Fiscal Forward Guidance: A Case for Selective Transparency[☆]

Ippei Fujiwara[a,b,*], Yuichiro Waki[c,1]

[a]*Faculty of Economics, Keio University and ABFER, Tokyo, Japan.*
[b]*Crawford School of Public Policy, Australian National University, Canberra, Australia.*
[c]*School of Economics, the University of Queensland, Australia.*

Abstract

Should the fiscal authority use forward guidance to reduce future policy uncertainty perceived by private agents? Using dynamic general equilibrium models, we examine the welfare effects of announcing future fiscal policy shocks and show that *selective transparency* is desirable — announcing distortionary future policy shocks can be detrimental to ex ante social welfare, whereas announcing non-distortionary shocks generally improves welfare. Sizable welfare gains are found with constructive ambiguity regarding the timing of a tax increase in a realistic fiscal consolidation scenario. However, being secretive about distortionary shocks is time inconsistent, and welfare loss from communication may be unavoidable.

Keywords: fiscal policy; private information; forward guidance; news shock; Bayesian persuasion
JEL codes: D82; E62; H20; E30

1. Introduction

Forward guidance has been extensively used in the conduct of monetary policy of many developed countries since the onset of the Great Recession, and was even used by some central banks even before the crisis (Svensson, 2015). Forward guidance is thought to increase social welfare through an explicit commitment to a future course of policy action, or through the direct communication of superior information possessed by a central bank.[2] The importance of commitment has been emphasized in the New Keynesian literature in general (Woodford, 2003) as well as in the zero lower bound situation (Eggertsson and Woodford, 2003). Recent theoretical studies such as Bassetto (forthcoming) and Fujiwara and Waki (2015) investigate the situations in which the two types of forward guidance are useful or not.

This paper studies the role of the second type of forward guidance in the conduct of fiscal policy, referred to as *fiscal forward guidance*, by asking if and when the fiscal authority can improve welfare by providing its superior information about future policy actions. This question is relevant for two reasons. First, in reality, fiscal policy changes are often pre-announced. The empirical literature of fiscal policy effects recognizes that economic variables respond differently to pre-announced and to announced policy changes (Mertens and Ravn, 2010, 2011, 2012; Leeper, Walker, and Yang, 2013). Differential effects of anticipated and unanticipated shocks open up the possibility that communication by the fiscal authority may be a useful policy tool. Second, it is often argued that fiscal policy uncertainty is large: Baker, Bloom, and Davis (2016) construct newspaper-based uncertainty indices and indeed find that "[f]iscal matters, especially tax

[☆]This study is conducted as a part of the project "On Monetary and Fiscal Policy under Structural Changes and Societal Aging" undertaken at the Research Institute of Economy, Trade and Industry (RIETI). We are also grateful for financial support from JSPS KAKENHI Grant-in-Aid for Scientific Research (A) Grant Number 15H01939 and 18H03638.

[*]Corresponding author
Email addresses: ippei.fujiwara@keio.jp (Ippei Fujiwara), ywakiecon@gmail.com (Yuichiro Waki)
[1]Present address: Faculty of Economics, Aoyama Gakuin University, Tokyo, Japan.

[2]Campbell, Evans, Fisher, and Justiniano (2012) call the former kind of forward guidance *Odyssean forward guidance* and the latter *Delphic forward guidance*.

policy, stand out... as the largest source of policy uncertainty, especially in recent years." Government communication may be useful in resolving such uncertainty.

The welfare effects of fiscal forward guidance are evaluated using a standard neoclassical growth model. To focus on the role of communication, fiscal policy actions such as spending and distortionary taxes are modeled as exogenous stochastic processes. The government obtains private information about future policy shocks and sends a noisy signal to the public through fiscal forward guidance. The signal acts as a news shock, and forward guidance brings about early resolution of uncertainty regarding future policy shocks. We consider uncertainty about the level of policy actions and the timing of policy action changes.[3]

Our main finding is that the sign of the welfare effect depends on whether fiscal forward guidance is about distortionary taxes or spending. Forward guidance about future distortionary tax shocks reduces ex ante welfare, while forward guidance about spending shocks improves it. This result is first proved in a simple model, and then confirmed in a more elaborate model containing various numerical exercises. Hence, ex ante optimal communication policy features *selective transparency* — being transparent about spending shocks but secretive about tax shocks. An intuitive explanation is as follows. Imagine that shocks to spending and taxes are orthogonal. Spending news shocks improve ex ante welfare in the first-best allocation. They also move both the equilibrium allocation and the first-best allocation in a similar manner, resulting in ex ante welfare increases. However, distortionary tax news shocks do not affect the first-best when spending and taxes are orthogonal. Therefore, tax news shocks merely exacerbate inefficient fluctuations of the equilibrium allocation, reducing ex ante welfare. The above welfare implications can be reversed when shocks to spending and taxes are strongly correlated.

How large can the welfare effect of fiscal forward guidance be in a realistic setting? To answer this question, we augment a scenario of fiscal consolidation in Japan examined in Hansen and Imrohoroglu (2016) with uncertainty on the timing of a consumption tax increase. The welfare loss from being transparent about the future course of consumption taxes can be as large as 0.04% in consumption equivalent units, which is comparable to the welfare gain from smoothing business cycles in RBC models.

However, selective transparency is time inconsistent. If the government can send verifiable information to the public, the government is tempted, ex post, to communicate its private information about future tax shocks if the future tax realizations happen to be less distortionary than expected by the public. Therefore, without the ability to commit, welfare gain from selective transparency may not be achievable.

Throughout the paper our attention is limited to fiscal policy shocks. Although non-policy shocks such as technology shocks are not formally analyzed here, our conjecture is that our main result generalizes to such shocks. News about non-distortionary shocks is likely to be welfare-enhancing while news about distortionary shocks is likely to reduce welfare.[4] We also purposefully focus on the representative-agent framework for two reasons. First, it allows us to identify the key mechanism at work. Second, it demonstrates that our results do not rely on the presence of specific heterogeneity, market incompleteness, or inefficiency that may arise from uninsurable idiosyncratic risk, the overlapping generation structure, or inefficient coordination.

A number of positive studies emphasize the importance of anticipated fiscal shocks. Ramey (2011) re-examines the size of the fiscal multiplier considering the timing of the spending news, and Mertens and Ravn (2011, 2012) examine the effects of anticipated and pre-announced tax shocks in the US. Yang (2005) uses an RBC model with anticipated tax shocks to show that a standard SVAR exercise is mis-specified. Leeper, Walker, and Yang (2013) show that tax foresight creates difficulties in econometric inference on the effectiveness of fiscal policy, and examine both narrative and DSGE approaches to resolve them. Bi, Leeper, and Leith (2013) examine whether fiscal consolidation leads to economic expansion when the timing of the

[3]In Online Appendix B.1 we consider uncertainty shocks following Bloom (2009). Born and Pfeifer (2014) and Fernandez-Villaverde, Guerron-Quintana, Kuester, and Rubio-Ramirez (2015) explore the impacts of fiscal uncertainty, expressed as the time-varying volatility shocks in a canonical DSGE model using the higher-order perturbation method. Our approach is to solve the model of Brock and Mirman (1972) in a closed form to examine the effects of time-varying volatility *news* shocks.

[4]Fujiwara and Waki (2015) show that, when the only friction is price stickiness, technology shocks are non-distortionary under the optimal monetary policy and technology news shocks improve welfare.

consolidation as well as its composition are uncertain. They investigate the role of anticipated consolidation, which is modeled as policy news shocks. To the best of our knowledge, our paper is the first attempt to explore the welfare effect of fiscal policy anticipation.

Following the seminal work by Morris and Shin (2002), there is a vast literature on the role of policymakers' communication when private agents are heterogeneously and privately informed. The literature has found that transparency, modeled as an increased precision of a public signal, can reduce welfare. The underlying mechanism is strategic complementarity of individuals' actions, which can result in excessive use of a public signal as it is useful to predict the actions of others (Amato, Morris, and Shin, 2002). The mechanism in our paper is different — there is no strategic interaction, and a public signal does not help predict the actions of others in our representative-agent model.

More closely related are studies on Bayesian persuasion (Rayo and Segal, 2010; Kamenica and Gentzkow, 2011; Jehiel, 2015). There is an informed party (Sender) who observes private information, and an uninformed party (Receiver) who takes an action that affects payoffs of both parties. An informative signal from Sender affects Receiver's posterior belief and action. Assuming that Sender can commit before she observes private information to a signal-generating structure, this literature has been trying to characterize the ex ante optimal disclosure policy for the Sender in various settings. Our paper can be viewed as its application to a macroeconomic policy question.

Fujiwara and Waki (2015) examine the role of Delphic forward guidance in monetary policy using New Keynesian models in which the central bank has private information about various future shocks. As shown in this paper, secrecy about some shocks can be ex ante desirable. The main mechanism is the forward-looking New Keynesian Phillips curve that is absent in this paper.

The remainder of this paper is organized as follows. Section 2 sets up a simple, three-period model and show that selective transparency is desirable. Section 3 demonstrates the robustness of our results by numerical exercises using a standard general neoclassical growth model. In Section 4, we quantify welfare loss from transparency. Section 5 discusses the sustainability of selective transparency and possible consequences of introducing heterogeneity. Section 6 concludes.

2. A simple analytical framework

We begin our analysis with a simple model in which a future fiscal policy action is stochastic. The representative household has access to linear saving technology. Fiscal forward guidance affects the equilibrium outcome through the household's expectations and saving decision.

Time is discrete and there are three periods, $t \in \{0, 1, 2\}$. There are two actors in the economy, the representative household and the government. Fiscal policy actions such as tax and spending take place in period 2. They are exogenous random variables and are the only source of uncertainty. In period 0, both parties are endowed with common information regarding the period-2 fiscal policy, which is represented by a σ-field $\mathcal{F}_0$. A shorthand $\mathbb{E}_0[.]$ denotes the expectation operator conditional on the period-0 information, $\mathbb{E}[.|\mathcal{F}_0]$. At the beginning of period 1, the government receives private information about the period-2 policy actions and may communicate some information to the household. The representative household then Bayes-updates its belief and chooses consumption and savings optimally, and an equilibrium realizes. The information possessed by the household in period 1 after government communication is represented by a σ-field $\mathcal{F}_1^P$ with $\mathcal{F}_0 \subset \mathcal{F}_1^P$. Conditional expectation given $\mathcal{F}_1^P$, $\mathbb{E}[.|\mathcal{F}_1^P]$, is denoted by $\mathbb{E}_1^P[.]$. The superscript P is attached to emphasize that it is the private sector's expectation.

After the communication, the representative household solves:

$$\max_{C_1, C_2, S} u(C_1) + \mathbb{E}_1^P[v(C_2)]$$

subject to the period-1 budget constraint, $C_1 + S = Y_1$, and the period-2 budget constraint, $C_2 = (1 - \tau_2^K)RS + T_2$, where Y_1 is exogenous income in period 1, T_2 is lump-sum fiscal transfer in period 2, S is saving, R is a constant gross real return on saving, and τ_2^K is the savings tax in period 2. Both u and v are strictly increasing, strictly concave C^2 functions.

All the fiscal policy actions take place in period 2, and the government budget constraint is given by $G_2 + T_2 = \tau_2^K RS$, where G_2 denotes wasteful spending by the government in period 2.

The equilibrium condition is summarized by

$$1 = \mathbb{E}_1^P\Big[\frac{v'(RS - G_2)}{u'(Y_1 - S)} R(1 - \tau_2^K)\Big]. \tag{1}$$

In what follows, two policy specifications are examined.

2.1. *Specification 1: Distortionary tax shock only*

The first specification assumes that the saving tax τ_2^K is random yet the spending G_2 is constant. The lump-sum transfer T_2 adjusts to satisfy the government budget. We show that providing more information about the future distortionary tax shock can be harmful to welfare.

Equation (1) then reduces to

$$\frac{u'(Y_1 - S)}{v'(RS - G_2)R} = 1 + \mathbb{E}_1^P[-\tau_2^K].$$

Fiscal forward guidance then affects an equilibrium only through $X := \mathbb{E}_1^P[-\tau_2^K]$. The above condition implicitly defines the equilibrium saving function, $S(X)$, which is increasing due to strict concavity of u and v.

Once the household receives its information about the future tax rate, the conditional expectation variable X takes a particular value, x. The household's equilibrium utility when $X = x$ is

$$W(x) = u(Y_1 - S(x)) + \mathbb{E}_1^P[v(RS(x) - G_2)] = u(Y_1 - S(x)) + v(RS(x) - G_2).$$

We call $W(x)$ the *interim* social welfare, because it is associated with a particular realization x of X and is evaluated before the actual tax rate τ_2^K realizes. It is maximized at $x = 0$, because the first-best saving is achieved in equilibrium. Hence, deviation of X from zero is undesirable.

Our interest is, however, whether it is good from the *ex ante* point of view to enable the household to forecast future policy actions better. For this purpose, the appropriate criterion is *ex ante* welfare — the household's equilibrium expected utility evaluated at time 0: $\mathbb{E}_0 W(X) = \mathbb{E}_0[W(\mathbb{E}_1^P[-\tau_2^K])]$.

Our key finding is that the interim welfare $W(x)$ is a concave function over some interval $[x_L, x_U]$. Assuming that τ_2^K is distributed between $-x_U$ and $-x_L$, Jensen's inequality implies $\mathbb{E}_0[W(\mathbb{E}_1^P[-\tau_2^K])] \le \mathbb{E}_0[W(\mathbb{E}[-\tau_2^K|\mathcal{G}])]$ for any σ-field $\mathcal{G}$ such that $\mathcal{F}_0 \subset \mathcal{G} \subset \mathcal{F}_1^P$. In other words, if $\mathcal{F}_1^P$ is replaced with such a $\mathcal{G}$, welfare improves. This implies that ex ante welfare is higher the less information the private agents have in period 1. The following proposition formalizes this point:

Proposition 1. *Suppose that u and v are C^3 functions. Then there exists a nonempty interval $[x_L, x_U]$ around 0 such that, if τ_2^K is distributed on $[-x_U, -x_L]$, no matter what the distribution of τ_2^K is, more information reduces ex ante welfare: for any σ-field $\mathcal{G}$ such that $\mathcal{F}_0 \subset \mathcal{G} \subset \mathcal{F}_1^P$, we have $\mathbb{E}_0\left[W(-\mathbb{E}[\tau_2^K|\mathcal{F}_1^P])\right] \le \mathbb{E}_0\left[W(-\mathbb{E}[\tau_2^K|\mathcal{G}])\right]$, with strict inequality if and only if $\mathbb{E}[\tau_2^K|\mathcal{G}] \neq \mathbb{E}[\tau_2^K|\mathcal{F}_1^P]$ with non-zero probability.*

Proof is in Online Appendix A. Hence, forward guidance about future distortionary tax reduces welfare, at least in a neighborhood of the first best. The intuition is as follows. Because the first-best allocation is constant and the representative household is risk-averse, it is socially undesirable when an equilibrium allocation becomes more risky. When the household is given more information about future taxes, its tax expectations $\mathbb{E}_1^P[-\tau_2^K]$ become more accurate and move with the newly provided information that was not originally forecastable. It is as if the expectations are hit with an additional orthogonal shock. Formally, for any $\mathcal{F}_0 \subset \mathcal{G}$,

$$\mathbb{E}[-\tau_2^K|\mathcal{G}] = \mathbb{E}[-\tau_2^K|\mathcal{F}_0] + \left\{\mathbb{E}[-\tau_2^K|\mathcal{G}] - \mathbb{E}[-\tau_2^K|\mathcal{F}_0]\right\}. \tag{2}$$

The second term on the right-hand side in equation (2) is the updating term, which is, by definition, orthogonal to $\mathcal{F}_0$ and has mean zero conditional on $\mathcal{F}_0$. Therefore, $\mathbb{E}[-\tau_2^K|\mathcal{G}]$ is a mean-preserving spread of $\mathbb{E}[-\tau_2^K|\mathcal{F}_0]$, and more information makes an equilibrium allocation more risky.

2.1.1. A log utility example

Interim welfare, W, can indeed be concave not only in a very small neighborhood of $x = 0$, but for a wide range of x. To see this, consider a log utility example in which $u(C) = v(C) = \ln C$ and $R = 1$.

The equilibrium condition (1) in this case reduces to $s/(1-s) = 1 + \mathbb{E}_1^P[-\tau_2^K]$, where $s := S/Y_1$ is the saving rate. The interim welfare when $X = \mathbb{E}_1^P[-\tau_2^K]$ takes the value of x, $W(x)$, can be analytically solved as: $W(x) = \ln(1+x) - 2\ln(2+x) + 2\ln Y_1$. This function, depicted in Figure 1, is strictly concave on $[-1, \sqrt{2}]$. Hence, under the reasonable assumption that the tax rate is distributed between about -141% (i.e. 141% saving subsidy) and 100%, more information reduces welfare.

In Online Appendix B.2, we also consider an extended model with one more period. Lump-sum tax and transfer are prohibited, and in response to the period-2 tax rate shock, the government is required to adjust the period-3 tax rate in order to honor the initial debt.[5] We find that the welfare effect of forward guidance remains negative even if it is the period-3 labor tax rate, not the lump-sum tax, that adjusts. Hence, the negative welfare effect of forward guidance about the future tax rate is not an artifact of the availability of lump-sum tax and transfer.

2.2. Specification 2: Spending shock only

In the second specification, the saving tax is constant and the government spending is random. The lump-sum transfer adjusts to satisfy the government budget. When the saving tax is zero, information revelation is weakly beneficial for ex ante welfare. This is because the equilibrium allocation solves the problem of the social planner who is endowed with the same information as the household in period 1. If the planner's information set increases, ex ante welfare never decreases because the planner can always choose not to use additional information. If additional information is useful for the planner, ex ante welfare strictly improves. The logic extends to more general models unless an equilibrium is distorted.

When the saving tax is non-zero, information revelation is not necessarily beneficial for welfare. However, its welfare effect is found to be negative only in a few instances.

Consider the model in which spending can take only on two values, $G_2 \in \{G_H, G_L\}$ with $G_H > G_L$. Let ρ be the household's posterior probability of $G_2 = G_H$ at the beginning of period 1, i.e. $\rho = \mathbb{E}[I_{\{G_2=G_H\}}|\mathcal{F}_1^P]$, where $I_{\{\cdot\}}$ is the indicator function. Then an equilibrium is indexed by ρ. For a given ρ, the equilibrium condition is given by:

$$u'(Y_1 - S) = (1-\tau_2^K)R\{\rho v'(RS - G_H) + (1-\rho)v'(RS - G_L)\}.$$

Let $S(\rho)$ be the saving function, i.e. for any ρ, the above equilibrium condition is satisfied at $S = S(\rho)$. Inada condition implies that $S(\rho) \in (G_H/R, Y_1)$ as far as $\rho \in (0,1]$. Clearly $S(\rho)$ is strictly increasing in ρ. Assuming that u and v are both C^2, the implicit function theorem implies that S is a C^1 function.

Let $W(\rho)$ be the equilibrium expected utility of the household with the posterior being equal to ρ, i.e.

$$W(\rho) := u(Y_1 - S(\rho)) + \{\rho v(RS(\rho) - G_H) + (1-\rho)v(RS(\rho) - G_L)\}.$$

Ex ante utility is thus $\mathbb{E}_0[W(\rho)] = \mathbb{E}_0\left[W\left(\mathbb{E}[I_{\{G_2=G_H\}}|\mathcal{F}_1^P]\right)\right]$. As in the distortionary tax case, whether W is concave or convex plays an important role in determining the welfare effect of forward guidance.

Because the equilibrium condition implies

$$-u'(Y_1 - S(\rho)) + R\{\rho v'(RS(\rho) - G_H) + (1-\rho)v'(RS(\rho) - G_L)\} = \frac{\tau_2^K}{1-\tau_2^K}u'(Y_1 - S(\rho)),$$

the derivative of W can be written then as:

$$W'(\rho) = \frac{\tau_2^K}{1-\tau_2^K}S'(\rho)u'(Y_1 - S(\rho)) + \{v(RS(\rho) - G_H) - v(RS(\rho) - G_L)\}.$$

[5]The model also features endogenous labor supply, labor income tax, and a Cobb-Douglas production function.

The terms in braces capture the direct utility effect of changing ρ. When ρ is increased, it shifts the probability weight from the state $G_2 = G_L$ to the state $G_2 = G_H$ and has the direct utility effect. The first term captures the indirect utility effect through saving.

When $\tau_2^K = 0$, the equilibrium attains the first best. Observe that the first term disappears and that the second term is increasing in ρ. It follows that W is a *convex* function. Hence, Jensen's inequality implies more information provision *improves* ex ante welfare. If $\tau_2^K \neq 0$, however, the first term may be sufficiently strongly decreasing, thereby making W' strictly decreasing. Although there are such cases, it appears that either (i) the tax distortion needs to be large or (ii) the elasticity of intertemporal substitution needs to be large. Even when either one is assumed, W is only locally concave in these cases. The numerical examples below illustrate that negative effects of information provision are obtained only when ρ lies in a relatively small subset of $(0, 1]$. Overall, forward guidance about future (non-distortionary) spending shocks tends to increase ex ante welfare.

2.2.1. Numerical examples

In the first example, log utility is assumed: $u(c) = v(c) = \ln c$. Parameters are $R = 1$, $Y_1 = 1$, $G_H = 0.3$, $G_L = 0.1$, and $\tau_2^K = 0.6$. The second example uses a CRRA utility $u(c) = v(c) = c^{1-\sigma}/(1-\sigma)$ with $\sigma = 0.2$. Hence, the elasticity of intertemporal substitution is 5. The saving tax is set to 0.2. Other parameters are the same as in the first example.

The top left panel in Figure 2 shows the W' function in example 1. It is decreasing up to around $\rho = 0.2$ while increasing for higher ρ. When τ_2^K is lowered to 0.4, the function W' is mostly increasing, except for very low values of ρ as shown in the top right panel. The bottom left panel depicts the W' function in the second example. Again, for some low values of ρ, this function is decreasing. The function becomes mostly increasing when τ_2^K is lowered to 0.1 from 0.2.

2.3. Discussion

It is important to note that the undesirability of revealing information about the saving tax shock does not require that an equilibrium has zero distortion to start with, i.e. $\mathbb{E}_0\tau_2^K = 0$. In such a case, any information moves the expected tax away from zero, which is the peak of the interim welfare function. Hence, any news is bad news. This resembles a well-known result in optimal capital taxation: a completely surprise capital taxation is non-distortionary. However, the analogy is valid only when the expected tax rate is initially zero. The negative welfare effect of news holds true more generally, despite the fact that some news can move the expected tax closer to zero and improves the *interim* welfare.

Because it is possible that credible revelation of tax news increases interim welfare for some realizations of news, being secretive about future policy shocks is time-inconsistent. When the tax distortion happens to be smaller than expected, such information is good news and interim welfare increases if the household obtains the information. If the government is unable to commit, it may be tempted to release some information to the private sector to raise interim welfare even when it is undesirable ex ante.

2.3.1. Bayesian persuasion

Our results are closely related to the literature of Bayesian persuasion. Our model can be easily mapped into that of Bayesian persuasion: the government is the informed party (Sender) that designs and commits to information disclosure policy to maximize its ex ante expected payoff, and the private agents constitute the uninformed party (Receiver) that takes actions based on its posterior belief. Optimal fiscal forward guidance corresponds to the optimal disclosure policy considered in this literature.[6]

We have related the welfare effect of forward guidance to whether interim welfare is concave or convex in Receiver's posterior belief. This result can be viewed as a corollary of those in Kamenica and Gentzkow (2011), which show that gains from disclosure arise from a "concavification" of Sender's expected utility

[6] There are also studies that examine the effects of information acquisition in principal-agent problems. For example, Sobel (1993) examines how the timing at which the agent has access to information never observed by the principal affects the principal's payoff in a moral hazard problem.

written as a function of Receiver's posterior belief. If this function is concave, a further concavification is irrelevant, and there is no gain from disclosure. If it is convex, a concavification through full transparency is desirable. Interim welfare in our model corresponds to this function. At the same time, our result does not rely on multidimensional private information when showing undesirability of information revelation, unlike Rayo and Segal (2010) and Jehiel (2015).[7]

Our contribution is to show that the basic insight of Bayesian persuasion can be extended to relevant macroeconomic policy questions. In macroeconomic models, various distortions introduce wedges between the social and the private incentives, causing misalignments of incentives even when the social objective is to maximize household utility. Socially optimal disclosure policy may feature non-transparency.

3. A general neoclassical growth model

Now we set up a more elaborate neoclassical growth model to examine a case where the timing of policy change is uncertain and a case where the spending and tax shocks are imperfectly correlated.[8] A calibrated version of this model is also used to quantify the welfare effect.

As in the previous model, all economic agents start in period 0 with the same information. From period 1 on, without forward guidance, the private sector can observe only contemporaneous shocks. With forward guidance, the private sector is assumed to observe *perfectly* n-period ahead shocks each period. We examine how ex ante welfare changes as n increases from zero. Section 3.3 summarizes the findings when future shocks are only observed imperfectly.

The representative household maximizes $U(c_1, l_1) + \mathbb{E}_1^P \sum_{t=2}^{\infty} \beta^{t-1} U(c_t, l_t)$ subject to the budget constraint, $(1+\tau_t^C)c_t + k_{t+1} = (1-\tau_t^K)r_t k_t + (1-\tau_t^L)w_t l_t + (1-\delta)k_t + T_t$, for all $t \geq 1$, taking the initial capital $k_1 = \overline{K}_1$ as given. The utility function $U(c, l)$ is given by $(c^{1-\sigma} - 1)/(1-\sigma) - \chi l^{1+\eta}/(1+\eta)$. The representative firm owns the Cobb-Douglas production technology $Y = K^\alpha L^{1-\alpha}$ and maximizes its profit taking the rental rate for capital, r, and wage, w, as given. Its optimality condition is given by $r_t = \alpha K_t^{\alpha-1} L_t^{1-\alpha}$ and $w_t = (1-\alpha) K_t^\alpha L_t^{-\alpha}$.[9] The government uses its tax revenue for spending, G, and lump-sum transfer to the household, T. Its budget constraint is $\tau_t^C C_t + \tau_t^K r_t K_t + \tau_t^L w_t L_t = G_t + T_t$. Finally, the resource constraint is $C_t + K_{t+1} = K_t^\alpha L_t^{1-\alpha} + (1-\delta)K_t$. Again ex ante welfare is the welfare criterion: $\mathbb{E}_0 \sum_{t=1}^{\infty} \beta^{t-1} U(c_t, l_t)$.

3.1. Timing uncertainty

First we consider a case with timing uncertainty. Our preferred interpretation is that the government may have some discretion over the exact timing of implementing policy changes.[10] Empirically, as illustrated by Mertens and Ravn (2012), implementation lags across tax liability changes are widely distributed, suggesting that the timing of implementation may be uncertain ex ante.[11]

To model the timing uncertainty, we assume that the private sector knows that distortionary tax or government spending will change to a known level, but does not know exactly when the change will

[7]Still, we can interpret our results through the insight provided by Jehiel (2015), that the relative concavity of Receiver's utility and the relative sensitivity of Sender's utility are crucial. Consider two states, $\tau_{high}^K > \tau_{low}^K > 0$. Under full disclosure, the household's saving is more downwardly distorted in the τ_{high}^K state than in the τ_{low}^K state. By not revealing the information, the government can increase the household saving in the τ_{high}^K state while reducing it in the τ_{low}^K state. Note that, because the household's utility is concave in saving, interim welfare is more sensitive to the household saving in the τ_{high}^K state. The welfare gain in the τ_{high}^K state is big enough to offset the welfare loss in the τ_{low}^K state, due to the relative sensitivity.

[8]Online Appendix B.1 derives some analytical results for the Brock-Mirman model. Forward guidance reduces welfare, whether it is about the timing of future tax changes or a future second-moment ("uncertainty") shock to the saving tax.

[9]Here, c_t, k_t, and l_t denote consumption, capital, and labor at the individual level in period t, and C_t, K_t, and L_t denote the same variables at the aggregate level.

[10]In 2011, the then Japanese Prime Minister Noda announced the consumption tax hike to 8% in 2014 and then to 10% in 2015, and it was approved by the upper house plenary session. In 2014, after the first tax increase to 8%, the Prime Minister Abe postponed the second tax increase but made it explicit that it should be implemented in 2017. It was postponed further in 2016.

[11]There are cases in which implementation timing have been clearly announced. For example, D'Acunto, Hoang, and Weber (2016) estimate the impact of unexpected VAT rate change, of which implementation timing was announced explicitly.

occur. Although the model has four policy variables, $(\tau_t^C, \tau_t^K, \tau_t^L, G_t)$, only one of them is turned on at a time. The model is calibrated to annual frequency, and parameter values are reported in Table 1. Computation uses the endogenous grid method (see Online Appendix C for details).

The results in the three-period model hold true in this general setting — news about a future distortionary tax change reduces ex ante welfare, but news about a future spending change increases it. Because the results for labor income and consumption taxes are qualitatively the same as those for capital income tax, they are reported in Online Appendix D.

3.1.1. Capital income tax

Suppose that τ_t^K follows a two-state Markov chain with initial condition $\tau_1^K = 30\%$, that τ_t^K switches from 30% to the steady state value of 20% with probability $1 - p$, and that 20% is the absorbing state. The persistence parameter p is set to 0.8.

Figure 3a shows that ex ante welfare decreases with n. It decreases steeply for small n's, suggesting that the marginal welfare loss from additional information is bigger when private agents do not possess much information about future shocks. Mertens and Ravn (2012) report that the median anticipation horizon for anticipated tax shocks is six quarters in the post-World War II US data, which is where the marginal welfare loss is large in the figure. Secrecy emerges as an optimal communication policy for future tax changes.

Now we use the $n = 10$ case to illustrate the time-inconsistency problem. At time 1, there are 11 possibilities: the household foresees either that the capital income tax will be reduced for sure at time $t \in \{2, 3, ..., 11\}$ or that the tax will be cut after $t = 12$. For each possibility, interim welfare in period 1 is computed and plotted in Figure 3b with the tax-cut timing on the horizontal axis. Interim welfare in period 1 is decreasing in the tax-cut timing — the earlier the distortionary tax is cut, the higher the interim welfare. If the government is unable to commit, it is tempted to announce the timing of the tax cut when it is earlier than originally expected.

3.1.2. Spending

For the spending news case, we assume that government spending is initially 10% of the steady state output and then doubles. All distortionary taxes are constant. Figures 3c and 3d display ex ante and interim welfare. Even though the equilibrium is not efficient due to constant distortionary taxes, news about future spending increases ex ante welfare.

3.1.3. Robustness

The welfare effect of announcement declines when taxes are made less distortionary. For example, when σ is raised from unity, it lowers the elasticity of intertemporal substitution. A lower elasticity implies that the household's response to news about intertemporal distortion is small, and thus the capital income tax news has a small effect on the equilibrium outcome. Another example is when the capital income tax is imposed on the after-depreciation rental rate, $r_t - \delta$, and not on the rental rate itself, r_t. A distortive effect of tax becomes smaller.

3.2. Correlation between spending and taxes

Now let us examine cases where these shocks are correlated. Positive correlation occurs, for example, when tax revenue adjusts to satisfy spending need. Negative correlation is likely during fiscal consolidation in which the government cuts spending while raising taxes.[12]

To allow for imperfect correlation, it is convenient to assume that tax and spending shocks follow continuous stochastic processes. The consumption tax is set to 10%. The capital and labor income tax rates are assumed to be the same: $\tau_t^L = \tau_t^K = \tau_t$. Both G_t and τ_t are modeled as AR(1) processes: $\ln G_t = (1 - \rho) \ln G_{ss} + \rho \ln G_{t-1} + \epsilon_t^g$, and $\ln \tau_t = (1 - \rho) \ln \tau_{ss} + \rho \ln \tau_{t-1} + \epsilon_t^\tau$. The same AR(1) coefficient, ρ, is used to make the two processes roughly comparable. Also, the variances of ϵ_t^g and ϵ_t^τ are set to the same number,

[12] Using the US narrative record, Romer and Romer (2010) find that spending-driven tax changes have been virtually non-existent after 1975 and that deficit-driven tax changes occurred rather frequently between late 1970s and early 1990s.

$\nu > 0$, and the steady state relationship $\tau_{ss} = G_{ss}/Y_{ss}$ is imposed. Hence, spending, G_t, and a proxy for tax revenue, $\tau_t Y_{ss}$, have the same probability distribution.

Two specifications are examined. In the first specification, the n-period ahead tax shock is perfectly observed and is correlated with a shock to spending, but spending is also hit by a surprise shock. In the second specification, it is the spending shock that is perfectly observed and a surprise shock hits the tax rate. Let $\{u_t^1\}$ and $\{u_t^2\}$ be independent, IID standard normal random sequences. Their subscript denotes when these shocks are observed. In the first specification, $\epsilon_t^\tau = \sqrt{\nu} u_{t-n}^1$ and $\epsilon_t^g = \sqrt{\nu}(\sqrt{1-\gamma^2} u_t^2 + \gamma u_{t-n}^1)$, where ν is the variance of ϵ's and $\gamma \in [-1, 1]$ is the correlation coefficient of ϵ_t^τ and ϵ_t^g. In the second, $\epsilon_t^g = \sqrt{\nu} u_{t-n}^1$ and $\epsilon_t^\tau = \sqrt{\nu}(\sqrt{1-\gamma^2} u_t^2 + \gamma u_{t-n}^1)$. Parameter values are reported in Table 2. The model is calibrated to quarterly frequency. Because the state space is high dimensional for large n, we solve the model by a second order approximation using Dynare.

Figures 4a and 4b show the results for the first and second specifications, respectively. They display, at each level of correlation, how ex ante welfare changes with n. For each value of the correlation coefficient, ex ante welfare when $n = 0$ is normalized at 0, and welfare for $n \geq 1$ is expressed in consumption-equivalence (%). When shocks are uncorrelated, the tax news reduces welfare whereas the spending news increases it, confirming our previous results. The welfare effect in the first specification remains negative when γ is less than 0.2. In contrast, the welfare effect in the second specification is positive unless γ is lowered to around -0.7. Comparison between Figures 4a and 4b reveals that, for a given correlation structure and given n, ex ante welfare is higher in Figure 4b. Hence, using the tax news to convey information about future spending is inefficient.

In sum, unless the spending and tax shocks have strong negative correlation, the government should provide accurate information about future spending shocks while hiding information about future tax shocks as much as possible. However, when these shocks are strongly and negatively correlated, the government should not reveal spending news either. This suggests that constructive ambiguity about future fiscal consolidation can be welfare improving because spending and taxes are expected to have negative correlation under fiscal consolidation.

3.3. Partial disclosure

So far, numerical experiments have only compared full disclosure with no disclosure. Online Appendix E examines partial disclosure — the private agents receive imperfect signals about the future policy shocks. Our results are robust: if the information is about the tax shock, improving the signal precision reduces ex ante welfare; if instead the information is about the spending shock, more accurate signals are better for welfare.

4. Quantifying the welfare effects

Our last exercise quantifies the welfare effect of forward guidance using a specific fiscal consolidation scenario. Hansen and Imrohoroglu (2016) use a neoclassical growth model to quantify the fiscal adjustment needed for Japan to reduce the long-run debt-to-GDP ratio to 60%. One of their experiments involves a very sharp increase in consumption tax to approximately 60% when the debt-to-GDP ratio hits 250%, and then a decline to 47% when the debt-to-GDP ratio reaches the assumed target of 60%.

The Markov switching model in Section 3.1 is employed again. Parameter values are set in accordance with Hansen and Imrohoroglu (2016) and reported in Table 3.[13] Policy uncertainty is modeled as follows. The consumption tax follows a two-state Markov chain. The initial tax rate is 8%. The tax rate changes to 50% with probability 0.3 each period, and 50% is the absorbing state. Because the fiscal reform takes place in year 2018 in Hansen and Imrohoroglu (2016), we choose the transition probability of 0.3 to make the

[13] Our model does not incorporate utility from real bond holdings and, therefore, debt repayment is equivalent to lump-sum transfer. It also abstracts from technology and population growth, but their values are almost zero in Hansen and Imrohoroglu (2016).

probability of the fiscal reform *not* taking place for 10 years sufficiently low. It is $0.7^{10} \approx 0.028 < 0.03$ with our choice.[14] Other taxes and spending are fixed at constant values.

Again, private agents observe the tax rates in the next n periods and welfare is computed for different values of n. Figure 5 shows ex ante welfare as a function of n. Welfare loss monotonically increases to around 0.04% as n is increased, and most of the loss materializes when n is raised from 0 to 3. There is a welfare gain from constructive ambiguity about the timing of fiscal consolidation, and its size is comparable to the gain from business cycle smoothing in representative-agent models.

5. Discussion

Is selective transparency sustainable? As discussed already, a time-inconsistency problem on the part of the government hinders the implementation of selective transparency. Because private agents can profit from *unilaterally* obtaining more information, including future tax shocks, the government may be subject to pressure to release its private information. Hirshleifer (1971) shows that the private gain from information acquisition and dissemination may exist even if the information does not have any social value. Hence, when information acquisition and dissemination are costly, these costs will be wasted. In our setting, the social value of tax news is indeed negative, but the private sector wastes resources trying to acquire the information. A formal analysis is warranted to understand if and when selective transparency is sustainable or not.

Departures from a representative-agent framework. Following Morris and Shin (2002), numerous studies have examined the role of information provision by a policymaker when private agents are heterogeneously informed. In a static example with quadratic objectives, Angeletos and Pavan (2007) show that more precise information increases welfare if the signal is about an "efficient" shock that moves the social and private objectives in the same way, and that it decreases welfare if it is about an "inefficient" shock that acts as a wedge between the two objectives. Although there is no clear mapping from our dynamic economy to their economy, perhaps it is natural to interpret a spending news shock as an efficient shock and a distortionary tax news shock as an inefficient one. Hence, our conjecture is that selective transparency would remain optimal when private agents are heterogeneously informed.

Heterogeneity may provide other channels through which forward guidance affects welfare. Public information revelation before trading hinders risk-sharing opportunities because it transforms risk into heterogeneity (known as the Hirshleifer (1971) effect). Risk-averse individuals may prefer zero public information revelation ex ante. At the same time, with heterogeneity and incomplete markets, unexpected policy shocks may generate redistribution ex post and act as a surprise, uninsurable redistribution shock. This could be undesirable ex ante. Forward guidance about such shocks may improve welfare.

6. Conclusion

What are the welfare consequences of fiscal forward guidance? It can be detrimental to ex ante welfare when it is about future distortionary tax shocks, while it can be welfare-enhancing if it is about future spending. Hence, optimal forward guidance takes the form of selective transparency. This result is shown analytically in some models and demonstrated numerically in more general models. Welfare gain from selective transparency is found to be big for large, but not totally unrealistic, fiscal adjustments.

Acknowledgement: We thank Kosuke Aoki, Marco Bassetto, Paul Beaudry, Andres Bellofatto, Efrem Castelnuovo, Masaru Inaba, Luigi Iovino, Olivier Jeanne, Kei Kawakami, Keiichiro Kobayashi, Ryo Jinnai, Sagiri Kitao, Nobu Kiyotaki, Anton Korinek, Ellen McGrattan, Bruce Preston, an anonymous referee, the associate editor (Francesco Bianchi) and the editor (Yuriy Gorodnichenko), and participants at the 2016 Southern Workshop In Macroeconomics (SWIM) at University of Auckland, the AJRC and HIAS Joint Conference on Recent Issues in Finance and Macroeconomics at ANU, the 3rd Annual Workshop of the

[14]Hence, delayed consolidation does not require higher tax rates. Bi, Leeper, and Leith (2013) take it into account and investigate the consequences from fiscal consolidations in a model where timing and composition of fiscal consolidation is uncertain.

Australasian Macroeconomics Society (WAMS), and seminars at the RIETI, Bank of England, Bocconi University, University of Washington, Keio University, the University of Tokyo, and Hitotsubashi University for useful comments and discussions.

Amato, J. D., S. Morris, and H. S. Shin (2002): "Communication and Monetary Policy," *Oxford Review of Economic Policy*, 18(4), 495–503.

Angeletos, G.-M., and A. Pavan (2007): "Efficient Use of Information and Social Value of Information," *Econometrica*, 75(4), 1103–1142.

Baker, S. R., N. Bloom, and S. J. Davis (2016): "Measuring Economic Policy Uncertainty," *The Quarterly Journal of Economics*, 131(4), 1593–1636.

Bassetto, M. (forthcoming): "Forward Guidance: Communication, Commitment, or Both?," *Journal of Monetary Economics*.

Bi, H., E. M. Leeper, and C. Leith (2013): "Uncertain Fiscal Consolidations," *Economic Journal*, 0, F31–F63.

Bloom, N. (2009): "The Impact of Uncertainty Shocks," *Econometrica*, 77(3), 623–685.

Born, B., and J. Pfeifer (2014): "Policy risk and the business cycle," *Journal of Monetary Economics*, 68(C), 68–85.

Brock, W. A., and L. J. Mirman (1972): "Optimal economic growth and uncertainty: The discounted case," *Journal of Economic Theory*, 4(3), 479–513.

Campbell, J. R., C. L. Evans, J. D. Fisher, and A. Justiniano (2012): "Macroeconomic Effects of Federal Reserve Forward Guidance," *Brookings Papers on Economic Activity*, 44(1 (Spring), 1–80.

D'Acunto, F., D. Hoang, and M. Weber (2016): "Unconventional Fiscal Policy, Inflation Expectations, and Consumption Expenditure," *mineo*.

Eggertsson, G. B., and M. Woodford (2003): "The Zero Bound on Interest Rates and Optimal Monetary Policy," *Brookings Papers on Economic Activity*, 34(1), 139–235.

Fernandez-Villaverde, J., P. Guerron-Quintana, K. Kuester, and J. Rubio-Ramirez (2015): "Fiscal Volatility Shocks and Economic Activity," *American Economic Review*, 105(11), 3352–84.

Fujiwara, I., and Y. Waki (2015): "Private news and monetary policy," Globalization and Monetary Policy Institute Working Paper 238, Federal Reserve Bank of Dallas.

Hansen, G., and S. Imrohoroglu (2016): "Fiscal Reform and Government Debt in Japan: A Neoclassical Perspective," *Review of Economic Dynamics*, 21, 201–224.

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

Jehiel, P. (2015): "On Transparency in Organizations," *Review of Economic Studies*, 82(2), 736–761.

Kamenica, E., and M. Gentzkow (2011): "Bayesian Persuasion," *American Economic Review*, 101(6), 2590–2615.

Leeper, E. M., T. B. Walker, and S. S. Yang (2013): "Fiscal Foresight and Information Flows," *Econometrica*, 81(3), 1115–1145.

Mertens, K., and M. Ravn (2010): "Measuring the Impact of Fiscal Policy in the Face of Anticipation: A Structural VAR Approach," *Economic Journal*, 120(544), 393–413.

Mertens, K., and M. O. Ravn (2011): "Understanding the Aggregate Effects of Anticipated and Unanticipated Tax Policy Shocks," *Review of Economic Dynamics*, 14(1), 27–54.

Mertens, K., and M. O. Ravn (2012): "Empirical Evidence on the Aggregate Effects of Anticipated and Unanticipated US Tax Policy Shocks," *American Economic Journal: Economic Policy*, 4(2), 145–81.

Morris, S., and H. S. Shin (2002): "Social Value of Public Information," *American Economic Review*, 92(5), 1521–1534.

Ramey, V. A. (2011): "Identifying Government Spending Shocks: It's all in the Timing," *The Quarterly Journal of Economics*, 126(1), 1–50.

Rayo, L., and I. Segal (2010): "Optimal Information Disclosure," *Journal of Political Economy*, 118(5), 949–987.

Romer, C. D., and D. H. Romer (2010): "The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks," *American Economic Review*, 100(3), 763–801.

Sobel, J. (1993): "Information Control in the Principal-Agent Problem," *International Economic Review*, 34(2), 259–269.

Svensson, L. E. (2015): "Day One Keynote Address: Forward Guidance," *International Journal of Central Banking*, 11(4), 19–64.

Woodford, M. (2003): *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton University Press, Princeton.

Yang, S.-C. S. (2005): "Quantifying tax effects under policy foresight," *Journal of Monetary Economics*, 52(8), 1557 – 1568.

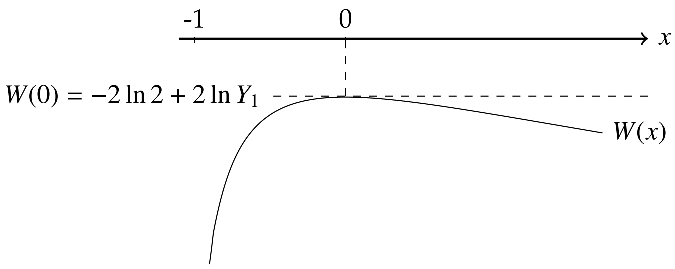
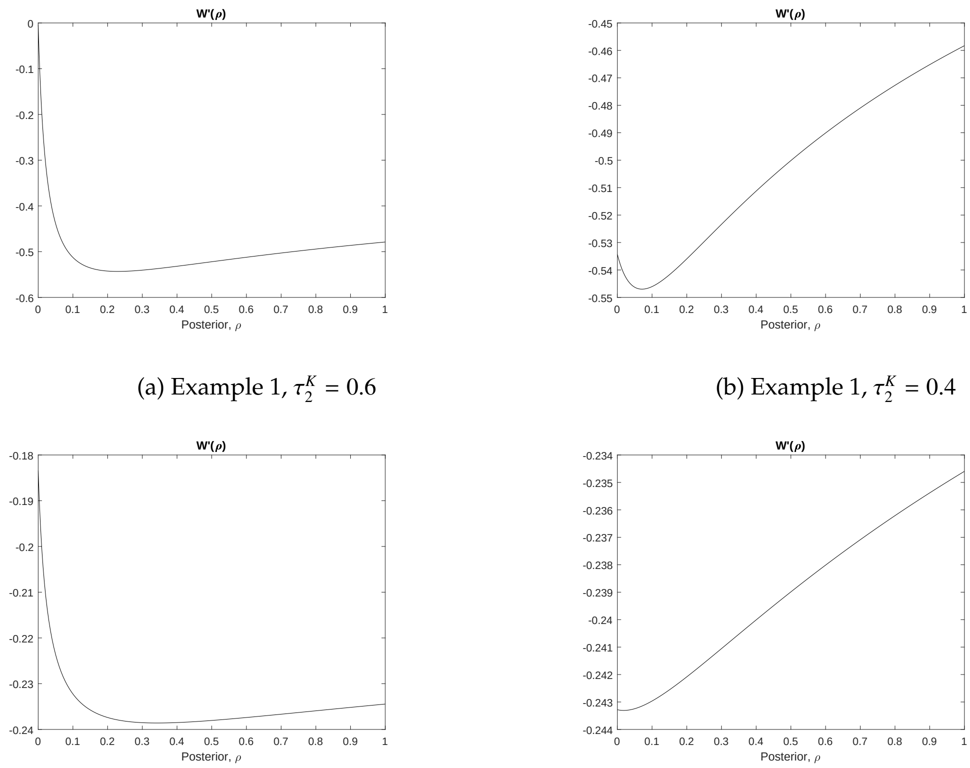


Figure 1: Interim social welfare as a function of a realization x of $\mathbb{E}_1^P[-\tau_2^K]$



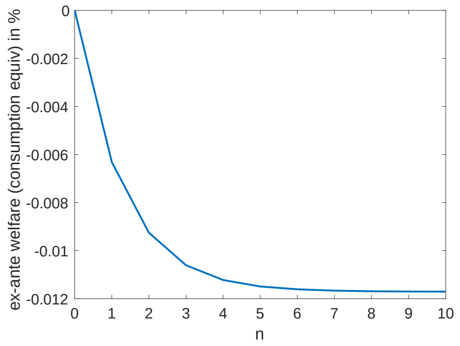
(a) Example 1, $\tau_2^K = 0.6$

(b) Example 1, $\tau_2^K = 0.4$

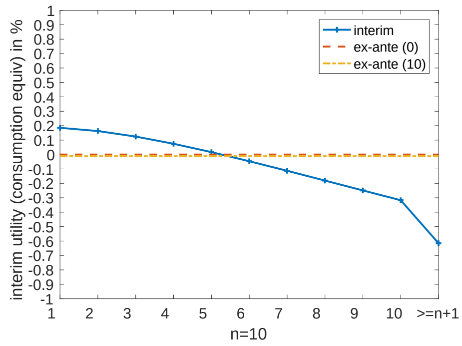
(c) Example 2, $\tau_2^K = 0.2$

(d) Example 2, $\tau_2^K = 0.1$

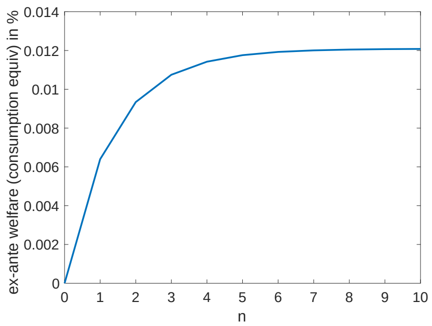
Figure 2: Derivative of interim welfare, $W'(\rho)$. Spending shock only.



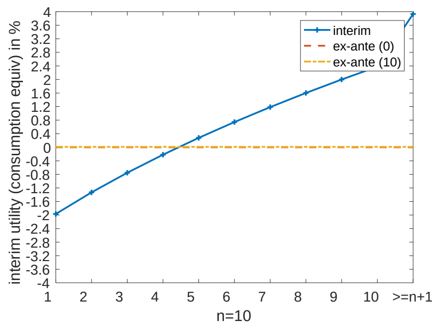
(a) Capital income tax: ex ante welfare



(b) Capital income tax: interim welfare



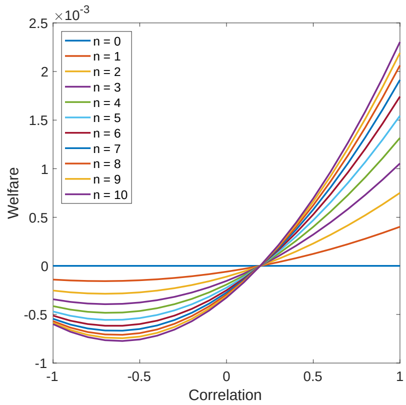
(c) Spending: ex ante welfare



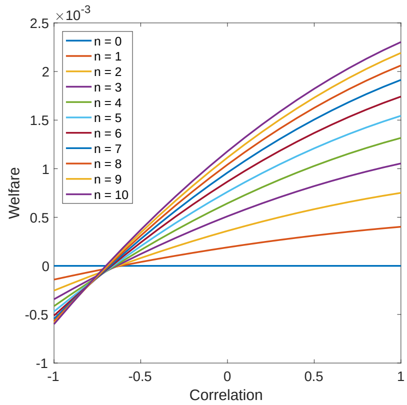
(d) Spending: interim welfare

Left panels show ex ante welfare when the private sector observes n-period ahead shocks. Welfare are expressed in consumption unit, relative to welfare at $n = 0$. Right panels display interm welfare for $n = 10$ for different values of private information.

Figure 3: Ex ante and interim welfare measured in consumption unit: capital income tax and government spending



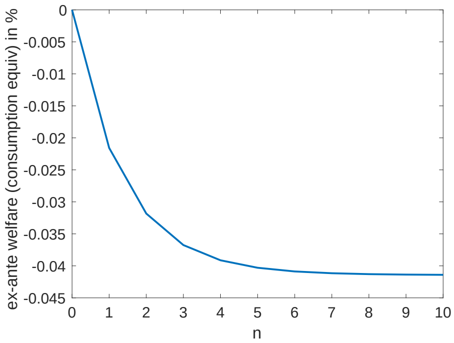
(a) τ news shock



(b) G news shock

Ex ante welfare when the private sector observes n-period ahead shocks, for different values of correlation. At each value of correlation, welfare are expressed in consumption unit, relative to welfare at $n = 0$.

Figure 4: Welfare gain from news



Ex ante welfare when the private sector observes n-period ahead shocks. Welfare are expressed in consumption unit, relative to welfare at $n = 0$.

Figure 5: Ex ante welfare in consumption unit

Table 1: Parameter values for the model with timing uncertainty

Preference parameters	
Discount factor, β	0.96
Relative risk aversion, σ	1
Labor disutility weight, χ	1
Inverse of the Frisch elasticity of labor supply, η	1
Technology parameters	
Capital share parameter, α	0.3
Depreciation rate, δ	0.1
Fiscal policy parameters in the steady state	
Spending share in output, G/Y	0.2
Consumption tax, τ^C	0.1
Capital income tax, τ^K	0.2
Labor income tax, τ^L	0.2
Initial capital, $\overline{K}_1$, relative to the steady state	80%

Table 2: Parameter values for the model with correlated shocks

Preference parameters	
Discount factor, β	0.99
Relative risk aversion, σ	1
Labor disutility weight, χ	1
Inverse of the Frisch elasticity of labor supply, η	1
Technology parameters	
Capital share parameter, α	0.3
Depreciation rate, δ	0.03
Fiscal policy parameters in the steady state	
Spending share in output, G/Y	0.2
Consumption tax, τ^C	0.1
Capital income tax, τ^K	0.2
Labor income tax, τ^L	0.2
Fiscal policy shock parameters	
AR(1) coefficient, ρ	0.9
Unconditional variance of $\ln G_t$ and $\ln \tau_t$, $v/(1-\rho^2)$	0.0025

Table 3: Parameter values for the Hansen-Imrohoroglu experiment

Preference parameters	
Discount factor, β	0.9677
Relative risk aversion, σ	1
Labor disutility weight, χ	22.6331
Inverse of the Frisch elasticity of labor supply, η	2
Technology parameters	
Capital share parameter, α	0.3783
Depreciation rate, δ	0.0842
Fiscal policy parameters in the steady state	
Spending share in output, G/Y	0.2362
Consumption tax, τ^C	0.5
Capital income tax, τ^K	0.3557
Labor income tax, τ^L	0.3324