategies disregard the government's announcement, and the government's signalling strategy disregards the realization of the shock. The only difference between babbling and non babbling pooling equilibria is in terms of out of equilibrium beliefs.

At a pooling equilibrium, the government sends the same signal in any state of the world, so that workers cannot infer any information from signals, and therefore supply the same amount of labor in any state of the world, irrespective of government's announcements.

3.2 Efficiency and equilibrium selection

Let us now compare the different equilibria from an ex ante point of view, that is, when averages (or expected values) are based on the prior distribution of shocks. For an individual with ability β , let $\bar{\ell}_\beta^S$, $\bar{y}_\beta^S$, $\bar{u}_\beta^S$, and $\bar{\ell}_\beta^P$, $\bar{y}_\beta^P$, $\bar{u}_\beta^P$, denote the ex ante expected levels of labor supply, production and indirect utility, at a separating and at a pooling equilibrium, respectively.

Proposition 2 (Ex ante Pareto dominance)

For any parameter constellation, any ability distribution, and any level β of individual ability, the following holds: (i) $\bar{\ell}_\beta^S < \bar{\ell}_\beta^P \iff \delta > 2$; (ii) $\bar{y}_\beta^S > \bar{y}_\beta^P$; (iii) $\bar{u}_\beta^S > \bar{u}_\beta^P$.

Proof Labor supply by an individual with ability β , when the state of the world is θ , is $\ell_\beta^S(\theta) = (1-t)^{\frac{1}{\delta-1}}(\beta + \theta)^{\frac{1}{\delta-1}}$ at a separating equilibrium and $\ell_\beta^P(\theta) = \ell_\beta^P = (1-t)^{\frac{1}{\delta-1}}(\beta + \bar{\theta})^{\frac{1}{\delta-1}}$ at a pooling equilibrium. $y_\beta^S(\theta) = (\beta + \theta)\ell_\beta^S(\theta)$ and $y_\beta^P(\theta) = (\beta + \theta)\ell_\beta^P$ are the corresponding production levels; and $u_\beta^S(\theta) = (1-t)y_\beta^S(\theta) - \frac{[\ell_\beta^S(\theta)]^\delta}{\delta} + t \int_b^B y_\beta^S(\theta) dF(\beta)$ and $u_\beta^P(\theta) = (1-t)y_\beta^P(\theta) - \frac{(\ell_\beta^P)^\delta}{\delta} + t \int_b^B y_\beta^P(\theta) dF(\beta)$ are the corresponding levels of indirect utility. Ex ante expected levels of individual labor supply, individual production and individual indirect utility at the two equilibria are then, respectively, $\bar{\ell}_\beta^S = (1-t)^{\frac{1}{\delta-1}} \left[p(\beta + \vartheta)^{\frac{1}{\delta-1}} + (1-p)(\beta - \vartheta)^{\frac{1}{\delta-1}} \right]$ and $\bar{\ell}_\beta^P = \ell_\beta^P$; $\bar{y}_\beta^S = (1-t)^{\frac{1}{\delta-1}} \left[p(\beta + \vartheta)^{\frac{\delta}{\delta-1}} + (1-p)(\beta - \vartheta)^{\frac{\delta}{\delta-1}} \right]$ and $\bar{y}_\beta^P = (1-t)^{\frac{1}{\delta-1}} [\beta + \bar{\theta}]^{\frac{\delta}{\delta-1}}$; and $\bar{u}_\beta^S = \left(\frac{\delta-1}{\delta} \right) (1-t)\bar{y}_\beta^S + t \int_b^B \bar{y}_\beta^S dF(\beta)$ and $\bar{u}_\beta^P = \left(\frac{\delta-1}{\delta} \right) (1-t)\bar{y}_\beta^P + t \int_b^B \bar{y}_\beta^P dF(\beta)$. Points (i) and (ii) then immediately follow by convexity (or concavity), and

point (iii) is a corollary of point (ii). ■

Notice that, for any parameter constellation and ability distribution, ex ante expected levels of individual labor supply, production and indirect utility, whose relationships are identified in Proposition 2, are well defined, independently of whether a separating or a pooling equilibrium (or both) exist. Therefore Proposition 2 establishes that, for any tax rate, transparent and credible revelation of information is ex ante Pareto superior to information hiding. Yet, as we already know from the previous analysis, high tax distortions may prevent the transparent outcome from materializing in equilibrium.

The intuition behind Propositions 2 is very simple. Transparency allows individuals to work more when they are more productive and less when they are less productive. This unequivocally raises the ex ante level of individual production, relative to no information disclosure. Although it also raises the ex ante level of individual disutility of labor (since workers dislike fluctuations in labor effort), this latter effect is always more than compensated by the higher expected level of individual consumption.¹⁹

Ex ante Pareto dominance thus clearly and univocally selects the separating equilibrium whenever it exists. Yet ex ante Pareto dominance is not (always) a good selection criterion in the present context, because, whenever $t \in [t^*(0, p), t^*(0, 1)]$, government's preferences over equilibria are reversed in different states of the world: in booms the government would prefer to be in a separating equilibrium, in which it reveals its private information, thus boosting labor supply and welfare; in recessions it would prefer to be in a pooling equilibrium, in which information is not revealed, so that labor sup-

¹⁹Transparency raises individual expected leisure time if the elasticity of labor supply is $\gamma < 1$ (i.e., for $\delta > 2$). In this case, labor supply is a concave function of expected wages. This implies that, relative to the case of no information, labor supply reductions in recessions are more pronounced than increases in booms. If the elasticity of labor supply is $\gamma > 1$ (i.e., for $\delta < 2$), by contrast, labor supply is a convex function of expected wages and transparency raises individual expected labor supply, relative to information hiding.

ply and welfare are higher than with perfect information.²⁰ It is therefore worthwhile to look at different equilibrium refinements.

In Albornoz et al. (2009) we discuss three kinds of refinements: standard refinements based on Kohlberg and Mertens (1986), which restrict off-the-equilibrium-path beliefs; a recent refinement, explicitly introduced by Chen et al. (2008) to select equilibria in cheap talk games, called No Incentive to Separate (NITS); and a stronger refinement, the Neologism Proof Equilibrium, proposed by Farrell (1993). We argue that restricting off-equilibrium beliefs has little power for cheap talk games;²¹ that NITS is only selective for very low tax rates, namely for $t < t^*(0, p)$, in which case it selects the separating equilibrium; and that the separating equilibrium is the only Neologism Proof equilibrium. While we refer the reader to Albornoz et al. (2009) for the details of this analysis, the implication is that we should expect the economy to coordinate on the separating equilibrium whenever it exists. This is stated in the following remark.

Remark 1 (Equilibrium transparency for low tax distortions)

Equilibria are Neologism Proof whenever possible if and only if equilibrium government information is transparent whenever $t \leq t^(0, 1)$.*

3.3 Transparency, shocks and inequality

We restrict attention to equilibria that are Neologism Proof whenever possible. We refer to the tax rate interval $[0, t^*(0, 1)]$ as to the support of transparency, and say that parameter or distributional changes favor (reduce)

²⁰The proof of this claim follows from Proposition 1 and from the fact that, letting $W^P(-\vartheta)$ and $W^S(-\vartheta)$ denote social welfare in recession at a pooling and at a separating equilibrium, respectively, and using equations (2) and (3), we have that $W^P(-\vartheta) \geq W^S(-\vartheta) \iff [Z(t) \leq 0 \text{ for } \mu = 0 \text{ and } \nu = p] \iff t \geq t^*(0, p)$. The fact that $t^*(0, p) < t^*(0, 1)$ is proved analytically for $\delta \in \{1.5, 2\}$ in Albornoz et al. (2009), Appendix B, and it can also be shown numerically for a great variety of parameter constellations.

²¹The extension to mixed strategies matters for this argument.

transparency if they increase (decrease) $t^*(0, 1)$.²²

It is easy to show that, if shocks are small, then an increase in shock magnitude, ϑ , favors transparency, because it raises the distortion caused by information hiding in recessions, relative to the tax distortion suffered under transparency.²³ Notice that while shock magnitude is important, the frequency of booms and recessions is irrelevant for transparency, because $t^*(0, 1)$ is determined by the welfare comparison between announcing L and H , conditional upon being in recession.²⁴ Moreover, whether labor supply elasticity favors transparency or not cannot be established in general terms.²⁵

More interesting are the effects of inequality on transparency. In the next proposition we use Lorenz dominance (second order stochastic dominance) as a criterion to establish whether a distribution has more inequality than another one.

Proposition 3 (Effects of inequality)

For any parameter constellation and distributional assumption, the effects of skill inequality on transparency depend on labor supply elasticity. In particular, consider a shift from skill distribution F to a more unequal distribution G , dominated by F with respect to second order stochastic dominance.

- *If $\gamma = 1$, such an increase in inequality has no effects on transparency.*
- *If $\gamma < 1$, it favors transparency.*

²²Recall from equations (2) and (3) that $t^*(0, 1)$ is obtained by equating to zero $Z(t)$ for posterior beliefs $\mu = 0$ and $\nu = 1$. Recall as well that the first term of $Z(t)$ reflects the overall leisure utility gain caused by announcing L , relative to H , in recessions; the second term reflects the corresponding overall consumption utility loss.

²³Formally, for $\vartheta = 0$, we have $Z(t) = 0$ for all $t \in [0, 1]$. Moreover, provided $E(\beta^{\frac{2-\delta}{\delta-1}}) < \infty$, it holds that $\frac{\partial Z(t)}{\partial \vartheta} = 0 \iff t = 0$ and that $\frac{\partial Z(t)}{\partial \vartheta} < 0$ for all $t \in (0, 1]$. This implies $\lim_{\vartheta \rightarrow 0} t^*(0, 1) = 0$ and $\lim_{\vartheta \rightarrow 0} \frac{\partial t^*(0, 1)}{\partial \vartheta} = E(\beta^{\frac{2-\delta}{\delta-1}})/2E(\beta^{\frac{1}{\delta-1}}) > 0$.

²⁴Notice that this implies no discontinuity of equilibrium informational policy as fluctuation frequency vanishes. The reason is that the non informative equilibrium then converges to the informative one, since along the equilibrium path posterior beliefs are $\nu = p$, and approach perfect information as p converges to either zero or one.

²⁵In Albornoz et al. (2009) we present some numerical results on the effects of γ .

- If $\gamma > 1$, letting $\hat{\gamma} = \frac{2}{1-t^*(0,1)} > 2$, we have that $\gamma \in (1, \hat{\gamma}]$ is a sufficient condition for it to reduce transparency.

Proof Given posterior beliefs $\mu = 0$ and $\nu = 1$, from equation (2), we can write

$$Z(t) = \int_b^B z(\beta) dF(\beta),$$

where

$$z(\beta) = \frac{1-t}{\delta} \left[(\beta + \vartheta)^{\frac{\delta}{\delta-1}} - (\beta - \vartheta)^{\frac{\delta}{\delta-1}} \right] - (\beta - \vartheta) \left[(\beta + \vartheta)^{\frac{1}{\delta-1}} - (\beta - \vartheta)^{\frac{1}{\delta-1}} \right].$$

By Jensen's inequality, if $z(\beta)$ is a convex function of β at $t = t^*(0, 1)$, then an increase in inequality (in the distribution of productivity) will determine a rise in $Z(t)$ and consequently a rise in $t^*(0, 1)$. By contrast, if $z(\beta)$ is concave at $t = t^*(0, 1)$, then inequality will reduce $t^*(0, 1)$. The proposition is then a corollary of Lemma 3 in Appendix, which shows that $z(\beta)$ is linear for $\delta = 2$, strictly convex for $\delta > 2$ and strictly concave for $\delta \in [\frac{3-t}{2}, 2)$. Just recall that $\gamma = \frac{1}{\delta-1}$, so that $\gamma \leq 1 \iff \delta \geq 2$. Moreover, $t^*(0, 1) \in (0, 1)$ and, for any $t \in (0, 1)$, $\delta \geq \frac{3-t}{2} \iff \gamma \leq \frac{2}{1-t}$. ■

First notice that most of the literature on information transparency assumes $\gamma = 1$ (which means linear labor supply) and thus assumes away the effects of inequality. We elaborate below on the special case of linear labor supply. Yet the general picture is that inequality matters for government transparency, and the way it does so depends on the shape of the labor supply curve. In particular, for plausible values of labor supply elasticity (i.e., for $\gamma < 1$), inequality favors transparency.

To grasp the intuition of this result, notice that $t^*(0, 1)$ depends on the welfare comparison between (credibly) revealing and not revealing information about a recession. Given welfare convexity, inequality raises welfare under both communication regimes, so the comparison depends on whether

inequality raises welfare *faster* under transparency than under information hiding. Given our preferences, while production is always convex in ability, labor supply is concave whenever it is rigid ($\gamma < 1$). In this case, in recessions an increase in inequality lowers aggregate (or, which is the same, average, across the population) labor supply and raises aggregate (or average) production and welfare. Transparency in recessions raises leisure and reduces consumption, relative to information hiding, for each individual. Both the individual utility gain from transparency due to higher leisure and that from information hiding due to higher consumption, relative to the other communication regime, are convex in ability. In Proposition 3 we prove that, for $\gamma < 1$ (and for any tax rate), also their difference, i.e., the overall individual utility gain from transparency, relative to information hiding, is convex in ability. In other words, with rigid labor supply, the leisure component prevails on the consumption component in determining (for any tax rate) the convexity of the relative utility gain to transparency. Thus an increase in inequality indeed raises welfare in recessions *faster* under transparency than under information hiding, and so it expands the support for transparency. By contrast, for elastic labor supply, the consumption component prevails over the leisure component in determining the concavity of the relative utility gain to transparency, thus the result is reversed.²⁶

4 The Politico-Economic Equilibrium

We have considered so far the informational policy of the government for a given tax rate. We have obtained that whether or not the government is transparent critically depends on the existing tax rate being above or below of a threshold level. The value of this threshold turns out to depend on the

²⁶In detail, we show that this is true for any tax rate when $\gamma \in (1, 2]$, and that it continues to hold at $t = t^*(0, 1)$ at least for an interval of $\gamma > 2$. While we cannot offer a proof of the result for any possible higher value of labor supply elasticity, such values are indeed contrary to any empirically plausible estimate of γ .

level of inequality. Moreover, the ruling tax rate will also plausibly depend on the degree of inequality. This is certainly the case when the tax rate is chosen by majority voting. Therefore, in order to complete the model we need to examine the politico-economic equilibrium of the economy, in which the outcome of majority voting is consistent with the conditions for the existence of a given informational policy.

We now proceed to the analysis of the choice of tax rates under majority voting, assuming skewed skill distributions with the median below the mean. Denoting by β_m the median skill, i.e., $F(\beta_m) = \frac{1}{2}$, we assume $\beta_m \leq E(\beta)$. We follow the standard analysis by Meltzer and Richard (1981). As we have already mentioned, the alternative informational policies generate distinct regimes. Under truthful information individuals choose labor supply in a regime of income fluctuations with perfect certainty about the state of the world. In the other regime the government's announcements are not informative and individuals are uncertain about the true state of the world when they make labor supply choices. We first solve for the majoritarian tax rate under each informational policy and then examine the existence and properties of the politico-economic equilibrium. In particular, we restrict attention to equilibria which are Neologism Proof whenever possible, so that, according to Remark 1, if the majoritarian tax rate satisfies $t \leq t^*(0, 1)$, then the government is transparent in equilibrium.

4.1 Voting over taxes

In our model, in any state of the world and under any informational policy, individual income is monotonically increasing in individual ability. Therefore the same is true for ex ante expected individual income. Moreover, for any tax rate, there is a unique level of transfers that balances the government budget. Since consumption is a normal good, we can apply the standard analysis by Meltzer and Richard (1981) and obtain that preferences over taxes are monotonically decreasing in expected individual income, so that

the decisive voter will be the voter with median (expected) income, who is indeed the voter with median skill β_m . Under each information regime, the tax rate chosen by the median voter equalizes the elasticity of mean expected income to the tax rate (in absolute value) and the complement to one of the ratio of median to mean expected income.

Let superscripts S and P denote an informative (separating) and a non-informative (pooling) regime, respectively. In regime $i = S, P$, the ex ante expected median income is $\bar{y}_{\beta_m}^i$ and the per capita expected income is $E(\bar{y}_\beta^i) = \int_b^B \bar{y}_\beta^i dF(\beta)$. Denoting $K(x) \equiv \int_b^B (\beta + x)^{\frac{\delta}{\delta-1}} dF(\beta)$, for $x = \vartheta, -\vartheta, \bar{\theta}$, we can state the following proposition.

Proposition 4 (Majoritarian tax rate)

Given the government's information policy, the median voter selects a tax rate $t^i \in (0, 1)$ such that

$$-\frac{t^i}{E(\bar{y}_\beta^i)} \frac{dE(\bar{y}_\beta^i)}{dt} = 1 - \frac{\bar{y}_{\beta_m}^i}{E(\bar{y}_\beta^i)},$$

where $i = S$ if the government is informative and $i = P$ if it is non-informative. Explicit calculation yields

$$t^S = 1 - \frac{1}{\delta - (\delta - 1) \frac{p(\beta_m + \vartheta)^{\frac{\delta}{\delta-1}} + (1-p)(\beta_m - \vartheta)^{\frac{\delta}{\delta-1}}}{pK(\vartheta) + (1-p)K(-\vartheta)}}, \quad (4)$$

$$t^P = 1 - \frac{1}{\delta - (\delta - 1) \frac{(\beta_m + \bar{\theta})^{\frac{\delta}{\delta-1}}}{K(\bar{\theta})}}. \quad (5)$$

Proof The characterization in terms of median and mean income immediately follows from Meltzer and Richard (1981). It then just a matter of calculation to obtain the expression for t^S and t^P .²⁷ ■

²⁷To see that such tax rates are strictly between zero and one, observe that, under each information regime, the median voter's ex ante expected utility is eventually decreasing in t ; each individual's most preferred tax rate is decreasing in β ; it is strictly positive for

4.2 Politico-Economic Equilibrium

We have just determined the tax rate selected by the median voter for each given government information regime. In the previous sections we established that, given the tax rate, the equilibrium of the announcement game is informative if $t \leq t^*(0, 1)$, and non informative otherwise. We now verify whether the tax rate selected by the median voter under each possible information regime is indeed consistent with that regime.

The tax rate t^S and an informative policy by the government constitute a politico-economic equilibrium if and only if $t^S \leq t^*(0, 1)$. In turn, t^P and a non-informative policy constitute a politico-economic equilibrium if and only if $t^P > t^*(0, 1)$.

The conditions for these inequalities to hold are hard to express for a general value of δ . Both the threshold $t^*(0, 1)$ and the majoritarian tax rate depend on the degree of inequality. The wider the gap between median and mean income, the higher the tax rate preferred by the median voter. However, as we have seen in the previous section, the effect of higher inequality on the threshold tax level depends on δ . When $\delta > 2$ inequality raises the threshold level and when $\delta < 2$ inequality lowers it.

For the remainder of this section we restrict to the case of $\delta = 2$, which corresponds to linear labor supply. Moreover, for clarity of exposition, we focus on the standard case of white noise shocks, that is, with $\bar{\theta} = 0$. The extension to the case of $\bar{\theta} \neq 0$ is straightforward and is discussed below, together with the implications for the case of $\delta \neq 2$. Denote by $\epsilon \equiv \frac{\vartheta}{E(\beta)}$ the relative size of the shock; by $v \equiv \frac{V(\beta)}{E(\beta)^2}$ the normalized skill variance, where $V(\beta) = \int_b^B [\beta - E(\beta)]^2 dF(\beta)$; and by $\psi \equiv \left[\frac{\beta_m}{E(\beta)} \right]^2$ the square of the median to mean ratio. Substituting $\delta = 2$ into $t^*(0, 1)$ in (3), and into (4) and (5), and using subscript L for the case of linear labor supply, we have $t^*(0, 1) = t_L^*(0, 1)$ and $t^i = t_L^i$ for $i = S, P$, where

the individual with mean skill level $E(\beta)$; and we assumed $\beta_m \leq E(\beta)$. In Albornoz et al. (2009) we provide an explicit derivation.

$$t_L^*(0, 1) = \epsilon, \quad (6)$$

$$t_L^S = \frac{1 - \psi + v}{2 - \psi + 2v + \epsilon^2}, \quad (7)$$

$$t_L^P = \frac{1 - \psi + v}{2 - \psi + 2v}. \quad (8)$$

The case of $\delta = 2$ is a useful benchmark because the threshold tax is independent of inequality. Hence we just need to examine the conditions under which the chosen tax will be larger or smaller than the fix value ϵ . So, the larger the relative shock magnitude the wider the range of taxes that induce an informative policy by the government. Concerning t_L^S and t_L^P , it is immediate to derive the following remarks.

Remark 2 (Effects of shocks and inequality on taxes)

Both t_L^S and t_L^P are increasing in the normalized skill variance v and decreasing in the (squared) median to mean ratio ψ . Moreover, t_L^S is decreasing in the normalized shock magnitude ϵ , whereas t_L^P is independent of ϵ .

Remark 3 (Comparison between t_L^S and t_L^P)

$t_L^S \leq t_L^P$, with equality if and only if $v = \infty$. The distance between t_L^P and t_L^S increases in ϵ .

In words, inequality raises the tax rate selected by the median voter under each information regime. The median voter chooses lower taxes in the informative than in the non-informative regime. The difference in majoritarian tax rates between these two cases is increasing in the importance of information (or, which is the same, of aggregate shocks).

Observe that, for any distribution, any value of $\psi \in (0, 1)$ imposes a lower bound $(\sqrt{\psi} - 1)^2$ to the values of v compatible with it.²⁸ So any

²⁸For any $F(\beta)$, given the squared median to mean ratio ψ , since the normalized variance v is a convex function of β , it is minimized by concentrating $\frac{1}{2}$ of the normalized distribution on $\sqrt{\psi}$ and $\frac{1}{2}$ on $(2 - \sqrt{\psi})$. Hence, $v \geq (\sqrt{\psi} - 1)^2$.

feasible combination of v and ψ has to satisfy the restriction $v \geq (\sqrt{\psi} - 1)^2$. We are now ready to state existence and characterize the politico-economic equilibrium, which, according to Remark 1, is required to feature transparent information whenever $t \leq t^*(0, 1)$.

Proposition 5 (Politico-economic equilibrium)

Assume $\delta = 2$, $\bar{\theta} = 0$, and $\psi \leq 1$. Let $g(\psi, \epsilon) \equiv \frac{1-\epsilon}{1-2\epsilon}\psi - 1$. For any ability distribution and any feasible combination of ϵ , v and ψ , a politico-economic equilibrium exists.

- If $\epsilon \geq \frac{1}{2}$, then the equilibrium is informative, with tax rate t_L^S .
- If $\epsilon < \frac{1}{2}$, then the following holds.
 - for $v \leq g(\psi, \epsilon)$, the equilibrium is informative, with tax rate t_L^S ;
 - for $v > g(\psi, \epsilon) + \frac{\epsilon^3}{1-2\epsilon}$, the equilibrium is non informative, with tax rate t_L^P ;
 - for $v \in \left(g(\psi, \epsilon), g(\psi, \epsilon) + \frac{\epsilon^3}{1-2\epsilon}\right]$, then both an informative and a non informative equilibrium exist, with respective tax rate t_L^S and t_L^P .

Proof For $\epsilon \geq \frac{1}{2}$, we have $t_L^S \leq t_L^P \leq t_L^*(0, 1)$. Now consider $\epsilon < \frac{1}{2}$. In this case, $t_L^S \leq t_L^*(0, 1) \iff v \leq g(\psi, \epsilon) + \frac{\epsilon^3}{1-2\epsilon}$ and $t_L^P > t_L^*(0, 1) \iff v > g(\psi, \epsilon)$. ■

Proposition 5 conveys the following message: because the median voter is never going to select a tax rate on the decreasing side of the Laffer curve, the majoritarian tax rate is at most $\frac{1}{2}$. If $t_L^*(0, 1) \geq \frac{1}{2}$, the majoritarian tax is necessarily below $t_L^*(0, 1)$ and the unique equilibrium is informative, with tax rate t_L^S . In turn, if $t_L^*(0, 1) < \frac{1}{2}$, then at low levels of inequality the majoritarian tax rate is below $t_L^*(0, 1)$, independently of government information policy, so the unique equilibrium is again informative, with tax rate

t_L^S . At high levels of inequality the majoritarian tax rate is instead above $t_L^*(0, 1)$, again independently of government information policy, so the unique equilibrium is non-informative, with tax rate t_L^P . At intermediate levels of inequality, in turn, we have that $t_L^S \leq t_L^*(0, 1) < t_L^P$, so that there are two equilibria: one in which the government is informative and the majoritarian tax rate is t_L^S , and one in which the government is non-informative and the majoritarian tax rate is t_L^P .

Given the relative importance of aggregate shocks ϵ (and therefore given $t_L^*(0, 1)$), the measure on inequality that determines what kind of equilibrium exists depends on two features of the skill distribution: its normalized variance v and the (squared) median to mean ratio ψ . Increasing (in a feasible way) either the variance or the distance between the median and the mean (or both) moves towards higher taxes and non informative equilibria.

Figure 2 gives a qualitative representation of these results, given $\epsilon < \frac{1}{2}$. Among feasible combinations of v and ψ , the informative equilibrium exists in the area below the upper solid line, whereas the non informative equilibrium exists in the area above the lower solid line; between the two solid lines, they both exist.

Comparative statics on shock magnitude and inequality are then straightforward. Since we already discussed how majoritarian taxes depend on ϵ , v and ψ , and since for $\epsilon \geq \frac{1}{2}$ there is (always) a unique equilibrium (which is informative), we limit our discussion to the case of $\epsilon < \frac{1}{2}$ and to the effects of parameter and distributional changes on the existence range of informative and non informative politico-economic equilibria.

Figure 2: The politico-economic equilibrium under the assumptions of Proposition 5, with $\epsilon < \frac{1}{2}$.

Proposition 6 (Effects of shock magnitude)

Let $\epsilon < \frac{1}{2}$. Under the assumptions of Proposition 5, an increase in shock magnitude ϵ

- expands the existence range of informative equilibria;
- reduces the existence range of non informative equilibria.

Proof Given $\epsilon < \frac{1}{2}$, consider first $g(\psi, \epsilon) + \frac{\epsilon^3}{1-2\epsilon}$ as a function of ψ . A rise in ϵ raises its vertical intercept and makes it steeper, thus expanding the set of feasible pairs (ψ, v) such that $t_L^S \leq t_L^*(0, 1)$. Now consider $g(\psi, \epsilon)$ as a function of ψ . A rise in ϵ makes it steeper, although its vertical intercept is always $g(0, \epsilon) = -1$, for any $\epsilon \in (0, 1)$. Thus a rise in ϵ reduces the set of

feasible pairs (ψ, v) such that $t_L^P > t_L^*(0, 1)$. ■

The effects of a rise in ϵ are represented in Figure 2 by a shift from the solid to the dashed lines.²⁹ In turn, the effects of a rise in inequality, as measured by the (normalized) variance or by the (squared) median to mean ratio, are described in the following proposition.³⁰

Proposition 7 (Effects of inequality)

Under the assumptions of Proposition 5, the following holds.

- *For any $\epsilon < \frac{1}{2}$, if inequality is sufficiently low, the informative equilibrium exists. To be precise, there is a positive measure set of feasible pairs (ψ, v) , sufficiently close to $(1, 0)$, where it exists.*
- *Starting from one such pair, there exists a sufficient increase in v , such that only the non-informative politico-economic equilibrium exists.*

Proof Let $\epsilon < \frac{1}{2}$. Both the slope and the vertical intercept of $g(\psi, \epsilon) + \frac{\epsilon^3}{1-2\epsilon}$, considered as a function of ψ , tend to infinity as $\epsilon \rightarrow \frac{1}{2}$. In turn, $g(1, \epsilon) + \frac{\epsilon^3}{1-2\epsilon} = \frac{\epsilon^2+1}{1-2\epsilon}\epsilon \rightarrow 0$ as $\epsilon \rightarrow 0$. Then both results are a direct corollary of Proposition 5 and the following discussion. ■

Given $\delta = 2$ and $\bar{\theta} = 0$, the above analysis yields two results. First, inequality does not affect transparency when aggregate shocks are very important. This is due to the fact that majoritarian taxes cannot be too high, because of the inverted-U shape of the Laffer curve. Second, inequality clearly

²⁹Notice that, while Figure 2 is accurate in the qualitative features, quantitatively it over-expands the range of multiple equilibria and overlooks the convergence of the lower solid and dashed lines at $\psi = 0$. This is done to make it easier to read.

³⁰Since for normalized distributions a shift to a dominated distribution with respect to second order stochastic dominance implies an increase in (normalized) variance, we could easily rephrase Proposition 7 in terms of such increases in inequality, as we did in Proposition 3. The variance formulation is just more straightforward for the case of linear labor supply.

reduces transparency at lower levels of shock magnitude, because it raises majoritarian tax rates, eventually driving them outside the range, for which transparency is an equilibrium.³¹

Let us now consider the generalizability of the results obtained in this section. In the case of $\bar{\theta} \neq 0$, the only difference would be that the majoritarian tax rate in each information regime would be decreasing in the frequency of booms p , so that, given $\delta = 2$, a rise in p expands the support for transparent equilibria and shrinks the support for non-informative equilibria. While this would change the precise formulation of the thresholds in Proposition 5, it would not modify any other qualitative result.

If $\delta < 2$, inequality raises majoritarian taxes and reduces the threshold $t^*(0, 1)$, so that it unequivocally reduces transparency. The qualitative analysis in that case is likely to be very similar to the one we conducted. If $\delta > 2$, in turn, inequality raises both majoritarian taxes and $t^*(0, 1)$. By continuity, it seems that the qualitative results of our present analysis should extend to that case, at least as long as δ is not too high. For very high values of δ , in turn, the mechanism studied here loses interest. Indeed, as $\delta \rightarrow \infty$, labor supply becomes perfectly rigid, information manipulation becomes irrelevant and, in presence of inequality, the median voter chooses the highest possible tax rate.

5 Concluding remarks

This paper studies a model of government announcements about the future state of economic activity, in an economy characterized by government private information and persistent distortions. In the first part we take such distortions as given and show that, since they drive a wedge between social optimum and individual choices, even a benevolent government may be non-informative in an attempt to undo them. For concreteness, we focus on

³¹Recall that, by Proposition 3, for $\delta = 2$ such range is independent of inequality.

income tax distortions and on the consequent government's incentive to manipulate information to induce higher labor supply. We believe this is a novel and relevant channel. We find conditions for the emergence of informative and non-informative government communication regimes. Our analysis casts thus doubts on the commonsense view according to which the lack of government information transparency is simply a consequence of bad or corrupt bureaucrats. We also show that the informative equilibrium outcome is *ex ante* Pareto-dominant. This result suggests that in the presence of unremovable distortions, governments should commit to truthful communication. It thus provides a rationale for independent national statistical offices.

Quite naturally, we show that transparency is not an equilibrium when distortions are high. More interestingly, we find that, given tax rates, inequality has a direct effect on government transparency, which is positive or negative depending on labor supply elasticity. In particular, for plausible elasticity values (i.e., for rigid labor supply), the direct effect of inequality is to favor transparency. Yet, to the extent that inequality generates higher tax rates and therefore higher distortions, it also has an indirect effect, which reduces transparency.

To explore this mechanism, in the second part of the paper we let taxes be determined by the median voter. In this context, we find that, by raising tax distortions, inequality harms transparency. Beyond the median voter model, if the tax determination process is little sensitive to inequality, we should expect inequality and transparency to be positively correlated, whereas if the reverse is true, they are likely to be negatively correlated. We also find that shock magnitude favors transparency, since it reduces tax distortions.

We should thus expect credibility and reliability of government's information to be higher in high fluctuation times (e.g., the present crisis), and in those countries that exhibit high aggregate shocks (e.g., small open economies), low inequality if taxes are responsive to it (e.g., Scandinavia) or high inequal-

ity if they are not (e.g., the U.S.).³²

Our theory highlights the limits of equilibrium transparency when the government is benevolent, individuals are rational and no credible commitment is possible. We leave the analysis of transparency outside these assumptions for future investigation.³³ Within our framework, it is worth noting that precisely when the government lies, individuals are ex post happy that it lied. Therefore, the fact that the government's private information is ex post verifiable is not problematic. Moreover, the fact that we restrict to two elements both the state and message space polarizes equilibria on either full revelation or no revelation at all. An extension to the continuum case would generate equilibria with partial revelation and would thus allow to study the degree of information precision, but it would not affect the main intuition and the main results.³⁴

The main message of the paper goes well beyond the specific application we study. First, one can imagine different mechanisms of tax determination, without affecting the results of the first part of the paper. Second, the general idea that a benevolent government may manipulate information to undo an existing distortion can be readily applied to any kind of distortion, and not just to income taxation. Third, the argument extends to any principal-agent

³²All else equal, we predict that output and hours worked fluctuate more when the government is transparent. This is consistent with the evidence provided by Demertzis and Hughes-Hallett (2007) and with the recently uncovered negative relationship between taxation and output volatility (Debrun et al., 2008). Yet, since the government tends to be transparent when aggregate shocks are relatively large, the *ceteris paribus* condition should not be forgotten.

³³For instance, an incumbent government might want to be over-optimistic in order to influence individuals' beliefs on its ability, beyond the motives emphasized in this paper. While this would provide an extra incentive to hide bad news, we expect that it would not change our main results.

³⁴This can be seen most clearly in Albornoz et al. (2009), where mixed strategies allow for a semi-separating equilibrium. Another interesting extension concerns the case in which the government may influence individual choices both through its informational policy and through other instruments, such as monetary and fiscal policy. In this case, all the instruments in the hands of the government should be jointly modeled. This line of research remains open.

problem, in which the principal has private information on the relation between individual actions and results and can manipulate it to counterbalance the agent's suboptimal behavior.

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Appendix

Lemma 1 (Announcement in booms)

Given posterior beliefs, let individual labor supply strategies be defined by (1). In booms, the government's best response is to announce H if and only if $\nu \geq \mu$.

Proof If $\theta = \vartheta$ (i.e., in booms), social welfare is maximum when an individual with ability β chooses an effort level $(\beta + \vartheta)$. Taxes and uncertainty on θ make labor supply (1) suboptimally low, so the government's best response is to make the announcement that induces the highest expected value of θ , and therefore the highest level of labor supply. ■

Lemma 2 (Announcement in recessions)

Let individual labor supply strategies be defined by (1). If $\mu = \nu$, in recessions the government is indifferent between L and H . If $\mu < \nu$, then $t^(\mu, \nu) \in (0, 1)$; and in recessions the government's best response is to announce L if $t \leq t^*(\mu, \nu)$ and to announce H if $t \geq t^*(\mu, \nu)$.*

Proof Let $u_\beta^*(m|\theta)$ denote the utility gained by an individual with ability β when the government announces m , the true state of the world is θ , and individual strategies are described by (1), given $\mu < \nu$. If $\theta = -\vartheta$ (i.e., in recessions), we have

$$\begin{aligned} u_\beta^*(L|-\vartheta) &= (1-t)(\beta-\vartheta)(1-t)^{\frac{1}{\delta-1}}x_\mu + T^*(L|-\vartheta) - \frac{1}{\delta} \left[(1-t)^{\frac{1}{\delta-1}}x_\mu \right]^\delta, \\ u_\beta^*(H|-\vartheta) &= (1-t)(\beta-\vartheta)(1-t)^{\frac{1}{\delta-1}}x_\nu + T^*(H|-\vartheta) - \frac{1}{\delta} \left[(1-t)^{\frac{1}{\delta-1}}x_\nu \right]^\delta, \\ T^*(L|-\vartheta) &= t \int_b^B (\beta-\vartheta)(1-t)^{\frac{1}{\delta-1}}x_\mu dF(\beta), \\ T^*(H|-\vartheta) &= t \int_b^B (\beta-\vartheta)(1-t)^{\frac{1}{\delta-1}}x_\nu dF(\beta). \end{aligned}$$

The welfare difference between announcing L and H can be written as

$$\begin{aligned}
\Delta W &\equiv W(L, \ell^* | - \vartheta) - W(H, \ell^* | - \vartheta) = \\
&= \int_b^B [u_\beta^*(L | - \vartheta) - u_\beta^*(H | - \vartheta)] dF(\beta) = \\
&= (1 - t)^{\frac{1}{\delta-1}} Z(t).
\end{aligned}$$

If $\mu = \nu$, then $Z(t) = 0$ for any t . Now consider $\mu < \nu$. For $t = 1$, work effort is zero for any pair of posterior beliefs and we have $\Delta W = 0$. For $t < 1$, the sign of ΔW is equal to the sign of $Z(t)$. $Z(t)$ is a continuous function, strictly decreasing in t and with $Z(1) < 0$. We now prove that $Z(0) > 0$. Given $\mu < \nu$, we have $x_\mu < x_\nu$, so we can write

$$Z(0) = \int_b^B (x_\nu - x_\mu) \left[\frac{x_\nu^\delta - x_\mu^\delta}{\delta (x_\nu - x_\mu)} - (\beta - \vartheta) \right] dF(\beta),$$

Consider now the function $\frac{x^\delta}{\delta}$. For $\delta > 1$, it is convex and hence

$$x_\mu^{\delta-1} < \frac{x_\nu^\delta - x_\mu^\delta}{\delta (x_\nu - x_\mu)} < x_\nu^{\delta-1}.$$

From the first inequality, recalling that $x_\mu^{\delta-1} = (\beta - \vartheta + 2\mu\vartheta)$, we have $\left[\frac{x_\nu^\delta - x_\mu^\delta}{\delta (x_\nu - x_\mu)} - (\beta - \vartheta) \right] > 2\mu\vartheta$, so that

$$Z(0) > 2\mu\vartheta \int_b^B (x_\nu - x_\mu) dF(\beta) > 0.$$

Hence, $\forall(\mu, \nu) : 0 \leq \mu < \nu \leq 1$, there is a unique value of $t \in (0, 1)$, which we call $t^*(\mu, \nu)$, such that $Z(t^*(\mu, \nu)) = 0$. Explicit calculation yields (3). Hence, in recessions, for $t \in (0, t^*(\mu, \nu))$, $\Delta W > 0$ and the government strictly prefers to announce L ; for $t = t^*(\mu, \nu)$, $\Delta W = 0$ and the government is indifferent between the two signals, so that any randomization is a best response; and for $t \in (t^*(\mu, \nu), 1)$, $\Delta W < 0$ and the government strictly prefers to announce H . ■

Lemma 3 (Convexity/concavity of $z(\beta)$)

For any $t \in (0, 1)$, the function of β

$$z(\beta) = \frac{1-t}{\delta} \left[(\beta + \vartheta)^{\frac{\delta}{\delta-1}} - (\beta - \vartheta)^{\frac{\delta}{\delta-1}} \right] - (\beta - \vartheta) \left[(\beta + \vartheta)^{\frac{1}{\delta-1}} - (\beta - \vartheta)^{\frac{1}{\delta-1}} \right]$$

is linear for $\delta = 2$, strictly convex for $\delta > 2$ and strictly concave for $\delta \in \left[\frac{3-t}{2}, 2\right)$.

Proof The first and second derivative of $z(\beta)$ at a generic $t \in (0, 1)$ are

$$\begin{aligned} z'(\beta) &= \frac{1}{(\delta-1)} \left\{ (2-\delta-t) \left[(\beta + \vartheta)^{\frac{1}{\delta-1}} - (\beta - \vartheta)^{\frac{1}{\delta-1}} \right] + \right. \\ &\quad \left. - (\beta - \vartheta) \left[(\beta + \vartheta)^{\frac{2-\delta}{\delta-1}} - (\beta - \vartheta)^{\frac{2-\delta}{\delta-1}} \right] \right\}, \\ z''(\beta) &= \frac{1}{(\delta-1)^2} \left\{ (3-2\delta-t) \left[(\beta + \vartheta)^{\frac{2-\delta}{\delta-1}} - (\beta - \vartheta)^{\frac{2-\delta}{\delta-1}} \right] + \right. \\ &\quad \left. - (2-\delta)(\beta - \vartheta) \left[(\beta + \vartheta)^{\frac{3-2\delta}{\delta-1}} - (\beta - \vartheta)^{\frac{3-2\delta}{\delta-1}} \right] \right\}. \end{aligned}$$

For $\delta = 2$, $z''(\beta) = 0$ for any $t \in (0, 1)$, so $z(\beta)$ is linear.

For $\delta = \frac{3}{2}$, $z''(\beta) < 0$ for any $t \in (0, 1)$, so $z(\beta)$ is concave.

For $\delta \neq 2, \delta \neq \frac{3}{2}$, we can re-write

$$\begin{aligned} z''(\beta) &= \frac{(2-\delta)}{(\delta-1)^2} \left[(\beta + \vartheta)^{\frac{3-2\delta}{\delta-1}} - (\beta - \vartheta)^{\frac{3-2\delta}{\delta-1}} \right] \cdot \\ &\quad \cdot \left\{ \frac{(3-2\delta-t) \left[(\beta + \vartheta)^{\frac{2-\delta}{\delta-1}} - (\beta - \vartheta)^{\frac{2-\delta}{\delta-1}} \right]}{(2-\delta) \left[(\beta + \vartheta)^{\frac{3-2\delta}{\delta-1}} - (\beta - \vartheta)^{\frac{3-2\delta}{\delta-1}} \right]} - (\beta - \vartheta) \right\} \end{aligned}$$

and study the three sub-cases $\delta > 2$, $\delta \in \left(\frac{3}{2}, 2\right)$, $\delta \in \left(1, \frac{3}{2}\right)$.

For $\delta > 2$, the sign of $z''(\beta)$ is the same as the sign of the term in curly brackets. Let $a_0 = (\beta - \vartheta)^{\frac{3-2\delta}{\delta-1}}$ and $a_1 = (\beta + \vartheta)^{\frac{3-2\delta}{\delta-1}}$, notice that $a_0 > a_1$ and consider the function $g(a) = \left(\frac{3-2\delta}{2-\delta}\right) a^{\frac{2-\delta}{3-2\delta}}$. Since it is concave, we have

$\frac{g(a_0)-g(a_1)}{a_0-a_1} > g'(a_0) = (\beta - \vartheta)$. The left hand side in this inequality is the first term in the curly brackets for $t = 0$, so that we have $z''(\beta) > 0$ for $t = 0$. Since $\frac{\partial z''(\beta)}{\partial t} > 0$, we have that for any $t \in (0, 1)$, $z''(\beta) > 0$.

For $\delta \in (\frac{3}{2}, 2)$, the sign of $z''(\beta)$ is opposite to the sign of the term in curly brackets. We have $\frac{2-\delta}{3-2\delta} < 0$, so $g(a)$ is again concave, and again $a_0 > a_1$. So $\frac{g(a_0)-g(a_1)}{a_0-a_1} > g'(a_0) = (\beta - \vartheta)$ and $z''(\beta) < 0$ for $t = 0$. Since $\frac{\partial z''(\beta)}{\partial t} < 0$, we have that for any $t \in (0, 1)$, $z''(\beta) < 0$.

For $\delta \in (1, \frac{3}{2})$, using the fact that $(\beta + \vartheta)^{\frac{2-\delta}{\delta-1}} = (\beta + \vartheta)(\beta + \vartheta)^{\frac{3-2\delta}{\delta-1}}$ and $(\beta - \vartheta)^{\frac{2-\delta}{\delta-1}} = (\beta - \vartheta)(\beta - \vartheta)^{\frac{3-2\delta}{\delta-1}}$, and rearranging, we can write $z''(\beta) = \frac{1}{(\delta-1)^2} \left[A(\beta - \vartheta)^{\frac{3-2\delta}{\delta-1}} - B(\beta + \vartheta)^{\frac{3-2\delta}{\delta-1}} \right]$, where $A \equiv (\delta + t - 1)(\beta - \vartheta)$ and $B \equiv (\delta + t - 1)\beta + (3\delta + t - 5)\vartheta = A + 2(2\delta + t - 3)\vartheta$. Since $\delta \in (1, \frac{3}{2})$ implies that $(\beta - \vartheta)^{\frac{3-2\delta}{\delta-1}} < (\beta + \vartheta)^{\frac{3-2\delta}{\delta-1}}$, and $B > A \iff 2\delta + t > 3$, we have that a sufficient condition for $z''(\beta) < 0$ is $\frac{3-t}{2} \leq \delta < \frac{3}{2}$. ■