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Game theory and speculation on government bonds

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ABSTRACT

The aim of this paper is to propose a method to stabilize the rapid variations on the value of government bonds issued by the States, using Game Theory. In particular, we focus our attention on three players: a large speculative bank (hereinafter called Speculator), having immediate access to the market of government bonds, the European Central Bank (ECB) and a State in economic crisis, with a high public debt. In this regard, we will analyze the interaction between these three subjects: the Speculator, our first player, the ECB, our second player, and the State, our third player. The financial crisis, that hit the market of European government bonds, showed us that large speculators can influence the financial markets and benefit from the creation of arbitrage opportunities caused by themselves. In this way, the default probability of States in economic difficulty increases significantly and alarmingly. We already heard to talk about concepts like "spread" and "public debt," which has crippled the economies of great States, for instance Italy. In this paper we propose on financial transactions the introduction of a tax, which hits only the speculative profits. We show how the above tax would probably be able to avert the speculation. For this purpose, we compare the different behaviors adopted by the Speculator and by the ECB in case of absence or presence of the tax, with the consequent effects on the State that sells its government bonds, paying particular attention to the movement of the game equilibria. In fact, with the introduction of our tax, all equilibria of the game become excellent for the State in economic difficulty.

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1. Introduction

Lately, the global economic crisis is increased, affecting even States considered very important in the economy (as for example Italy). One of the causes of the crisis is the exponential growth in government bonds yields, which have increased the public debt (up to May 2011 the Italian government bonds offered a yield of approximately 4.80%, while in December 2011 it rose above the 7.50%). Fig. 1, made by Richard Portes, Professor of Economics at London Business School, shows the Italian situation (see http://www.bbc.co.uk/news/in-pictures-16090055).

In this regard, with our model (for a complete study of a game see Agreste et al., 2012; Baglieri et al., 2012; Carfì, 2008, 2009a,b,c, 2010; Carfì and Musolino, 2011a,b, 2012a,b,c,d, submitted for publication-a, submitted for publication-b, submitted for publication-c; Carfì and Ricciardello 2010, 2012a,b; Carfì and Schilirò, 2012a,b; Musolino, 2012, submitted for publication), we intend to propose a possible method to stabilize the government bonds markets of the States in economic difficulty, without any losses of collective gain. In this way, with the introduction of a simple but effective tax, the market would be able by itself to reduce yields on government bonds, without further economic measures at global level: thus the States in financial difficulty could finally begin (hopefully) a slow but steady economic recovery.

2. Methodologies

The normal-form game G, that we propose to model our financial interaction, requires a construction which takes place 3 times, which we say time 0, time 1/2 and time 1.

- At time 0 the Speculator (the first player) can decide:
1) to sell short government bonds, in order to obtain greater profit betting on a greater future yield of the bonds;
2) not to intervene in the government bonds market.
- At time 1/2 the ECB may decide to intervene in the bonds market in order to limit the growth of the bonds yield. In this way, even in case of lack of demand of government bonds, the issuer State finds the funds necessary to the national financial requirement.
- At time 1 the Speculator must eventually close its position (opened at time 0), by buying government bonds.

Remark. During the game, we will refer to an interest rate i which determines the yield on government bonds. When we pass from one time period to another one, we should actualize or capitalize the values that must be "transferred". But because the interest rate i_u, usually adopted in the capitalizations and discounts in our financial markets, is much lower than that one we use to get the yield of government bonds, we assume i_u equal to 0. Therefore, in this model, the values referred to different time period are not capitalized or discounted.

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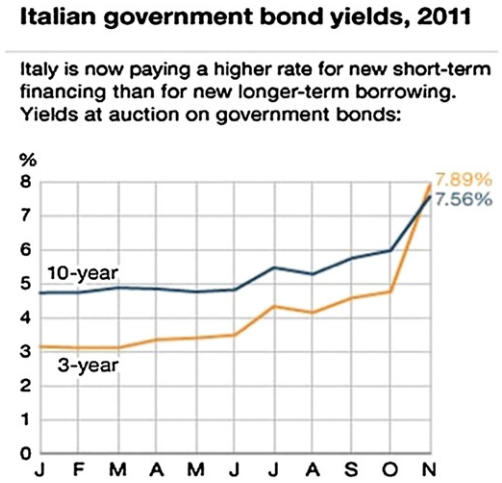

Fig. 1. The yield on Italian government bonds in 2011.

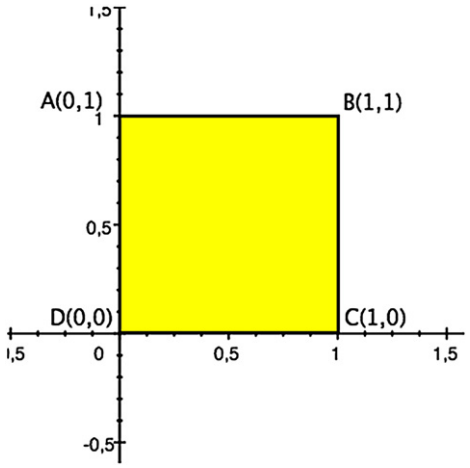

Fig. 2. The bi-strategy space of the game.

3. Financial preliminaries

Here we recall the financial concepts that we shall use in the present article.

1. M represents the quantity expressed in money of issued bonds (for example Italy has to issue a quantity equal to M of government bonds in order to face its financial commitments).
2. Short selling of bonds is a financial transaction involving the sale of bonds without having their property, hoping to buy them later at a lower price. So the short seller would realize a profit. In the event that we examine, talking about government bonds, the hope of short sellers consists in an increase of the yield on government bonds.
3. The government bonds are not normal goods with a purchase price and a sale price. The concept that characterizes them is the yield, which depends upon the interest to which they are sold. The yield on a government bond is given by the interest that remunerates the capital "loaned" to the State.

4. The description of the game

Our first player, the Speculator, may choose to sell short government bonds, in order to cause an increase in their yield and so to obtain a profit. In fact, at time 1 the Speculator must close the position opened in the government bonds market with a purchase transaction. Otherwise the Speculator can decide not to intervene in the government bonds market. Thus, the Speculator has the possibility to choose among the strategies $x \in [0, 1]$ which represents the percentage of the quantity of government bonds M that the Speculator decides to buy, depending if it intends: not to make any financial transaction ($x=0$); to sell short government bonds (xM is the quantity of short sold bonds) ($0<x\leq 1$).

On the other hand, the European Central Bank, that is our second player, operates in the bonds market in consequence of the operation of the first player. It may choose a strategy $y \in [0, 1]$, which represents the percentage of the quantity of government bonds M that the ECB purchases, depending if it intends: to buy government bonds of the State in economic difficulty ($y>0$); not to intervene in the government bonds market ($y=0$).

In Fig. 2 we illustrate graphically the bi-strategy space $E \times F$ of our game G.

5. The no tax game

5.1. The payoff function of the Speculator in the no tax game

The payoff function of the Speculator, which is the function that represents the gain of the first player, is given by the quantity expressed in money of purchased bonds xM, multiplied by the difference $R_1(x, y) - R_0$ between the value at time 1 of the yield to be cashed (at time 1 the Speculator buys the same amount of securities that it has sold short at time 0) and the value at time 0 of the yield to be paid (at time 0 the Speculator sells short a certain amount of government bonds).

The payoff function of the Speculator is given by:

$$f_1(x,y) = xM(R_1(x,y) - R_0), \tag{1}$$

where:

1) xM is the amount of government bonds that the Speculator short sells at time 0;
2) $R_1(x, y)$ is the value of the government bonds yield at time 1. We suppose it is given by

$$R_1(x,y) = i + mx - ny,$$

where:
- i is the interest that remunerates the capital "loaned" to the State;
- m is a marginal coefficient which indicates the incidence of x on $R_1(x, y)$;
- n is a marginal coefficient which indicates the incidence of y on $R_1(x, y)$.

The government bonds yield $R_1(x, y)$ depends on x because if the Speculator intervenes in the government bonds market with a strategy $x \neq 0$, the yield $R_1(x, y)$ is modified because a decline in demand has a positive effect on the interest charged on the government bond. $R_1(x, y)$ depends on y because if the ECB intervenes in the government bonds market with a strategy $y \neq 0$, the value $R_1(x, y)$ is modified because an increase in demand has a negative effect on the government bonds yield (the interest that remunerates the bond goes down). We are assuming by hypothesis both for x and y a linear dependence.

3) R_0 is the value of the government bonds yield at time 0. It is given by $R_0 = i$, where i is the interest remunerating the capital that is "loaned" to the State. R_0 is a constant because our strategies x and y have not impact on it.

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