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Uncertainty in the public debt market and stochastic long-run growth

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ABSTRACT

In a continuous time model, a representative household has to allocate its investment and consumption in an optimal manner under conditions of uncertainty. In the present study it is hypothesized that there are two types of assets: a risk-free and a risky asset. The risk-free asset is assumed to be the physical capital, while at the same time uncertainty is allowed to result from the exogenous random variations in the public debt market, rendering in this way government bonds to act as the risky asset. In the endogenous growth framework with productive public investment, the expected long-run growth rate, the dynamic path of consumption as well as the optimal allocation of investment between a risky and a riskless asset, are analytically derived. This kind of treatment allows us to create a locus for the long-run growth over the various levels of uncertainty. The outcome of the analysis is that a rise in uncertainty impacts negatively upon the long-run growth rate. In order to empirically assess the relationship between growth and uncertainty, we lay our emphasis on the US economy for the period 1957:1 to 2008:4. Within the framework of a bivariate BEKK–GARCH(1,1)-M model a significant negative relationship between uncertainty and economic growth has been established.

1. Introduction

The importance of public debt management lies in the fact that the government's debt portfolio is indisputably the largest financial portfolio in the country. As a result, the decisions made by the public debt manager (PDM) affect welfare and economic growth; therefore her actions ought to be guided by a clear macroeconomic orientation rather than by an opportunistic desire for short-run gains. In OECD countries the majority of the public debt management offices affirm, either formally or informally, that their main goal is to minimize the cost of servicing the debt. For example, in the Report of the Debt Management Review (1995) by the HM Treasury and the Bank of England it is noticeably stated that: "The objective of debt management policy is to minimize over the long term the cost of meeting the government's financial needs, taking account of the risk, whilst ensuring that debt management policy is consistent with monetary policy". The cost minimization objective, taking into account the risk of the corresponding debt structure, is critical primarily for the highly indebted countries so they are able to sustain their debt. On the contrary, in developed countries with low public debt, such a cost minimization strategy could well be used to save funds, which in turn may serve productive and non-productive public spending, highlighting in this way the beneficial role of a successful debt managing strategy in growth and welfare.

Missale (1999, pp 131) argues that "a strategy aimed at reducing interest costs is justified only when risk premia result from: market imperfections; informational asymmetries; expectations failures; and the governments' inability to credibly commit to future policy actions".[1] Relevant literature suggests that public debt issuing policies and strategies that may smooth or even eliminate the aforementioned matters are considered as optimal. A rise in the risk premia may result from various factors such as default risk, macroeconomic uncertainty, fiscal imbalance, lack of liquidity, volatility in the secondary market, political instability, matters related to monetary instability or even the transparency of the issuance pricing and auctioning of government securities. The IMF and the World Bank guidelines for the Public Debt Management (2003, pp 27) state that: "most countries have taken steps to increase the transparency of the auction process in the domestic market to reduce the amount of uncertainty in the primary market and achieve lower borrowing costs". Additionally, the same Public Debt Management (2003, pp 15) guidelines state that "it is important to note that all of the countries surveyed referred to the advantages of working collaboratively with market participants to develop their domestic government securities markets and minimize the amount of uncertainty in the market regarding government financing activities".

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[1] Issues such as: market imperfections, informational asymmetries, expectation failures and the government's inability to commit credibly to future policy actions, are extensively discussed in Missale (1999).

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According to the above, one may argue that the reduction of uncertainty in the primary public debt market may reduce the risk premia and therefore minimize the cost of public debt. The insight received from the case studies reported within the Guidelines for Public Debt Management (2003), is that PDM takes legislative measures and implements strategies in order to achieve the coveted cost minimization. The chronological orientation of these strategies is mostly of a short to a medium term. Hence our intention is to examine the long-run effects of these short/medium oriented strategies in the economy. More specifically the focus lies in the appraisal of how changes in the level of uncertainty, stemming from the bond market, may shift the balanced growth path in a stochastic endogenous growth framework where endogenous growth rises from public investment. In order to act in such a manner, a micro-funded household behaviour is implemented, as in Merton (1971), where the choices about optimal consumption and investment are made under uncertainty, incorporating at the same time a hypothesis according to which the risky asset is the public debt and not the private capital. Finally, a solution is provided for the continuous time case.

The intuition is as follows: a rise in the uncertainty level requires an appropriate compensation to investors which is revealed by a subsequent increase in the risk premium of bonds. This in turn stimulates the debt dynamics via the increased cost of servicing the debt, and as a result the government which finances its productive public spending through its dynamic budget constraint, needs to reduce investment. At the same time, investors tend to adjust their optimal allocation of investment according to the changes of the aggregate risk and the expected return. These two reactions force down the ratio of productive public spending to private capital which is the key determinant of growth in the endogenous growth model under consideration. A more rigorous analysis of the mechanism at work will be pursued under the light of the proposed macro-model.

The remainder of this article is organized as follows: Section 2 presents the proposed theoretical model. Section 3 proceeds with the analysis of the expected long-run growth under uncertainty. Section 4 illustrates the data and the econometric methodology. Section 5 provides a discussion on the empirical findings and finally, Section 6 concludes.

2. The model

The representative household's optimal choices for the consumption and the allocation of investment between a risky and a riskless asset (highlighted especially in Merton, 1971) caught the attention of the literature. The main source of uncertainty, modeled explicitly in most RBC and SDGE models, results in the exogenous stochastic variations of the dynamic innovation of technology. A technology shock alters the marginal product of labour, the marginal product of capital and output. This in turn alters interest rates, wages, taxes, capital formation or even the deficit and the public debt, depending on each model's idiosyncratic characteristics. The rational expectations mechanism allows agents to react optimally to these stochastic changes and to adjust their dynamic paths of consumption, labour or leisure and investment plans accordingly, thus leading the economy back to its steady state position. The usual investment choice in the aforementioned models is between a risky asset, that is private capital and a riskless asset, usually being the public debt. Since the present paper's main objective is to examine how the different levels of uncertainty in the bond market affect the long-run economic growth, the assumption made is that the economy's unique source of uncertainty stems from the bond market.

To provide a mathematical foundation, a typical decentralized competitive three sector model is developed. By letting the economy's single household to maximize its expected utility by choosing in an optimal manner its consumption and investment under the stochastic dynamic budget constraint, there is no substantial departure from Merton (1971). Formally, the household's maximization problem can be shaped as follows:

$$\max\ E\int_0^{\infty} e^{-\rho t}\frac{C^{\theta}}{\theta}dt \tag{1}$$

s.t.

$$dW = [r(1-h)W + RhW + \omega - C]dt + hW\sigma dz \tag{2}$$

where, household wealth (W) consists of private capital (K) and government bonds (B), ($W=K+B$), r is the interest rate and ω the wage rate. The share of wealth in government bonds is denoted as h and consequently $1-h$ is the share of wealth in privately owned capital. The expected return of the risky asset (B) is represented as R, with $R=r+f(\sigma^2)$ and $f'(\sigma^2)>0$, $f''(\sigma^2)>0$. Actually the $f(\sigma^2)$ is the risk premium associated with the variance σ^2 of the Wiener process (white noise) z, affecting the bond market. Additionally, $\theta<1$ is the steepness of the CES utility function and $\rho>0$ is the household's anticipation for consumption.

The corresponding maximum principle of this problem results in the following Hamiltonian–Jacobi–Bellman equation:

$$\rho V(W) = \max_{C,h}\left\{\frac{C^{\theta}}{\theta} + V'(W)[r(1-h)W + RhW + \omega - C] + \frac{1}{2}h^2W^2\sigma^2V''(W)\right\} \tag{3}$$

where, $V(W)$ is a value function. The optimality conditions are:

$$C = \left(V'(W)\right)^{1/\theta-1} \tag{4}$$

$$h = \frac{(r-R)V'(W)}{\sigma^2WV''(W)} \tag{5}$$

The endogenous growth framework arises from the aggregate production technology specification, which is $Y=AK^{1-a}G^{a}$ (A denotes technology).[2] The profit maximization behaviour of a competitive firm with no capital depreciation, defines the real interest rate and the wage rate as $r=(1-a)(1-\tau)AK^{-a}G^{a}$ and $\omega=a(1-\tau)AK^{1-a}G^{a}$, respectively. It is also assumed that τ is the tax rate (as government taxes output). Finally, the dynamic budget constraint of the government is $dB=(RB+G-T)dt+hW\sigma dz$, with $T=\tau Y=\tau AK^{1-a}G^{a}$.

The analytical solution of consumption, investment and the long-run growth rate is provided through the identification of the $V(W)$ function. By substituting into Eq. (3) the optimality conditions (4) and (5), the following is obtained:

$$\rho V(W) = -\frac{2(\theta-1)\sigma^2\left(V'(W)\right)^{\theta/\theta-1}V''(W) + \theta V'(W)\left((r-R)^2V'(W) - 2(\omega + rW)\sigma^2V''(W)\right)}{2\theta\sigma^2V''(W)} \tag{6}$$

A thorough examination of Eqs. (4), (5) and (6), reveals the solution for the non-linear differential Eq. (6) that has the following general form: $V(W)=\Psi W^{\theta}$, where Ψ is a coefficient to be determined. To this point it should be mentioned that the wage can be expressed as:

$$\omega = a(1-\tau)AK^{1-a}G^{a} = a(1-\tau)Ag^{a}K = a(1-\tau)Ag^{a}W(1-h) \tag{7}$$

considering that $W=K+B$ and $hW=B$,$(1-h)W=K$.

[2] We assume that technology is constant.