EUROPEAN UNIVERSITY INSTITUTE, FLORENCE

DEPARTMENT OF ECONOMICS

EUI WORKING PAPER No. 88/338

GOVERNMENT DEBT AND EQUITY CAPITAL IN AN ECONOMY WITH CREDIT RATIONING

by

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This paper was written while the first author was a Jean Monnet Fellow at the European University Institute. Financial support from C. N. R. is gratefully acknowledged.

BADIA FIESOLANA, SAN DOMENICO (FI)

Printed in Italy in March 1988
European University Institute
Badia Fiesolana
- 50016 San Domenico (Fi) -
Italy

ABSTRACT

We show that government debt may have a negative effect on the real return on stocks and crowd out equity capital in an economy where, because of bankruptcy risk and adverse selection, there exists a credit rationing equilibrium (in the sense of Stiglitz-Weiss [1981]). With credit rationing, some firms undertake investment projects whose expected real return is greater than the expected cost of borrowing for a unit of banks' loans. Then, the expected return on stocks is an increasing function of the average firms' debt-equity ratio. This implies that an increase in government debt, causing banks' disintermediation, will decrease the average expected return on stocks and crowd out equity capital.

INTRODUCTION.

Does government debt have a negative effect on the real return on capital and on stock prices? This claim is generally accepted but not clearly implied by standard economic models based on a general equilibrium framework. Using a macroeconomic model where capital is not allowed to adjust istantaneously in response to relative price movements, one finds that stock prices may fall in response to an increase in government debt since the latter pushes up the interest rate on bonds, i.e., the opportunity cost of holding capital. However, this is only a short run phenomenon. In the long run, government debt will crowd out productive capital and increase its marginal productivity. Therefore, the long run effect on stock prices is ambiguous.

In the present paper we provide an argument supporting the idea that a rise in the amount of government debt may have a negative effect on the real return on stocks and crowd out equity capital. The argument crucially depends on the existence of an equilibrium with credit rationing and on consumers' inability to eliminate risk in the capital market by portfolio diversification.

The existence of credit rationing is proved by assuming that banks cannot distinguish between investors undertaking projects with different levels of risk. In fact, because of adverse selection, under this assumption there may be an inverse relationship between the profitability of loans and the interest rate charged by banks. Tu put it in different words: a rise of the interest rate may induce borrowers with safer projects to withdraw from the market. If this is the case, banks may prefer to impose credit rationing instead of rising the interest rate to its market clearing level (the argument has been first used by Stiglitz and Weiss [1981]).

The inability of consumers to eliminate risk in the capital market by portfolio diversification is justified by assuming that shares are not infinitely divisible and that, given this indivisibility, the number of shares that any consumer should buy in order to eliminate risk is incompatible with its budget constraint.

We also assume that, in the economy to be analysed, there is an infinite number of firms and consumers and that banks are large enough to be able of eliminating risk through loans diversification. Finally, consumers are assumed to be risk averse and faced with three alternative assets: equities, deposits and government bills, the last two being perfect substitute. The model then generates two types of equilibria: an equilibrium with market clearing (MCE) and one with credit rationing (CRE), i.e., excess demand for loans.

In the MCE, government debt is completely neutral with respect to the level of firms' equity financing and it has no effect on the ratio between risky and non risky assets in consumers' desired portfolio. An increase in the amount of government borrowing perfectly crowds out the total level of deposits and leaves constant the stock of equities and their expected rate of return.

In the CRE, government debt is not neutral with respect to the desired level of risky assets in the consumers portfolio selection. In particular, we show that the expected rate of return on equities is an increasing function of the amount of consumers' total wealth net of government liabilities. In order to understand this result, consider a departure from an equilibrium situation due to an increase in government borrowing. This increase will have to be compensated by some change in the portfolio composition. Assume, as a first instance, that we only have a fall in consumers' demand for deposits. This will, in turn, imply a reduction of banks' loans. Now, since firms are rationed in the credit market, the expected return on stocks is increasing in the amount of loans that firms can actually obtain. In fact, since the rate of return of investment for levered firms is greater than the interest rate at which they can borrow, the return on shares is an increasing function of the debt-equity ratio. Thus, for any given level of equity financing, a reduction of banks' deposits induces a fall of the expected rate of return on equities. This fall will imply a riskless portfolio allocation, i.e., a reduction of the consumers' total investment in stocks. Thus, the net effect of the increase in government debt is a reduction of both equities and deposits.

I. THE MODEL.

We will work in the context of a two-period general equilibrium model where agents have to optimize their consumption and investment decisions with a given amount of endowments and facing future uncertain events. However, the model can also be easily reinterpreted as describing an equilibrium at time t of an overlapping generations economy.

The economy consists of:

- an uncountable infinity of identical consumers uniformly distributed in [0,1];
- an uncountable infinity of firms also uniformly distributed in [0,1] with two different types of technologies;
- a finite number of identical banks;

Consumers. To simplify the analysis, we assume that consumption takes place only in the second period of life. Each individual is endowed with a quantity of wealth W to be allocated between bank deposits D, government bonds B and equity capital K. D and B are assumed to be perfect substitute and paying a gross interest rate R. The gross rate of return on equity capital is a random variable $\tilde{z}$ whith expected value Z. This random variable has a finite number of possible realizations with a known probability distribution.

The uncertainty about the gross rate on equities comes from the assumptions that:

(a.1) firms' production technology gives rise to a random output;

(a.2) consumers are not able to diversify their equity capital among the existing firms and they invest in a single firm randomly drawn from the existing population.

The last assumption implies that consumers cannot exploit the law of large numbers (remember that there is an infinite number of firms) and thus eliminate uncertainty. The assumption that they can only invest in a single firm is made only for the sake of simplicity. More generally, one can assume incomplete diversification without altering the conclusions of the paper. Incomplete diversification can be easily justified by assuming that the shares to be sold in the stock market are not infinitely divisible, so that consumers have to invest in a finite number of firms.

Assume now that:

(a.3) consumers are risk-averse and maximize an expected utility function $E\{U(c)\}$, where U is strictly concave and $c = R(W - K) + \tilde{z}K$.

Then, we can express the solution of the consumers' maximization problem in the following way:

(1) $R[1 + \sigma(K,s)] = Z$

(2) $W = K + D + B$

where $\sigma(K,s)$ is a function representing the risk premium and s is a vector containing R and all the relevant characteristics of the probability distribution of the random variable $\tilde{z}$. Because of risk-aversion, σ has the following properties:

$\sigma(K,s) > 0$ for $K > 0$, $\sigma(0,s) = 0$, $\partial\sigma(K,s)/\partial K > 0$.

<u>Firms</u>. As mentioned before, there are two types of firms: H and L, where each type is distributed over an interval of 1/2 length. The technology displays constant returns to scale and is

such that a unit of capital invested today next period will produce:

$\alpha^i > 1$ with probability p^i

0 with probability $1 - p^i$

with i = H, L. We will also make the crucial assumption that:

(a.4) $\alpha^H > \alpha^L$, $p^H\alpha^H < p^L\alpha^L$ (implying $p^H < p^L$).

Thus, firms of type L are unambiguously better than firms of type H from the point of view of any investor who is not a risk-lover, since they are characterized by a higher expected return and a smaller risk.

Each firm is endowed with an amount of equity capital K^i. However, by the stated assumptions, $K^i = K$ for all i and we can omit the index. Any amount of investment exceeding K can be raised by obtaining bank loans M^i. Thus, total investment is $X^i = K + M^i$ with $K, M^i \geq 0$. A loan contract is assumed to be of the following type:

(a.5) if $\alpha^i = 0$ the firm i goes bankrupt and pays nothing to stokholders and banks.

Assuming that they are risk-neutral, firms will chose M^i by maximization of $p^i[X^i\alpha^i - M^i(1+\rho)]$ subject to $X^i = K + M^i$ and $M^i \geq 0$, where ρ is the interest rate on bank loans. This problem leads to the following solutions:

$M^i = 0$ iff $(1+\rho) > \alpha^i$;

M^i is the maximum obtainable iff $(1+\rho) < \alpha^i$;

M^i can be any number between 0 and $+\infty$ iff $(1+\rho) = \alpha^i$.

Now, since firms will have to distribute their profits next period, with probability p^i we have:

$$\alpha^i X^i = z^i K + (1+\rho)L^i$$

i.e.:

(3) $(\alpha^i - z^i)K = [(1+\rho) - \alpha^i]L^i$

where z^i is the gross rate of return on equity capital for the consumer who has invested in firm i when the investment project succeeds. Equation (3) can also be written as:

$$p^i z^i = p^i \alpha^i + p^i [\alpha^i - (1+\rho)]L^i /K$$

which is simply a way of stating Modigliani-Miller's proposition II (Modigliani-Miller [1958]), i.e., the expected rate of return on the shares of a levered firm increases in proportion to the debt-equity ratio (L^i /K), and the rate of increase depends on the spread between the expected rate of return on investment and the expected cost of a unit of debt.

Having specified the firms' optimization problem we can now give more specifications about the random variable $\tilde{z}$. In fact, under the stated assumptions, for each consumer it is:

$\tilde{z} = z^L$ with probability $p^L /2$;

$\tilde{z} = z^H$ with probability $p^H /2$;

$\tilde{z} = 0$ with probability $(1-p)$;

where $p = (1/2)(p^L + p^H)$. Then, we can specify:

$$s = (R, z^L, z^H, p^L, p^H).$$

Banks. There exist a finite number of financial intermediaries, called banks, issuing deposits and making loans. It is assumed that:

(a.6) banks are risk-neutral and unable to distinguish between types of firms, however they can eliminate risk by complete diversification of their loans among the set of existing firms.

Like Stiglitz-Weiss [1981], we will also assume that banks compete among themself and that they are price makers with respect to ρ. Moreover, in equilibrium they will have zero profits, a condition which is realized by adjusting the interest rate on deposits. This market structure leads to a Nash equilibrium in which banks maximize profits under the assumption that the choice of ρ does not affect their own level of intermediation.

By the law of large numbers, banks are never bankrupt. Then, in the absence of any reserve requirement, the amount of loans offered by banks will always be equal to the amount of deposits and their expected profits per unit of deposit will be equal to:

(4) $(1+\rho)[p^L\theta + p^H(1-\theta)] - R$

where θ is the expected ratio of loans given to firms of type L.

From the solution of the firms' maximization problem we can derive that:

$(1+\rho) \leq \alpha^L$ implies $\theta = 1/2$;

$\alpha^L < (1+\rho) \leq \alpha^H$ implies $\theta = 0$;

$(1+\rho) > \alpha^H$ implies that banks disappear from the model.

The banks' zero profit condition can be written as:

$R = (1+\rho)p$ for $(1+\rho) \leq \alpha^L$;

$R = (1+\rho)p^H$ for $\alpha^L < (1+\rho) \leq \alpha^H$

Now, assuming for simplicity that $\alpha^L p \neq \alpha^H p^H$, banks maximize profits by setting:

$(1+\rho) = \alpha^L$ iff $\alpha^L p > \alpha^H p^H$;

$(1+\rho) = \alpha^H$ otherwise.

Clearly, if $\alpha^L p > \alpha^H p^H$ there will be an excess demand for loans, since firms of type H will be seeking an unlimited quantity of loans and the available amount of credit is equal to the total level of deposits. In this case we assume that, being unable to distinguish between types of firms, banks will offer each firm an equal amount of loans M and the resulting equilibrium will be one with credit rationing (CRE). .

In the case $\alpha^L p < \alpha^H p^H$, instead, firms of type L will not try to get any loan and firms of type H wll be just indifferent about the amount of loans they can get. The resulting equilibrium is one in which nobody is rationed in the credit market, i.e., the latter is a market clearing equilibrium (MCE).

II. MARKET-CLEARING AND CREDIT RATIONING EQUILIBRIA.

A) Market clearing equilibrium.

Consider the case in which $\alpha^L p < \alpha^H p^H$. Under this condition, banks maximize profits by setting $(1+\rho) = \alpha^H$. From (3) we get $z^L = \alpha^L$ and $z^H = \alpha^H$, so that the expected rate of return on $\dot{K}$ is $Z^M = (1/2)(\alpha^L p^L + \alpha^H p^H) = \alpha$. Setting $(\alpha^H p^H, \alpha^L, \alpha^H, p^L, p^H) = s^M$, (1) implies:

(5) $\quad \sigma(K, s^M) = (\alpha - \alpha^H p^H)/\alpha^H p^H$.

Equation (3) determines a solution K^* provided that $B \in [0, W-K^*]$ and, together with (2), it describes an equilibrium for the present economy. This equilibrium will involve banks intermediation for $B < W - K^*$.

In this economy the amount of equity capital and its own expected rate of return are completely determined by consumers' preferences and the vector s^M and is completely independent of the amount of government borrowing. The only way in which an increase of government borrowing affects the economy is by crowding out, on a one-to-one basis, the amount of banks deposits.

Notice that in the present economy consumers' consumption (i.e., their second period wealth) is affected by the degree of leverage of firms. This result, which is in contrast with Modigliani-Miller's theorem, holds because firms may default on the banks' loans, i.e., they can go bankrupt. To see this more clearly, let c^M be the agents' second period consumption and $\lambda = D/K$ the average firms' debt-equity ratio (which is, in the present case, just equal to the debt-equity ratio of any individual firm of type H). Then, we have:

(6) $E(c^M) = B\alpha^H p^H + X[\alpha - (\alpha - \alpha^H p^H)\lambda(1+\lambda)^{-1}]$

(7) $V(c^M) = K^2 V(z) = K^2 V(\alpha) = [X(1 + \lambda)^{-1}]^2 V(\alpha)$

where E and V denote expected values and variances. As we can see from (6) and (7), an increase of the firms' debt-equity ratio has a negative effect both on the expected value and the variance of agents' future consumption. The negative effect on $E(c^M)$ is due to the simple reason that the expected rate of return on equities is higher than the riskless interest rate, so that a risk neutral agent would always prefer to buy shares instead of lending money. The negative effect of λ on $V(c^M)$ is due to the fact that the variability of the consumers' portfolio only depends on the amount of equity capital invested.

B) Credit rationing equilibrium.

Consider now the case in which $\alpha^L p > \alpha^H p^H$. As we know, this implies $(1+\rho) = \alpha^L$. Then, both types of firms borrow from banks and have an individual debt-equity ratio λ. From (3) we get:

$$z^L = \alpha^L$$

$$z^H = \alpha^H + (\alpha^H - \alpha^L)\lambda$$

which imply an expected rate of return on equities given by:

(8) $$Z^R = \alpha + (\alpha - \alpha^L p)\lambda.$$

Therefore, whereas in the MCE the expected rate of return on equities was equal to α, with credit rationing Z is an increasing function of λ. In fact, with market-clearing, the only levered firms were those for which the expected rate of return on investment was equal to the expected cost of borrowing, so that leverage did not affect the rate of return on equities issued by these firms. With credit rationing, however, Modigliani-Miller's proposition II holds for firms of type H, i.e., the expected rate of return on equities issued by firms of type H increases with their debt-equity ratio. Thus, λ has a positive effect on the expected return on equities as well.

Setting $(\alpha^L p, \alpha^L, \alpha^H + (\alpha^H - \alpha^L)\lambda, p^L, p^H) = s^R$ and taking (2) into consideration, (1) then gives:

(9) $K\sigma(K,s^R) = (W - B)(\alpha - \alpha^L p)/\alpha^L p.$

The left hand side of the above equation is monotonically increasing in K, is equal to zero for K = 0 and tends to be unbounded for K increasing to $+\infty$. Then, (9) determines a unique solution for the variable K, called K(B), provided that $B \leq B'$, with B' defined by $\sigma(W-B',s^R) = (\alpha - \alpha^L p)/\alpha^L p$. Clearly, we can also define a function D(B) = W - B - K(B).

Together with (2), (9) describes a CRE for the present economy. In this equilibrium B displays a sort of non-neutrality which is clear from the definition of the expected rate of return on equities:

$$Z^R = \alpha^L p + (\alpha - \alpha^L p)(W - B)/K$$

and by the one-to-one functional dependence of K on B. In particular, we have:

$$K'(B) = - \frac{K}{(1 + \eta)(W - B)}$$

where η is the elasticity of $\sigma(K,s^R)$ with respect to K evaluated at its equilibrium value. It is verified that $K'(B) \in [-1,0]$ and, since (2) implies $D'(B) = - (1 + K'(B))$, $D'(B) \in [-1,0]$ also.

Two conditions account for the emergence of the non-neutrality of B. First of all, the existence of a CRE. Secondly, the consumers' inability of eliminating the risk associated with the investment on equities. In fact, suppose that B suddenly increases. This implies a drop of K + D by an equal amount. If K stayd constant, like in a MCE, the expected rate of return on equities Z^R would unambiguously fall. Consumers would then try to reduce their holding of K and choose a new portfolio equilibrium with a lower risk premium. Thus, K has to fall. The amount by which K drops, however, has to be strictly less than the amount by which D falls. If this was not the case, Z^R would have to increase, leading to a new portfolio allocation in which K and the risk premium were higher than before. This allocation clearly contradicts the assumption that K decreases more than D.

The equilibrium with credit rationing is described in the figure at the end of the paper where the downward-sloping schedule ZZ graphs the variable Z^R as a function of K and for a given level of B and the upward-sloping schedule SS graphs the rate of return on the safe assets adjusted for the risk premium $\sigma(K,s^R)$. The intersection between the two curves establishes an equilibrium value of the aggregate level of equities for any given B. As shown in the figure, an increase in B shifts down ZZ and establishes a new equilibrium with a lower level of equities and a lower level of Z.

The way in which the firms' capital structure affects agents' consumption in a CRE is different from the one already described in the case of market clearing. In particular, we can observe that $E(c^R) = B\alpha^L p + \alpha X$, i.e., expected consumption is independent of the debt-equity ratio. The reason is that, even if the expected rate of return on equities is greater than the riskless rate R, an increase of the firms' level of debt increases Z^R in a way that compensates for the loss of expected consumption due a riskless portfolio. However, the firms' debt-equity ratio clearly affects the variance of c^R. To see this, notice that:

$$c^R = (B + D)\alpha^L p = (B + X\lambda(1+\lambda)^{-1})\alpha^L p$$

when the consumers' share has a zero return, and:

$$c^R = (B + D)\alpha^L p + X[\alpha^i - \alpha^L\lambda(1+\lambda)^{-1}]$$

with i = 1,2, otherwise. Thus, an increse in the firms' debt-equity ratio has a positive effect on the consumers' portfolio in the worst state of nature and a negative effect in any other case since a more levered capital structure decreases the total income from stocks. The effect of λ on the variance of c^R is negative as it can be checked from the expression:

$$V(c^R) = K^2 V(z) = K^2[V(\alpha) + F(\lambda)] = X^2(1+\lambda)^{-2}[V(\alpha) + F(\alpha)]$$

where:

$$F(\lambda) = (\alpha^H - \alpha^L p)\lambda[2(\alpha^H - \alpha) + \lambda(\alpha^H - \alpha^L)(1 - p^H/2) > 0.$$

It can also be checked that, while in a MCE $E(c^M)$ and $V(c^M)$ are unaffected by B, here we have that $E(c^R)$ and $V(c^R)$ are both decreasing functions of the stock of public debt. Therefore, government debt policy has also an influence on the expected utility of consumers' terminal wealth. However, the direction of this influence is ambiguous.

The non-neutrality of B in the present economy holds true even if we require the government to have a balanced intertemporal budget constraint. Consider the simplest case in which the government raises lump-sum taxes T on agents' terminal wealth in such a way as to have no debt in the next period. Then, $T = BR$ and $c = (B + D)R + K\tilde{z} - T = DR + K\tilde{z}$. Obviously, this does not modify equation (9) and everything has been said about the effect of B on Z and K goes through in the present case. The reason is that the non-neutrality of government debt management does not come from the effect of B on consumers' demand but from the effect that B has on the average firms' debt-equity ratio.

CONCLUSIONS.

We have shown that government debt may have a negative effect on the real return on stocks in an economy with a credit rationing equilibrium (in the sense of Stiglitz-Weiss [1981]). Crucial for this result is the fact that, because of credit rationing, for some firms the expected real return on investment is greater than the expected cost of borrowing for a unit of banks' loans, so that the expected return on stocks is an increasing function of the average firms' debt-equity ratio. This implies that an increase in government debt, causing banks' disintermediation, will always go along with a crowding out of equity capital.

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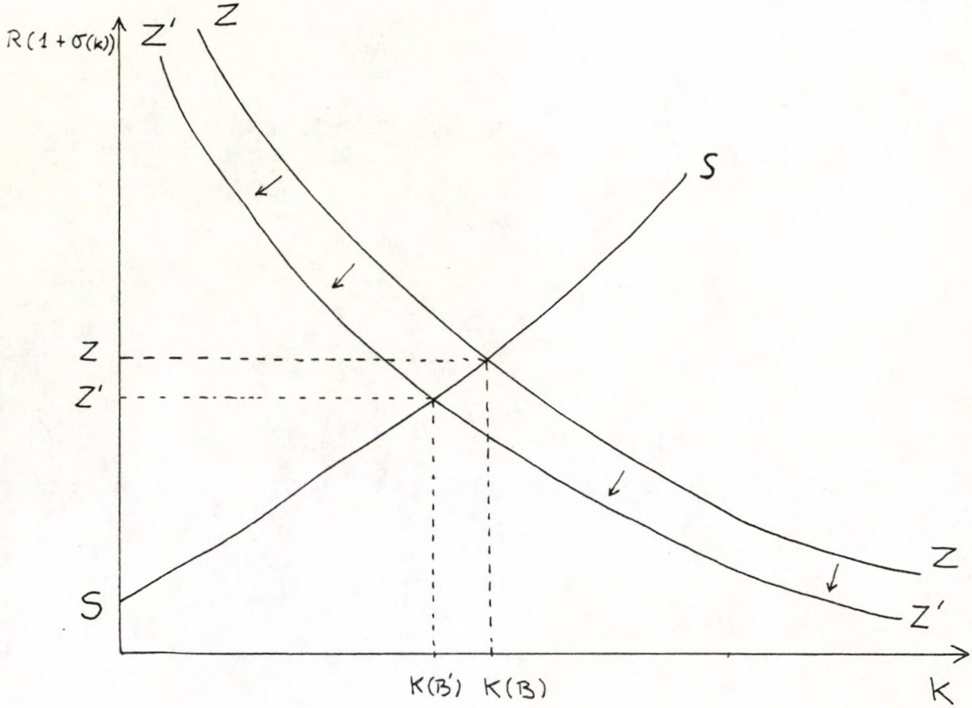
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