UNIVERSITY OF CAMBRIDGE

Faculty of Economics

Cambridge Working Papers in Economics

Cambridge Working Papers in Economics: 1761

A SHORT NOTE ON OPTIMAL DEBT MANAGEMENT UNDER ASYMMETRIC INFORMATION

Elisa Faraglia   Albert Marcet   Rigas Oikonomou   Andrew Scott

14 July 2017

We show that under asymetric information, if the government holds advanced information relative to the investors.some debt management policies may lead to bond market instability. The In particular, we show that the repurchase/reissuance strategy assumd in most of the current debt management literature would cause such a crisis and it would be therefore highly suboptimal.of a bond below its maturity this does compromise the ability of long bonds to provide fiscal insurance.

A Short Note on Optimal Debt Management under Asymmetric Information

Faraglia, Elisa * Marcet, Albert† Oikonomou, Rigas ‡ Scott, Andrew §

Preliminary Version

July 14, 2017

Abstract

We show that under asymetric information, if the government holds advanced information relative to the investors' some debt management policies may lead to bond market instability. The In particular, we show that the repurchase/reissuance strategy assumd in most of the current debt management literature would cause such a crisis and it would be therefore highly suboptimal.

1 Introduction

In this note we describe an informational mechanism that may lead debt managers not to buy back their debt before redemption. The repurchase/reissuance strategy (*r/r)* assumed by most of the literature on optimal debt management (DM) are an out of equilibrium path event.

One of the main concerns of debt management offices (DMO) in practice is not to undertake operations that will destabilize the bond market. In fact market stability is often in the DMO mandates. There is, however, little academic research on how a DMO may destabilize a bond market. The standard assumption is that all bond issuances are always fully repaid, under rational expectations investors should know that a default is impossible in these models. The key to the example below is an informational asymetry between government and investors: government knows about a future default ahead of investors. This informational asymmetry is similar in spirit to Myers and Majluf (1984), highly influential in corporate finance.[1]

If investors know that the government has superior information regarding future fiscal positions, they would interpret a r/r operation negatively and bond markets would shut down. This would be a disastrous outcome for the government. Since the benefits of r/r are small in equilibrium the

*University of Cambridge and CEPR.
†Institut d'Anàlisi Econòmica-CSIC, ICREA, Barcelona GSE, UAB, MOVE and CEPR.
‡Université Catholique de Louvain. Email: Rigas.Oikonomou@uclouvain.be
§London Business School and CEPR.

[1] Myers and Majluf (1984) use asymetric information to explain that equity issuance is very rare. They consider a firm that has superior information to investors. There will be occasions when existing shareholders lose more through a reduction in their current share price than they gain from undertaking a new project with positive NPV. Incumbent investors are aware of the asymmetry of information and so respond positively to a firm *not* issuing new equity to fund new projects.

government does not buyback debt until maturity. An r/r would cause the bond market to shut down due to a lemons problem so these operations do not take place.

The model also gives some insights about when a "pure buyback" (that is, a repurchase without reissuance) might take place. If the government is in a path of debt reduction a repurchase is needed to reduce the stock of long bonds outstanding in order to lower total debt. In this case a repurchase does not cause a bond crisis as agents understand there is a good reason for it. So the repurchases of US bonds observed around 2001-02 can be rationalized within the model as well.

The model presented below shows the simplest case we could find where r/r never occurs due to asymetric information. To display the effect as clearly as possible we use a utility function for which fiscal insurance is not available. Also, the model is extreme in that a tiny amount of repurchases trigger a bond crisis with certainty. In a more elaborate model we would have that agents' perceived probability of a bond crisis is an increasing function of repurchases, this is captured by the transaction cost function we use in section 6 on optimal repurchases in Faraglia, Marcet, Oikonomou and Scott (2017) (FMOS).

One additional virtue of the example below is that it further justifies the issuance of short bonds. Under the informational asymmetry considered a commitment to issue short bonds in the future is a way of evenly distributing debt maturities so that the government reduces its own incentives to default in any given period. Therefore the issuance of short bonds lowers the perceived probability of default, so that absence of r/r is in line with the main message provided in the paper, namely, that there are good reasons for issuing short bonds.

A three-period Model

We present a three-period version of the main model in FMOS with linear utility of consumption, asymetric information, early determination of taxes and endogenous repurchases of previously issued long bonds.

More precisely, the differences with the model in FMOS are:

-Government and investors live for 3 periods $t = 0, 1, 2$.

-Two maturities are issued, $S = 1$ and $N = 2$. For simplicity we introduce a constraint $b_0^1 = 0$.[2] Obviously $b_1^2 = 0$, so the only bonds to issue are (long) bonds b_0^2 (short) bonds b_1^1.

–Let $\mathcal{R}(\tau)$ be the tax revenue achieved each period when taxes are τ. $\mathcal{R}$ will be determined in equilibrium below.

-Tax rates τ_t applied in period t are chosen one period in advance. Therefore τ_0 is given at $t = 0$ but the government chooses τ_1, τ_2 given information available at $t = 0, 1$.

-At $t = 0$ there is a stock of previously issued bonds b_{-2}^2, b_{-1}^1, b_{-1}^2. Denote as $G_0 = g_0 + b_{-2}^2 + b_{-1}^1$ total government outlays at $t = 0$. There are $b_{-1}^2 > 0$ long bonds outstanding at $t = 0$, they may be repurchased by the government at competitive prices at $t = 0$ or they may be left in private hands until they mature at $t = 1$. We assume $G_0 > \mathcal{R}(\tau_0)$ so that the government will have to issue gross debt at $t = 0$.

-*Information Structure:* Investors know government spending one period in advance, but government has even better information and it knows spending two periods in advance. Formally, both

[2] This simplifies analysis as it implies that positive repurchases $R_0 > 0$ clearly imply a reissuance of long bonds and it avoids solving for a portfolio of bonds in period 0, thus we can focus on the issue of repurchases.

investors and the government know $(G_0, g_1, b^2_{-1}, \tau_0)$ at $t = 0$, and the government knows in addition g_2 at $t = 0$. Investors only become aware of g_2 in period $t = 1$. Investors do observe government policy at $t = 0$, in other words they observe long bond repurchases R_0.

Budget constraints of the government in periods $t = 0, 1, 2$ are, respectively

$$\begin{aligned} G_0 + R_0 p^1_0 &= \mathcal{R}(\tau_0) + b^2_0\, p^2_0 \\ g_1 + b^2_{-1} - R_0 &= \mathcal{R}(\tau_1) + b^1_1\, p^1_1 \\ g_2 + \left(b^2_0 + b^1_1\right)(1-h) &= \mathcal{R}(\tau_2) \end{aligned} \tag{1}$$

where R_0 denote repurchases in period $t = 0$ of previously issued long bonds. The government can choose a haircut h, which has to be applied uniformly to all maturities.

In addition we introduce the following constraints

$$0 \le R_0 \le b^2_{-1}, \tag{2}$$
$$1 \ge h \ge 0 \tag{3}$$
$$b^2_0, b^1_1 \ge 0$$

The bounds on repurchases hold by definition. Given that taxes are set one period in advance and the assumption $G_0 > \mathcal{R}(\tau_0)$ it is clear that R_0 amounts to a r/r operation: a repurchase $R_0 > 0$ mucst be financed with a higher issuance of b^2_0. Given the objective function detailed below the haircut h will only take values 0 or 1 in equilibrium.

To summarize, fiscal variables (G_0, τ_0, b^2_{-1}) are given at $t = 0$. The government chooses $(\tau_1, \tau_2, R_0, b^2_0, b^1_1, h)$ at $t = 0$ subject to (1) and (2) given information on (g_2).

Investors

Given the information structure detailed above the only random variable in this 3-period model is g_2, which is not observed by investors at $t = 0$. Before observing R_0 investors perceive that g_2 has distribution $F^I_{g_2}$. This may or may not be the true distribution of g_2.

Since the government chooses R_0 contingent on g_2 repurchases, investors will try to extract relevant information about g_2 from their observation on R_0. We specialize investor's utility $u(c) = c$. This utility simplifies the analysis of 3-period model and it highlights the role of asymetric information.[3] Therefore investors maximize

$$E^I_0 \left(\sum_{t=0}^{2} \beta^t \left[c_t + v(x_t)\right] \middle| R_0 \right)$$

The budget constraint of investors is analogous to (1) and we do not write it. Their choices at $t = 0$ are a function of R_0 as well as the given constants (G_0, τ_0, g_1). Their choices in period $t = 1$ are a function, in addition, of g_2. Agents' expectation E^I_0 are taken given investors' information and their perceived distribution $F^I_{g_2}$. Investors have rational expectations in that they know how g_2 maps into prices and government choices. Given information on $(G_0, \tau_0, g_1, R_0, b^2_0)$ they make forecasts about future values of g_2 and (potentially) bond prices at $t = 1$.

[3] For this utility function the yield curve is flat so that fiscal insurance as in Angeletos, Buera and Nicolini can not be achieved. Therefore this utility provides a stark result about how r/r may destabilize markets as there are no fiscal insurance benefits from policy. We discuss the effects of generalizing this utility function below.

Government

The government understands that equilibrium $\tau_t = 1 - v_{x,t}$ hence equilibrium labor supply for a tax rate τ is $L(\tau) \equiv T - {v'}^{-1}(1-\tau)$ and tax revenue $\mathcal{R}(\tau) \equiv \tau L(\tau)$.

The government takes pricing functions, as a function of g_2, as given.[4]

We now make two additional assumptions that we number for future reference

Assumption 1 The Laffer curve $\mathcal{R}(\tau)$ has a unique maximum, denoted $\mathcal{R}^{\max}$ attained at some interior tax $0 < \tau^{\max} < 1$. Furthermore, $\mathcal{R}$ is increasing in $[0, \tau^{\max}]$.

This holds for most utility functions used in the literature, for example, for $v(x) = -B\frac{(T-x)^{\gamma_l+1}}{\gamma_l+1}$, with $B, \gamma_l > 0$.

Let $\Pr ob_0^I$ denote investors' perceived probabilities at time $t = 0$. Let us assume parameter values are such that, in equilibrium investors perceive that there will be gross debt issuance at $t = 1$, namely

$$\Pr ob_0^I(b_1^1 > 0) = 1.$$

For sufficiently high initial debt this holds with most utility functions as it is necessary for tax smoothing without default.

Investors know that for realizations of g_2 such that

$$g_2 > \mathcal{R}^{\max} - G_0 + \mathcal{R}(\tau_0). \tag{4}$$

default is inevitable, since this inequality implies

$$g_2 > \mathcal{R}(\tau_2) - \left(b_0^2 + b_1^1\right)$$

therefore $h > 0$. Let the probability of "inevitable default" be the investors' perceived probability that (4) holds. We make the following assumption.

Assumption 2 $\mu^{INEV} > 0$.

In other words, we assume that investors think that the government may have no option but to default in period 2 with positive probability. Most papers on fiscal policy in modern economics simply assume that the government only issues debt guaranteeing that $\mu^{INEV} = 0$. But this can only be seen as a convenient simplification, for a reasonably calibrated support of g and given existing levels of government debt events such as (4) have positive probability. The standard definition would then imply that no equilibrium exists, while we consider here a situation where an equilibrium exists and, in some periods, the government may default.

As in the rest of the paper the government maximizes the utility of consumers but, in addition, it receives a penalty for defaulting and it maximizes

$$\sum_{t=0}^{2} \beta^t \left[c_t + v(l_t)\right] - \alpha I_+(h) \tag{5}$$

[4]Later we introduce the possibility that the government understands how its own actions about r/r may change bond pricing functions this will not change any conclusion.

where h is a haircut that takes place in the last period $t = 2$, I_+ the indicator function of the positive real line.[5,6]

As standard with models of optimal policy when the government has superior information we assume the government maximizes the "true" utility of the agent given the government's superior information, so the above discounted sum is maximized with knowledge of g_2.

Equilibrium

We keep the assumption of Ramsey equilibrium as in the main model of the paper. Here, equilibrium bond prices are a function $(p_0^1,\, p_0^2,\, p_1^1)$ mapping g_2 into R_+^3 such that if investors take it as given and if investors know the joint distribution of g_2 conditional on R_0. We will also denote the fiscal policy variables as functions of g_2.

Given the objective function of the government, Once the government incurs in a haircut it will incur in the largest possible haircut, as this allows the government to lower taxes and lower the distortion, so that $h(g_2) = 0$ or 1. Standard arguments we have that in equilibrium

$$\begin{aligned} p_0^1 &= \beta \\ p_0^2 &= \beta^2 \mu \\ p_1^1(g_2) &= \beta(1 - h(g_2)) \end{aligned}$$

The first line follows from our assumption that there is no default at $t = 1$. The second line takes into account that from the investors' point of view bonds will be repaid at $t = 2$ with probability $\mu \equiv \Pr ob^I(h(g_2) = 0 \mid R_0, b_0^2)$, where this conditional probability combines the marginal distribution $F_{g_2}^I$ with knowledge of the equilibrium function $h(g_2)$. Since g_2 is known to agents at $t = 1$, the equation for $p_1^1(g_2)$ says that if the government plans to exercise a haircut at $t = 2$, i.e. $h(g_2) = 1$, there will be a bond crisis at $t = 1$ as soon as agents observe the value of g_2.

In the full information economy and if $\mu^{INEV} = 0$ then $\mu = 1$ and $p_0^2 = \beta^2$. It is easy to see that in this case a repurchase at $t = 0$ plays the same role as issuing short bonds in period $t = 1$: any portfolio with positive repurchases $\widetilde{R}_0 \in (0, b_{-1}^2]$ achieves the same tax allocation as a portfolio without repurchase $\overline{R}_0 = 0$ and additional short bond issuance $\widetilde{b}_1^1 = \widetilde{R}_0/\beta$. Therefore under full information the optimal allocation is indeterminate, positive repurchases are compatible with optimality, they imply higher short bond issuance at $t = 1$, and they can happen in equilibrium.

But since since $\mu \leq 1 - \mu^{INEV}$ Assumption 2 gives $\mu < 1$ hence in this economy long bonds sell at a discount. If the government observes a g_2 that is fully fundable (ie. such that $h(g_2) = 0$) an r/r is costly because it involves re-issuing cheap long bonds. Algebraically, if $h(g_2) = 0$ the budget constraint at $t = 2$ can be written as

$$g_2 + \left(\frac{G_0 - \mathcal{R}(\tau_0)}{\beta^2 \mu} + \frac{g_1 + b_{-1}^2 - \mathcal{R}(\tau_1)}{\beta} + \frac{1}{\beta^2} \left(\frac{1}{\mu} - 1 \right) R_0 \right) = \mathcal{R}(\tau_2)$$

[5] Most papers considering haircuts assume there is a discontinuity at $h = 0$ of the penalty for a haircut, that is, there is a fixed cost of not repaying. That the haircut enters as an indicator function is an extreme version of this case and it simplifies our analysis.

[6] Note that we have included the term $t = 0$ in the discounted sum for analogy with the utility function of the rest of the paper. The attentive reader will notice that this term is actually a given constant and it can be dropped out from the objective function.

and since $\left(\frac{1}{\beta^2\mu}-\frac{1}{\beta}\right)$ choosing a $R_0>0$ only increases τ_2 hence it is suboptimal relative to $R_0=0$.

On the other hand if g_2 is such that $h(g_2)=1$ and $\mu>0$ the government would find it optimal to repurchase long bonds. Raising one unit of R_0 now lowers the bill at $t=1$ and, since there will be a haircut (and this is known to the government) the additional reissuance of long bonds at $t=0$ actually costs nothing. Algebraically, the budget constraints at $t=1,2$ now imply

$$\begin{aligned} g_1+b_{-1}^2-R_0 &= \mathcal{R}(\tau_1) \\ g_2 &= \mathcal{R}(\tau_2) \end{aligned}$$

so that the government would set R_0 as large as possible $(=b_{-1}^2)$ so as to lower τ_1 without a cost for τ_2. Therefore a $R_0>0$ would signal to investors that a default is on the way, given knowledge of the equilibrium functions this would imply $\mu=0$ and there would be a bond crisis. Therefore in equilibrium $R_0=0$.

Therefore, under the possibility of default, even if μ is close to 1 (ie, possibility of default is small) an r/r would magnify this probability and cause a bond crisis, as it gives the wrong signal to agents.

This proves

Result *In the 3-period model considered in this note, under Assumptions 1 and 2, we have that* $R_0=0$.

Repurchases if Debt is Decreasing

It is easy to see that repurchases will actually occur if the government is in a path of debt reduction. For this one just has to extend the above analysis to the case when $\mathcal{R}(\tau_0)>G_0$. In this case a repurchase is desirable as it just helps smooth taxes since it lowers the debt burden in period 1. Therefore $h(g_2)=0$ is compatible with $R_0>0$ and no bond market crisis occurs upon observing $R_0>0$.

This last point explains why some repurchases were observed in years 2000 and 2001, when the US government was running surpluses.

Generalizations

Although we have kept the analysis as simple as possible it should be clear that zero repurchases are going to be optimal under many generalizations.

For example, if the government understands how investors peceived proability of default changes upon observing a given value of R_0. The result of this equilibrium concept is the same as the one we use above and it keeps $R_0=0$.

The above argument proving $R_0=0$ rests on the fact that long bonds are costly because $\mu<1$. There are many other reasons in the real world why repurchases are costly. We have detailed them in section 6 of FMOS. Introducing transaction costs, liquidity value of bonds, small/uncertain benefits of r/r would only reinforce our argument.

Derivatives

Finally, a comment on derivatives. There is a view that even if r/r are unlikely because they involve large market intervention one could generate the same porftolio with appropriate derivatives that imply a small market intervention. In practice some DMO's have issued derivatives, while others (notably the British DMO) has not. In an informal conversation a British DMO officer told us they thought that issuing derivatives might destabilize markets.

Derivatives are controversial and costly for many reasons. Under the asymmetric information setup considered above derivatives would destabilize bond markets in exactly the same way that a repurchase would do: a derivative is also equivalent with a future issuance of short bonds, so it may send the message that a government is planning on defaulting. Therefore issuing derivatives can destabilize markets.

References

Faraglia, E., Marcet, A., Oikonomou, R. and Scott. A (2017) "Government Debt Management, the Long and the Short of It", *mimeo LBS.*

Myers, S. and N. Majluf (1984) "Corporate Financing and Investment Decisions when firms have information that investors do not have" *Journal of Financial Economics,* 13, 187-221.