Government Spending and Fiscal Rules in a Simple Endogenous Growth Model

SAKIR DEVRIM YILMAZ
103622006

İSTANBUL BİLGİ ÜNİVERSİTESİ
SOSYAL BİLİMLER ENSTİTÜSÜ
IKTISAT YÜKSEK LİSANS PROGRAMI

Tez Danismani: Ege Yazgan
2007

Government Spending and Fiscal Rules in a Simple Endogenous Growth Model

(Basit Bir Endojen Buyume Modelinde Devlet Harcamalari ve Mali Kisitlamalar)

SAKIR DEVRIM YILMAZ
103622006

Tez Danışmanının Adı Soyadı(İMZASI) : EGE YAZGAN
Jüri Üyelerinin Adı Soyadı (İMZASI) : ....
Jüri Üyelerinin Adı Soyadı (İMZASI) : ....

Tezin Onaylandığı Tarih : ....

Toplam Sayfa Sayısı:40

Anahtar Kelimeler (Türkçe)	Anahtar Kelimeler (İngilizce)
1)Mali Kisitlamalar	1)Fiscal Rules
2)Endojen Buyume	2)Endogenous Growth
3)Altyapi Yatirimi	3)Infrastructure
4)Simulasyon	4)Numerical Analysis
5)Saglik Harcamalari	5)Health

ABSTRACT

This thesis attempts to analyze the implications of imposing a Golden Rule of public finance (where the government is allowed to borrow for infrastructure investment) and a standard Primary Surplus Rule on fiscal balances and growth in an endogenous growth model with productive public infrastructure and health spending. I assume a closed economy with no money creation so the government's only source of revenue is taxes on output and interest income. Due to the high complexity and non-linearity of the model, numerical simulations are performed to analyze the transitional dynamics following various shocks. It is shown, under the calibrated parameter values that the Golden Rule performs better in terms of growth and speed of convergence than the primary surplus rule. Further, the numerical simulations also show that constraining the government to borrow for other forms of productive spending such as health through fiscal rules may entail significant growth and debt-reduction costs.

OZET

Bu tez Kamu finansmaninin altin kurali olarak da bilinen ve devletin yalnizca altyapi yatirimlari icin borclanmasina olanak saglayan "Altin Kural" ile standart faiz disi fazla hedefi mali kisitlamalarinin buyume ve kamu finansmani uzerindeki etkisini altyapi ve saglik harcamalarinin uretken oldugu endojen bir buyume modelinde incelemektedir. Modelde para olmamakla birlikte develetin tek gelir kaynagi uretim ve faiz geliri uzerinden aldigi vergi olarak varsayilmistir. Modelin lineer olmayan ve karmasik yapisi nedeniyle analitik cozumun yerine model t+50 icin simulasyonla cozulmustur. Secilen parametrelerle Altin Kural'in buyume ve dengeye yakinsama acisindan faiz disi fazla kuralindan daha iyi performans gosterdigi bulunmustur. Ayrica, sonuclar altyapi haricindeki uretken devlet harcamalarinda bu tarz kurallarla kisitlamaya gidilmesinin buyumeye ve kamu dengesine olumsuz etkiler yapabilecegini gostermistir.

“Government Spending and Fiscal Rules in a Simple Model of Endogenous Growth”

Sakir Devrim Yilmaz
103622006

İSTANBUL BİLGİ ÜNİVERSİTESİ
SOSYAL BİLİMLER ENSTİTÜSÜ
IKTISAT YÜKSEK LİSANS PROGRAMI

2007

TABLE OF CONTENTS

1 Introduction

There has been much debate in recent years on whether explicit fiscal frameworks may help to achieve and maintain fiscal discipline. Fiscal rules, in particular, have taken the form of maintaining fixed targets for the deficit (variously defined) and/or public debt ratios to GDP. Such rules have been used in industrial and developing countries alike. In the euro area, the commitment was made under the Stability and Growth Pact to limit the deficit to 3 percent of GDP. Brazil introduced a Fiscal Responsibility Law in May 2000 that prohibits financial support operations among different levels of government and requires that limits on the indebtedness of each level of government be set by the Senate. Similarly, Turkey has been targeting a strong primary surplus since the break of the last crisis in 2001.

A common criticism of standard deficit rules (including balanced budget rules) is that they are inflexible (to the extent that they are defined irrespective of the cyclical position of the economy) and tend to be pro-cyclical. In response, deficit rules have been refined and are now often applied either to a cyclically adjusted deficit measure (such as the structural budget deficit) or an average over the economic cycle. Chile, for instance, introduced in early 2000 a structural surplus rule (of 1 percent of GDP) that allows for limited deficits during recessions. The budget is adjusted not only for the effects of the business cycle on public finances, but also fluctuations in the price of copper (Chile's main export commodity). By doing so, advocates claim, these rules may allow the operation of automatic stabilizers and possibly provide some room for discretionary policy within the cycle.

However, this increased flexibility comes at a cost, because the benchmark against which fiscal performance is to be judged is made more complicated—especially if estimates of potential output are revised, as is often the case. This increases the scope to bypass the rules, making them potentially harder to enforce, which in turn may undermine their credibility. In countries with a poor track record of policy consistency, this may be particularly costly and lead to higher interest rates—potentially exacerbating debt sustainability problems.

Another criticism of deficit rules is that they discourage public investment. This line of criticism particularly directed to the primary surplus rules advocated by the IMF to most developing countries in order to strengthen public balances (BSB, 2005). In such a setting, the government is only allowed to finance interest payments through borrowing, which in turn results in the abolition of infrastructure and various other potentially productive investment due to budgetary concerns. Therefore, some economists have advocated a "golden rule" approach to budgetary policy, whereby the focus is on maintaining a balance or surplus on the current account (that is, current revenues less current expenditures), with capital expenditure financed from government savings and borrowing. However, this rule has also been criticized on a number of grounds; critics have pointed out, among other arguments, its vulnerability to creative accounting, and the fact that a preferential treatment of physical investment could bias expenditure decisions against spending other potentially productive outlays (such as education and health), and stress that what matters is the overall capital stock, be it private or public (see, for instance Buti, Eijffinger, and Franco (2003)).

In essence, components of recurrent expenditure (such as maintenance spending on infrastructure, schools, and hospitals) may be equally important to maintain the quality of the services produced by the capital stock in those categories. In a purely growth context, therefore, the question that arises is where should one draw the line when imposing a fiscal rule? This is the question that I address in this thesis, in the context of an endogenous growth model with public infrastructure and health spending and debt. In addition to spending in infrastructure, the government spends on health services (which raises labor productivity). Infrastructure spending, in turn, affects the production of both commodities and health services. Although the model could be extended to include education, maintenance or other productive government spending, the current distinction between infrasturcture and health spending is sufficient to point out the affects of different fiscal regimes on various policy experiments.

The remainder of the thesis is organized as follows. Part II expands the discussion on the benefits and disadvantages of fiscal rules, and particularly of golden rule and primary surplus rule. Part III presents the analytical model and examines the nature of the equilibrium growth path with a balanced budget, which is called the "benchmark" case, as well specifying the two alternative fiscal rules: a golden rule and a primary surplus rule. Because the resulting dynamic system cannot be solved analytically, numerical simulations are performed in each case. Part IV presents the calibration procedure and reports the results of experiments, where I consider both the stability properties of the model and the speed of convergence (in response to various shocks) to the steady state. I investigate, in particular, which rule yields higher steady-state growth and more rapid convergence than the other one, and also analyze the dynamics of the debt-output ratio and debt-private capital ratio in response to a variety of policy experiments. This part also delivers a brief sensitivity analysis (with respect to one of the parameters) in order to assess the robustness of the results derived with initially calibrated values. The final part of the thesis offers some concluding remarks and identifies possible lines of future research.

2 Literature Review

As noted earlier, a common criticism of budget rules that take the form of strict limits on fiscal deficit-to-GDP ratios is that they discourage public investment. A fiscal rule that caps the overall budget deficit puts both current and investment spending on an equal footing in the measurement of the deficit that is subject to the rule. The danger, of course, is that whenever the rule becomes binding, the government will choose to cut those spending categories that are politically least costly to get rid of. If the political cost of postponing or abandoning investment projects is lower than the political cost of constraining current expenditure—as is often the case in practice—an overall deficit rule will entail a built-in bias against public investment spending—and may therefore be detrimental to growth, in the presence, for instance, of a complementarity effect between public capital and private investment. The primary surplus rule particularly opens way to such a bias against public investment by restraining the government to borrow for infrastructure projects, yielding to the abandonment of investment projects rather than reducing unproductive current expenditure.

The existence of this bias has led a number of economists, most notably Blanchard and Giavazzi (2004), to advocate reliance on a "golden rule", whereby the focus is on maintaining a current balance (that is, current revenues less current expenditures) or surplus, with capital expenditures being financed from government savings and borrowing.[1] Under the Blanchard-Giavazzi rule, governments can borrow in net terms on a continuous basis only to the extent that this net borrowing finance net public investment, that is, gross investment less capital depreciation (which counts as current spending)[2]. This rule therefore allows gross borrowing for the purpose of refinancing maturing debt, which would leave net debt unaffected. They argued that, as a result of the golden rule, the debt stock of European Union (EU) countries would gradually become fully backed by public capital. The existing debt stock, reflecting past deficits, would gradually shrink in relation

[1] To the extent that public investment boosts the economy's output potential on a permanent rather than just temporary basis, it caters to the needs of not only the present generation but also future generations. On intergenerational equity grounds, this provides a rationale to spread the costs of such investment over both current and future generations, by financing investment through government borrowing instead of current tax revenues.

[2] Musgrave (1939) was an early proponent of a rule aimed at excluding capital outlays from the operating budget, while including depreciation of the government capital stock.

to the economy's GDP as a result of the requirement that no new borrowing would be permitted in net terms to finance current spending. All new net borrowing would be matched by net investment, that is, increases in the public capital stock. Blanchard and Giavazzi (2004) also noted that public investment as a share of GDP has fallen in the euro area since the Pact was agreed upon. Moreover, Everaert (1997) found that declining public physical capital investment has significantly lowered long-run economic growth in Europe. In Belgium for example, he estimates that the decline can account for a decrease in economic activity of about 0.6 percentage points each year. However, Turrini (2004) argued that the impact of the EU rules for fiscal discipline is not a clear-cut one. On the one hand, after phase II of EMU, public investment is found to be more negatively affected by debt levels. This is consistent with the view that in the run-up to Maastricht the budgetary adjustment implied a significant decline in public investment, especially in high-debt countries. On the other hand, results indicate that after phase II of EMU public investment became positively related to previous period budget balances, so that the improvement in the budget balances consequent to the introduction of the EU fiscal rules may have helped to create room for public investment in several EU countries.

At a more conceptual level, the golden rule itself has attracted much criticism. First, advocates of the golden rule have often emphasized the need to exclude capital expenditure on infrastructure from the fiscal deficit rule. In countries with large infrastructure gaps, certain projects (such as roads, ports, airports) may indeed have rates of return that are so high, and a degree of complementarity with private investment that is so high, that they justify receiving priority in the design of a public investment program. However, in other countries (particularly low-income countries), investment in health and human capital may be an equally important priority, in part because it may have a larger impact on growth. Excluding public investment in "basic" infrastructure only (as opposed to investment in schools and hospitals) from fiscal targets would create a bias against these other components of public investment.

Second, this rule continues to be evoked as a good guide to policy even in the face of much evidence that some current expenditure—such as on operation and maintenance that keeps existing infrastructure in good condition or that contributes to health outcomes and the accumulation of human capital—can promote growth more effectively than capital expenditure *per se as documented by* Kalaitzidakis et al (2004). Put differently, components of recurrent expenditure such as spending on schools, and hospitals) may be equally important to maintain the quality of the services produced by the capital stock in those categories.

Moreover, there is growing evidence suggesting that in these countries, externalities associated with public infrastructure may be more important that commonly thought. Indeed, it has been found that infrastructure may have a sizable impact on health and education outcomes.[3] As noted in Agenor (2005c), there is a high level of microeconomic evidence supporting the complementarity between public infrastructure and health and education. Among the various studies, Behrman and Wolfe (1987), Rosenzweig et al (1997), Lavy et al (1996) have shown that access to clean water and sanitation reduces infant mortality by a significant amount, suggesting that infrastructure helps to improve health and thereby productivity. As argued in Agenor (2005b) and Agenor et al (2006), access to electricity will also improve health outcomes through reducing the cost of boiling water, and reducing the need to rely on smoky traditional fuels for cooking as well as its essentiality for the functioning of hospitals and the delivery of health services. Better transportation networks also contribute to easier access to health care, particularly in rural areas. With regards to the productivity effect of health on output, Sala-i Martin et al (2004) found that a positive relation between increase in life expentancy and increase in long run growth.

There is also evidence of direct linkages between infrastructure and education. Electricity allows for more studying and greater access to learning technology. Enrollment rates and the quality of education tends to improve with better transportation networks, particularly in rural areas. Greater access to sanitation and clean water in schools also tends to raise attendance rates(Agenor 2005c). Although I do not attempt to model explicitly the impact of infrastructure on education, and its implications for the design of fiscal rules, the focus on health is sufficient to illustrate the potential implications of adding a learning technology.

The foregoing suggestion suggests that, alternative rules may have an ambiguous effect.As noted earlier, current spending on education and health enhances human capital. Excluding them from say, a primary surplus rule is all the more important in countries where vast amounts of flow spending in infrastructure are wasted and turn only partly into public capital, and

[3] See Agénor and Moreno-Dodson (2006) and Agénor and Neanidis (2006) for a more detailed discussion.

if public capital in infrastructure has a small complementarity effect with private investment. In such conditions, singling out public investment from other budget items makes little sense; a tax reform that alleviates distortions and translates into a lowers tax burden on firms may leads to higher private investment (and higher growth) and may be preferable to an increase in public investment. At the same time, however, public capital in infrastructure may have (as noted in the introduction) a sizable impact on health and education outcomes. If these effects are sufficiently strong, a rule that entails some bias toward investment in infrastructure only may still lead to higher growth rates—despite some degree of inefficiency in the investment process itself. The question that arises, therefore, is where should one draw the line in imposing a deficit rule. However, despite the importance of the issue, very few papers have attempted to address the affects of different fiscal regimes on growth in a model including debt accumulation. In a continuous-time setting, while Ghosh et al (2004a) focused on steady state welfare-maximizing solutions under the golden rule and primary surplus rule, Ghosh et al (2004b) and Ghosh and Nolan (2005) studied the steady state characteristics of endogenous growth models with public infrastructure capital under the same rules. Similarly, Greiner et al (2000) also analyze the steady-state effects of an increase in tax rate and infrastructure spending under golden rule and primary surplus rule but they do not deliver any transitional dynamics analysis[4]. However, particularly the speed of convergence and volatility during the transition may prove to be significantly important for the performance of the economy in the short run.

The analytical framework and subsequent numerical simulations in this research will attempt to shed some light on the importance of these various effects. In line with the discussion above and following Agenor (2005c), I will deploy a Barro (1990) type endogenous growth model where public infrastructure and health spending enter the production function for output directly, and the production of health services similarly depends on infrastructure and health spending. The model will be simulated for t+50 periods, and the transition to the steady state in response to a shock to policy parameters under the golden rule and primary surplus rule will be compared. Thus, as well as providing a steady-state analysis, this research will additionally deliver the

[4]Annicchiarico et al (2004) use an overlapping-generations model in order to analyze transitional dynamics. However, their model defines fiscal rules as periodical target values for debt rather than restictions on borrowing as in Ghosh et al (2004a), Greiner et al (2000) and others.

transitional dynamics associated with various policies under golden rule and primary surplus rule.

3 The Analytical Model

The economy I consider is populated by an infinitely-lived representative household, who produces a single traded commodity. The good can be used for consumption or investment. The government has no access to seigniorage (i.e there is no money creation and therefore no inflation tax in the model) but can issue bonds to finance its deficit. It collects a proportional tax on output, and spends on infrastructure and health services. In order to keep the model simple and tractable, I will asume that public infrastructure spending enters the production function as a flow rather than as a stock. In a purely growth context as in this research, this assumption does not effect the results in a significant way (Agenor 2005a). I also assume that the governmnet services its debt and provides lump-sum transfers to households. Infrastructure and health services (which are produced by the government) are provided free of charge.

3.1 Production

Commodities are produced, in quantity Y, with private capital, K_P, public capital in infrastructure, G_I, and effective labor, defined as the product of the quantity of labor and productivity, A. Population growth is zero. Normalizing the population size to unity and assuming that the technology is Cobb-Douglas yields[5]

$$Y = G_I^{\alpha} A^{\beta} K_P^{1-\alpha-\beta}, \tag{1}$$

where $\alpha, \beta \in (0,1)$.

Productivity depends solely on the availability of health services, H. For simplicity, I assume that the relationship between A and H is linear, so that $A = H$. Using this result with (1) yields

$$Y = (\frac{G_I}{K_P})^{\alpha}(\frac{H}{K_P})^{\beta} K_P. \tag{2}$$

From standard conditions for profit maximization, the (pre-tax) wage rate, ω, and the direct pre-tax rental rate on capital, r_K, are given by

$$\omega = \beta Y/H, \qquad r_K = \eta Y/K_P, \tag{3}$$

[5]Throughout the thesis, time subscripts are omitted for simplicity, and a dot over a variable is used to denote its time derivative.

where $\eta \equiv 1 - \alpha - \beta$.

As noted earlier, access to public infrastructure is provided at no cost to users. As in Agénor and Neanidis (2006), I will assume in what follows that the implicit rent corresponding to the marginal return on public capital, $\alpha Y/K_I$, accrues to private capital. The *effective* rate of return on private physical capital, r, exceeds therefore the direct marginal product given in equation (3). Indeed, from the identity $Y = \omega H + rK_P$, as well as the condition on ω, r is given by

$$r = \frac{(1-\beta)Y}{K_P} > r_K. \tag{4}$$

Production of health services requires combining government spending on health, G_H, and public capital in infrastructure. Assuming also a Cobb-Douglas technology yields

$$H = G_I^{\mu} G_H^{1-\mu}, \tag{5}$$

where $\mu \in (0, 1)$. Thus, G_H is "pure" (or "unproductive") public consumption when $\mu = 1$.

3.2 Household Optimization

The representative household's optimization problem can be specified as

$$\max_C V = \int_0^\infty \frac{C^{1-1/\sigma}}{1-1/\sigma} \exp(-\rho t) dt, \quad \sigma \neq 1, \tag{6}$$

where C is consumption, ρ the discount rate, and σ is the elasticity of intertemporal substitution.

The household's resource constraint is given by

$$\dot{W} = \dot{K}_P + \dot{B} = (1-\tau)(\omega H + rW) + T - C, \tag{7}$$

where $W = K_P + B$is total assets, consisting of private physical capital and government bonds, in quantity B, T is lump-sum transfers (taken as given by the household), $\tau \in (0, 1)$ is the tax rate on income. Taxes are levied on interest-inclusive income, with interest income consisting not only of the (effective) return to capital but also of the return to government bonds.Therefore $\omega H + rW = Y + rB$ is the tax base. Through standard (after-tax) arbitrage conditions, the rate of return on both categories of assets is identical and equal to r. For simplicity, I assume that private capital does not depreciate.

The household takes public policies and the depreciation rate as given when choosing the optimal sequence of consumption. Using (1), (6), and (7), the current-value Hamiltonian for problem (6) can be written as

$$L = \frac{C^{1-1/\sigma}}{1-1/\sigma} + \lambda[(1-\tau)(\omega H + rW) + T - C],$$

where λ is the co-state variable associated with constraint (7). From the first-order condition $dH/dC = 0$ and the co-state condition $-dH/dW = \dot{\lambda} - \rho\lambda$, optimality conditions for this problem take the familiar form

$$C^{-1/\sigma} = \lambda, \tag{8}$$

$$\dot{\lambda} = \lambda[\rho - (1-\tau)r], \tag{9}$$

together with the budget constraint (7) and the transversality condition

$$\lim_{t\to\infty} \lambda W \exp(-\rho t) = 0. \tag{10}$$

3.3 Government

The government invests in infrastructure capital, G_I, and spends on health services, G_H, unproductive expenses, G_U, transfers, T, and interest payments, rB. As noted earlier, it also collects a proportional tax τ on output. Thus, the government budget constraint is given by[6]

$$\dot{B} = \sum_{h=I,H,U} G_h + T + rB - \tau(Y + rB). \tag{11}$$

I first begin with the assumption that all components of spending are fixed fractions of total tax revenues:

$$G_h = \upsilon_h \tau(Y + rB), \;\; h = I, H, U \tag{12}$$

[6]From (7), (11), and the identity $Y = \omega H + rK_P$, the economy's consolidated budget constraint (or equivalently, the goods market equilibrium condition) is $C + \Sigma_{i=I,H} G_h + \dot{K}_P = Y$.

Using these equations, the government budget constraint, equation (11), can then be rewritten as

$$\dot{B} = rB - (1 - \sum_{h=I,H,T,U} \upsilon_h)\tau(Y + rB). \tag{13}$$

Finally, the government cannot run a Ponzi scheme, which implies that it is subject to the transversality condition

$$\lim_{t\to\infty} B \exp[-\int_0^\infty r_u du] = 0,$$

or equivalently

$$B_0 + \int_0^\infty (G + T) \exp[\int_0^t r_u du]dt = \int_0^\infty Z \exp[\int_0^t r_u du]dt. \tag{14}$$

where $G = \sum_{h=I,H} G_h$ and $Z = \tau(Y + rB)$.[7]

3.4 Balanced Budget Rule

As a benchmark case, let us consider the case of a zero deficit (or balanced budget) rule, I denote this rule BBR, and implement it by imposing $\dot{B} = 0$ in (11) and solving the government budget constraint for lump-sum transfers, T. Equivalently, setting the constant value of B equal to zero as well, the model determines endogenously the share of spending on transfers, υ_T:

$$\upsilon_T = 1 - \sum_{h=I,H,U} \upsilon_h. \tag{15}$$

This rule ensures that the transversality condition (14) is satisfied. It is a particular case of the rule $\dot{B} = \gamma_B B$, where $\gamma_B \in (0, 1)$ is a constant growth rate.

Determining the balanced growth path (BGP) associated with BBR proceeds in three steps. First, note that $\omega H + rW = \omega H + rK_P = Y$, and from (1) and (5),

$$Y = G_I^\alpha (\frac{G_I^\mu G_H^{1-\mu}}{K_P})^\beta K_P,$$

[7]Note that economies that have unsustainable policies in the medium run may have a sustainable public debt for $t \to \infty$.

Using (12), this expression can be rewritten as

$$\frac{Y}{K_P} = \left[\upsilon_I \tau(\frac{Y}{K_P})\right]^{\alpha+\mu\beta} \left[\upsilon_H \tau(\frac{Y}{K_P})\right]^{(1-\mu)\beta}, \tag{16}$$

using (4),

$$\frac{Y}{K_P} = \upsilon_I^{\alpha+\mu\beta/\Omega} \upsilon_H^{(1-\mu)\beta/\Omega} \tau^{\alpha+\beta/\Omega}. \tag{17}$$

where $\Omega \equiv 1 - \alpha - \beta$.

Second, from the budget constraint (7) with $\dot{B} = B = 0$,

$$\dot{K}_P = (1-\tau)Y + T - C,$$

using (15),

$$\dot{K}_P = qY - C,$$

where $q \equiv 1 - \tau \sum_{h=I,H,U} \upsilon_h$, so that $q \in (0,1)$. Dividing by K_P,

$$\frac{\dot{K}_P}{K_P} = q\upsilon_I^{\alpha+\mu\beta/\Omega} \upsilon_h^{(1-\mu)\beta/\Omega} \tau^{\alpha+\beta/\Omega} - c, \tag{18}$$

where $c = C/K_P$.

Third, taking logs of (8) and differentiating with respect to time yields $\dot{C}/C = -\sigma(\dot{\lambda}/\lambda)$. Substituting (9) this expression yields, setting $s \equiv (1-\tau)(1-\beta)$,

$$\frac{\dot{C}}{C} = \sigma[s(\frac{Y}{K_P}) - \rho],. \tag{19}$$

that is, using (17),

$$\frac{\dot{C}}{C} = \sigma s\upsilon_I^{\alpha+\mu\beta/\Omega} \upsilon_h^{(1-\mu)\beta/\Omega} \tau^{\alpha+\beta/\Omega} - \sigma\rho, \tag{20}$$

Equations (18), and (20) can be further condensed into a first-order non-linear differential equation in $c = C/K_P$

$$\frac{\dot{c}}{c} = (\sigma s - q)\upsilon_I^{\alpha+\mu\beta/\Omega} \upsilon_H^{(1-\mu)\beta/\Omega} \tau^{\alpha+\beta/\Omega} + c - \sigma\rho, \tag{21}$$

On the balanced growth path, consumtion and private capital grow at the same rate and therefore $\frac{\dot{C}}{C} = \frac{\dot{K}_P}{K_P}$. This implies that in steady state equilibrium, $\dfrac{\dot{c}}{c} = 0$. However, since the coefficent of c in (21) is positive, the equilibrium is (globally) unstable and the economy has to start from steady state to be able to keep on staying at steady state. Setting $\dfrac{\dot{c}}{c} = 0$ in (21) gives the steady state level of consumption as

$$\tilde{c} = \sigma\rho + (q - \sigma s)\upsilon_I^{\alpha+\mu\beta/\Omega}\upsilon_H^{(1-\mu)\beta/\Omega}\tau^{\alpha+\beta/\Omega}, \tag{22}$$

where where $\tilde{c}$ denotes the stationary value of c.

Inserting this result in (18) gives the steady state growth rate as

$$\gamma = \sigma s\upsilon_I^{\alpha+\mu\beta/\Omega}\upsilon_H^{(1-\mu)\beta/\Omega}\tau^{\alpha+\beta/\Omega} - \sigma\rho, \tag{23}$$

which will be positive as long as $s\upsilon_I^{\alpha+\mu\beta/\Omega}\upsilon_h^{(1-\mu)\beta/\Omega}\tau^{\alpha+\beta/\Omega} > \rho$[8]. In a regime with a balanced budget rule, the transversality condition takes the form

$$\lim_{t\to\infty} \lambda K_P \exp(-\rho t) = 0, \tag{24}$$

since there is no debt accumulation and $B = 0$. From (9),

$$\frac{\dot{\lambda}}{\lambda} = \rho - (1-\tau)(1-\beta)\upsilon_I^{\alpha+\mu\beta/\Omega}\upsilon_H^{(1-\mu)\beta/\Omega}\tau^{\alpha+\beta/\Omega}, \tag{25}$$

Noting that the transversality condition will be satisfied if $\frac{\dot{\lambda}}{\lambda} + \frac{\dot{K}_P}{K_P} - \rho < 0$ and using (25), (23), and $s = (1-\tau)(1-\beta)$ it follows that $s(\sigma - 1)\upsilon_I^{\alpha+\mu\beta/\Omega}\upsilon_H^{(1-\mu)\beta/\Omega}\tau^{\alpha+\beta/\Omega} - \sigma\rho < 0$ is the necessary condition for the transversality condition to hold. It is clearly seen that if $\sigma < 1$, which is in general true for especially developing countries as mentioned in the calibration section below, the condition is automatically satisfied. Therefore, assuming that $\sigma < 1$, the transversality condition holds regardless of the values of policy parameters υ_H, τ, and υ_I or technology parameters $\alpha$and β.

[8] As shown in the simulations, ρ is very close to zero, so this is not such a binding condition

However, the regime displays no transitional dynamics and following a shock, the consumption private capital ratio must jump to the new steady state value immediately.

3.5 Alternative Fiscal Rules

I now consider two alternative fiscal rules and begin with the golden rule, given the attention that it has received. As discussed earlier, funding capital expenditure from current revenues would imply a disincentive to undertake projects producing deferred benefits but entailing up-front costs; this disincentive may be particularly high during periods of fiscal adjustment.In tis setting, it is only the public infrastructure capital spending that should be financed via borrowing while the part that covers depreciation (or maintenance), which is not explicitly accounted for here, should remain tax financed.

3.5.1 The Golden Rule

The golden rule (denoted GR) can be implemented in this framework by requiring that the sum of (current) government spending on health, transfers, and interest payments, must be equal to a fraction, θ, of tax revenues:

$$G_U + G_H + T + rB = \theta\tau(Y + rB), \tag{26}$$

where $\theta \in (0,1)$.I will also assume that all spending shares continue to be fixed fractions of total revenues, as indicated in (12). Thus, equation (26) determines residually lump-sum transfers as

$$T = \tau(\theta - \upsilon_H - \upsilon_U)(Y + rB) - rB, \tag{27}$$

Combining (11) and (26) implies also that, borrowing increases as a result of excess investment in infrastructure over the remaining tax revenues:

$$\dot{B} = G_I - (1 - \theta)\tau(Y + rB), \tag{28}$$

Using (12), equation (28) now becomes

$$\dot{B} = -(1 - \upsilon_I - \theta)\tau[Y + rB], \tag{29}$$

Dividing (29) by B yields,

$$\frac{\dot{B}}{B} = -(1 - \upsilon_I - \theta)\tau b^{-1}[(\frac{Y}{K_P}) + rb], \tag{30}$$

where $b = B/K_P$. From (4),

$$\frac{\dot{B}}{B} = -(1 - \upsilon_I - \theta)\tau b^{-1}[1 + (1 - \beta)b]\frac{Y}{K_P},$$

$$\frac{\dot{B}}{B} = -(1 - \upsilon_I - \theta)b^{-1}\tau g(\frac{Y}{K_P}), \tag{31}$$

where $g = [1 + (1 - \beta)b]$

Equation (31) implies that debt increases over time only if $\upsilon_I + \theta > 1$ The household budget constraint (7) can be rewritten as

$$\frac{\dot{K}_P}{K_P} = -\frac{\dot{B}}{B}b + (1 - \tau)[\frac{Y}{K_P} + rb] + z - c,$$

where $z = T/K_P$. Substituting (31) in this expression,

$$\frac{\dot{K}_P}{K_P} = [(1 - \upsilon_I - \theta)\tau + (1 - \tau)]\, g(\frac{Y}{K_P}) + z - c, \tag{32}$$

Finally, dividing (27) by K_P yields

$$z = (\theta - \upsilon_H - \upsilon_U)\tau(\frac{Y + rB}{K_P}) - rb,$$

that is, using (4),

$$z = [(\theta - \upsilon_H - \upsilon_U)\tau g - (1 - \beta)b]\,(\frac{Y}{K_P}), \tag{33}$$

Substituting into (32), and simplifying,

$$\frac{\dot{K}_P}{K_P} = [(1 - \Pi\tau g]\,(\frac{Y}{K_P}) - c, \tag{34}$$

where $\Pi \equiv \upsilon_I + \upsilon_H + \upsilon_U$.

Note, however, that equation (17) is not valid under golden or primary surplus rule rule because $\omega H + rW = Y + rB$.Therefore, equation (16) becomes

$$\frac{Y}{K_P} = \left[\upsilon_I \tau (\frac{Y + rB}{K_P})\right]^{\alpha+\mu\beta} \left[\upsilon_h \tau (\frac{Y + rB}{K_P})\right]^{(1-\mu)\beta}, \tag{35}$$

which, after the same steps as above gives,

$$\frac{Y}{K_P} = \upsilon_I^{\alpha+\mu\beta/\Omega} \upsilon_h^{(1-\mu)\beta/\Omega} \tau^{\alpha+\beta/\Omega} g^{\alpha+\beta/\Omega}. \tag{36}$$

Therefore,

$$\frac{\dot{C}}{C} = \sigma s \upsilon_I^{\alpha+\mu\beta/\Omega} \upsilon_h^{(1-\mu)\beta/\Omega} \tau^{\alpha+\beta/\Omega} g^{\alpha+\beta/\Omega} - \sigma\rho, \tag{37}$$

and

$$\frac{\dot{K}_P}{K_P} = [(1 - \Pi\tau g]\, \upsilon_I^{\alpha+\mu\beta/\Omega} \upsilon_h^{(1-\mu)\beta/\Omega} \tau^{\alpha+\beta/\Omega} g^{\alpha+\beta/\Omega} - c, \tag{38}$$

Using (36), equations (31), (37) and (38)can be further manipulated to produce a first-order differential equation system in c, and b, where $b = \frac{Y}{K_P}$,which consists of

$$\frac{\dot{c}}{c} = \{\Pi\tau g + \sigma s - 1\}\, \upsilon_I^{\alpha+\mu\beta/\Omega} \upsilon_h^{(1-\mu)\beta/\Omega} (\tau g)^{\alpha+\beta/\Omega} - \sigma\rho + c, \tag{39}$$

$$\frac{\dot{b}}{b} = \left\{ \left[\Pi + b^{-1}(\upsilon_I + \theta - 1)\right] \tau g - 1 \right\} \upsilon_I^{\alpha+\mu\beta/\Omega} \upsilon_h^{(1-\mu)\beta/\Omega} (\tau g)^{\alpha+\beta/\Omega} + c, \tag{40}$$

The BGP is a set of functions $\{c, b\}_{t=0}^{\infty}$ such that equations (39) and (40), the budget constraint (26), and the transversality condition (10), are satisfied, and consumption, debt and the stock of private capital, all grow at the same constant rate γ.[9]The growth rate is given by (37) or equivalently by (31).

[9] γ is also the rate of growth of output of commodities and health services, given the assumption of constant returns to scale.

3.5.2 Primary Surplus Rule

Under a general primary surplus rule (PSR), the constraint linking current expenditure and tax revenues is given by

$$G_U + G_H + G_I + T = \theta\tau(Y + rB), \tag{41}$$

which indicates that public spending on health and unproductive outlays, investment in infrastructure, and transfers to households, must all be financed by a fraction θ of total tax revenues.

Combining (11) and (41) yields

$$\dot{B} = rB - (1-\theta)\tau(Y + rB), \tag{42}$$

which states that interest payments, to the extent that they are not covered by a residual fraction $1-\theta$ of tax revenues, must be financed by borrowing.

Using (12) and dividing by B,

$$\frac{\dot{B}}{B} = -(1-\theta)\tau b^{-1}[(\frac{Y}{K_P}) + rb] + r,$$

which, using (36), and the definition of g, can be written as

$$\frac{\dot{B}}{B} = \left[(\theta-1)b^{-1}\tau g + (1-\beta)\right] \upsilon_I^{\alpha+\mu\beta/\Omega}\upsilon_h^{(1-\mu)\beta/\Omega}(\tau g)^{\alpha+\beta/\Omega}. \tag{43}$$

As in the previous section, dividing the household budget constraint (7) by K_P gives

$$\frac{\dot{K}_P}{K_P} = -\frac{\dot{B}}{B}b + (1-\tau)[(\frac{Y}{K_P}) + rb] + z - c,$$

where $z = T/K_P$. Using (12) and (41),

$$T = (\theta - \upsilon_H - \upsilon_M - \upsilon_U - \upsilon_I)\tau[Y + rB], \tag{44}$$

Dividing (44) by K_P, together with (36), yields

$$z = [(\theta - \upsilon_H - \upsilon_U - \upsilon_I)\tau g]\, \upsilon_I^{\alpha+\mu\beta/\Omega}\upsilon_h^{(1-\mu)\beta/\Omega}(\tau g)^{\alpha+\beta/\Omega}, \tag{45}$$

Substituting (43) and (45) in the above equation, the growth rate of private capital becomes

$$\frac{\dot{K}_P}{K_P} = (1 - \Pi\tau g)\upsilon_I^{\alpha+\mu\beta/\Omega}\upsilon_h^{(1-\mu)\beta/\Omega}(\tau g)^{\alpha+\beta/\Omega} - c, \tag{46}$$

The growth of rate of consumption, $\dot{C}/C$, is as defined in (19). Together with (43) and (46), these equations can be rearranged to define the dynamics of the economy under the general primary surplus rule. The dynamic equations driving c, is given, as before, by (39), whereas the equation of motion for b is now given by

$$\frac{\dot{b}}{b} = \left\{ \left[\Pi + (\theta - 1)b^{-1}\right] \tau g - \beta \right\} \upsilon_I^{\alpha+\mu\beta/\Omega}\upsilon_h^{(1-\mu)\beta/\Omega}(\tau g)^{\alpha+\beta/\Omega} + c, \tag{47}$$

The steady-state growth rate is given equivalently by (37), or, from (43).[10]

I therefore have two dynamic systems to consider: the Golden Rule (GR), consisting of (39) and (40), and the Primary Surplus Rule (PSR), consisting of (39), and (47), As discussed earlier, it was shown that under the balanced budget rule (BBR), system is unstable in the vicinity of the BGP. For the other rules as well, saddlepath stability (even in a local sense) is not guaranteed, given their high degree of nonlinearity and the complexity of the relevant conditions. Indeed, in both systems, c can jump whereas b is predetermined. Saddlepath stability requires therefore one unstable (positive) root. The Routh-Hurwicz conditions require that the determinant of the Jacobian matrix of partial derivatives of the dynamic system be negative (in order to exclude two negative or two positive roots). However, due to the high non-linearity and complexity of the model, these conditions are very difficult to establish in an unambiguous way. Therefore, analytically, the necessary conditions for saddlepath stability and the existence of a balanced growth path with positive values for c and b cannot be derived. To examine whether stability is verified under plausible values for the parameters, and to study how the speed of convergence to the steady state (following a shock) depends on the specification of the rule, so I turn to numerical simulations.

[10] In the simulation results reported later, θ is set at $\theta = 1$; this assumption ensures indeed that $\gamma > 0$ in equation (43).

4 Numerical Results

In order to conduct the numerical analysis in this chapter, the technology and spending share parameters, along with initial values for output, debt and private capital should be calibrated. Therefore, I proceed in this direction now.

4.1 Calibration

As my starting point, the parameters are chosen to roughly match some "stylized" facts about low-income developing countries with reasonably high debt-output ratios. I consider an economy with output Y normalized to $1,000$. The private capital stock K_P is set at 2,000, implying that the initial private capital-output ratio is 2.[11]

The elasticities of production of goods with respect to public infrastructure spending and effective labor, α and β respectively, are set equal to 0.2 and 0.5. These estimates imply a share of private capital in output equal to 0.3. For the health technology, an appropriate value for the coefficient μ is more difficult to identify, because most of the empirical evidence is microeconomic in nature. At the same time, as noted earlier, assessing the impact of infrastructure on growth and stability is a key purpose of the model. Accordingly, I choose an initial value of $\mu = 0.2$, to perform sensitivity analysis below.

The rate of time preference, ρ, is set at 10 percent. Interpreting each period as 3 years, this gives a yearly discount value of 3.3 per cent, a fair choice regarding the literature[12]. This leads to a discount factor of approximately 0.967. Private consumption, C, which is determined from the goods market equilibrium condition, represents about 85 percent of output. The intertemporal elasticity of substitution is set at 0.2. As noted earlier, this is consistent with the evidence for developing countries, as discussed by Agénor and Montiel (2006).

The tax rate on output (which is also the share of total government spending in output), τ, is set at 0.2. This value is in line with actual ratios

[11] These values are is in line with the calibrated values for same parameters in Agenor (2005c)

[12] While Greiner et al (2000) take the discount rate 3 per cent, Agenor (2005c) uses 4 per cent instead. Therefore, the choice of the discont rate lies in between these two values.

for many low-income countries, where taxation (which is essentially indirect in nature) provides a more limited source of revenue than in higher-income countries. The initial shares of government spending on infrastructure services and health services, υ_I and υ_H respectively, are set at 0.2 and 0.25. The share of "unproductive" spending, υ_U (which here includes also public wages and salaries, which are not explicitly accounted for) is set at 0.2. Thus, in the benchmark case, the share of transfers , υ_T, is 0.35, as implied by the budget constraint (15). Multiplying these shares by the tax rate implies that spending on infrastructure investment represents 4.0 percent of output in the base period, whereas spending on health services amounts to 5.0 percent of output. The estimates used here can be viewed as representing an "intermediate" case of a government committed to allocating roughly half of its resources to physical and human capital accumulation.

The initial stock of public debt, B is set at 400. The coefficient θ is set at 1 for both computational simplicity, and to ensure that in the absence of dynamic adjustment in the model, the government does not become a net creditor in the steady state.

Calibration of the model around these initial values and parameters (which involves also determining appropriate multiplicative constants in the production functions for goods and educated labor) produces the baserun solution. Given the values described above, initial ratios of c, and b are, respectively, 0.85, 0.21 for Golen Rule, whereas the initial steady-state growth rate is equal to 2.5 percent.

4.2 Numerical Simulations

I now examine the stability and convergence properties of the models associated with the rules derived earlier. To do so I use both the base calibration and the alternative cases described in the previous section. With consumption being a forward-looking variable, I use the "extended path" method of Fair and Taylor (1984) as the solution procedure. This iterative procedure is quite convenient (once a discrete-time approximation of the model is written) because it allows one to solve perfect foresight models in their nonlinear form. The terminal condition imposed on consumption is that its growth rate at the terminal horizon (t+50 periods here) must be equal to the growth of the private capital stock, given the condition that $c = C/K_P$ must be constant along the balanced growth path. The simulations are performed using the E-views program.

4.2.1 Golden Rule

I first experiment with the Golden Rule, increasing the government spending shares on investment in infrastructure, and health and tracking the dynamics of the ratio of public debt stock to private capital, B/Kp, public debt stock to income measured as B/Y, and the growth rate of output. In order to do so, the baseline solution with the initial values calibrated above is first calculated. Then, the shock is given to the policy parameters and the model is re-simulated for t+50 periods and deviations from baseline values are obtained. As the first experiment, I assume that the spending share on infrastructure increases by 5 % from 0.2 to 0.25[13]. Figure 1 displays the deviations from baseline values for debt private capital ratio, debt-output ratio and the growth rate of output respectively in three panels in this case.

In GR, the effect of the increase in infrastructure spending on debt accumulation are twofold : An increase in the debt stock due to higher borrowing, and a subsequent increase in interest payments as the marginal productivity of private capital, r, also increases with the shock. The increase in interest payments translates to a higher tax base and further increases borrowing for infrastructure and crowds out private capital in subsequent periods but it also increases transfers since all government spending is proportional to the tax base. Therefore the overall effect on output depends on the strength of these affects and relative productivity of these factors of production.The upper and middle panels reveal that in response to an increase in v_I, the debt-output ratio drop instantenously and the magnitude of the drop gets even larger in the first periods. This is because public infrastructure spending is assumed to enter the production function contemporenously and output increases simultenously as v_I increases but debt is a pre-determined variable and therefore the level of debt remains constant for one period. For the same reason, debt-private capital ratio remains constant for one period after the shock, because both variables are predetermined. Apart from this, both B/Kp and B/Y display volatile dynamics, falling significantly initially but stabilizing at higher values than the baseline. In essence, the debt-output ratio increases much less than debt-private capital ratio (and stabilizes at a value very close to the baseline) because the increase in v_I directly effects output through infrastructure spending whereas the positive affect on Kp comes through indirect affects on disposable income, $(1-\tau)Y$, and transfers

[13]It is essential to note that the government finances infrastructure spending through borrowing under Golden Rule, so borrowing increases each period as well.

as well the negative crowding out of increase in debt on private capital accumulation (see 7).As the lower panel displays, the growth rate of output increases instantenously as v_I increases and then displays a cyclical pattern, increasing initially but then falling as diminishing returns set in and the interest rate -the return to private capital at the same time - stabilizes. However, still, there is a significant increase in growth as the steady state growth rate increases by about 2%.

Next, consider the case that the government increases v_H through borrowing, althoug it is constrained by the rule to do so. In other words, let the government violate the rule permanently and increase v_H by 5 per cent from 0.25 to 0.3. This experiment in a way tries to investigate the dynamics if the rule were altered and the government were allowed to borrow in order to finance other productive spending at time 0. Figure 2 displays the dynamics in this case. The upper panel shows that public debt-private capital ratio behaves more or less similar to a increase in v_I and stabilizes at a slightly higher level than above because higher productivity of health compared to infrastructure increases the return to private capital more after the shock and the crowding out effect of interest payments on transfers is higher when v_H increases by 5 per cent (see (27). Due to higher productivity of health than infrastructure, the debt-output ratio stays strictly below the baseline value, although additional spending is financed via borrowing. In other words, the positive affect of additional health spending on output more than compensates for the increase in the level of debt, and therefore B/Y falls both through transition and at the steady state. Similarly, the growth rate of output is also higher than the case of an increase in v_I through borrowing.

4.2.2 Primary Surplus Rule

I now conduct a similar analysis using the primary surplus rule. However, in this case, since the government is only allowed to borrow for interest payments, an increase in the share of infrastructure spending should be mathced with a simultenous decrease in one of the other spending shares[14]. Figure 3 and Figure 4 display the dynamics when the 5 per cent increase in v_I is financed by a 5 percent decrease in share of transfers (v_T)and share of health spending (v_H) respectively. When the increase in vi is financed by a cut in

[14]As above, it could be assumed that the rule is altered at time 0 and the government is allowed to borrow for productive spending here as well. However, the analysis in this paper is sufficient to emphasize the point so I will not pursue this way here.

vT or Vh, the behaviour of debt-private capital ratio and debt-output ratio entirely depends on the relative productivities of infrastructure, private capital and health. When the cut in v_T finances the additional spending on infrastructure, the debt-private capital ratio and debt-output ratio both fall since infrastructure is calibrated to be more productive than private capital with the assigned parameter values. As a result of this, the growth rate of output is also higher than the baseline value through the transition and the steady state, although the growth performance is worse than the golden rule (Figure 5). However, the opposite is true when the additional spending is financed by a decline in health services. Both debt-private capital ratio and debt-output ratio increase and stabilize at a higher value than baseline. Further, the growth rate of output falls and stabilizes at a lower value than the baseline. Basically, this experiment, together with an increase in v_H through borrowing under the golden rule as above, captures the aforementioned bias towards infrastructure investment under a strict budgetary regime. If the government is restricted to borrow for other productive spending than infrastructure as under the Golden Rule, the emphasis on infrastructure investment might lead to a lower growth and worse budget performance (measured as B/Y) than possible through borrowing to finance (at least partially) other productive spending, specified as health here. Similarly, under a primary surplus rule where the government is not allowed to borrow to finance any type of current or investment spending, a bias towards infrastructure might lead to a reduction on other possibly productive spending, which might hamper growth and lead to a worse budget performance. In a purely growth context, this in turn requires a very careful assesment of the relative productivities of certain types of government spending.

4.2.3 Cut in Unproductive Spending

Next, consider the case that the increase in infrastructure spending is financed by a cut in unproductive government spending under both rules. Figure 6 compares the behaviour of variables of interest. First of all, it is clear from upper and middle panel that if we consider the debt ratios, golden rule performs much better in terms of volatility and stabilizes more quickly than primary surplus rule. The main reason for this is that the level of debt is not affected by interest payments under GR and therefore the variations in interest rate is not reflected in the stabilization of debt-private capital and debt-output ratio. On the contrary, under the PSR, the volatility of the interest rate also causes a large volatility in these ratios. The fall in both ratios is significantly higher under the primary surplus rule than under the golden rule throughout the transition but at the steady state, they stabilize slightly below zero and very close to each other. With respect to growth, the lower panel shows that golden rule is both more stable and yields higher growth than primary surplus rule this time.

4.2.4 Increase in Tax Rate

And finally, let us assume that the government increases the tax rate by 2% from 0.2 to 0.22. This will lead to more resources from national income being spent on infrastructure and health, as well as an increase in the total level of unproductive spending and transfers and a fall in disposable income that will create a crowding out affect on private capital. The results are displayed in the three panels in Figure 7. In this case, debt-private capital ratio and debt-output ratio behave in a similar way as above. The only significant difference is that the Golen Rule now stabilizes at a slightly higher B/K_P ratio than the baseline, but still it is more stable than primary surplus rule. Regarding the debt-output ratio, the primary surplus rule performs better through the transition but both rules stabilize just below their baseline ratios, Golden Rule stabilizing slightly lower than its baseline compared to primary surplus rule. In terms of growth, the growth rate of output increases under both rules but Golden Rule outperforms the Primary Surplus Rule through the transition and the steady state as before.

4.2.5 Lower Health-Infrastructure Elasticity

Finally, I perform experiments with the sensitivity of health output to infrastructure capital, namely μ, using the GR and Primary Surplus Rule as above and applying a 5 percentage-point increase to υ_I financed by a cut in unproductive spending. The results are displayed in Figure 8 for $\mu = 0.1$. Clearly, the impact of a lower elasticity of health to infrastructure is to decrease the fall in the debt-output ratio and debt-private capital ratio. Comparing Figure 6 and Figure 8, it is clear that a lower elasticity of infrastructure in the production of health services favours PSR against GR. It takes the GR slightly longer now in the middle panel to catch PSR and the wedge between the growth performances of two rules is more narrow now. This is simply because with $\mu = 0.1$ the government borrows for less productive infrastructure under GR and the crowding-out effect of debt accumulation on private capital is thus stronger against the positive effect of productive government spending on output. This result suggests that a lower elasticity of infrastructure inproduction of health would strengthen the above results when the government borrows for health under the GR and invests in infrastructure through a cut in health spending under PSR. In both cases, with $\mu = 0.1$, the results would favour health more against infrastructure and therefore the positive affects of an increase in υ_H through borrowing under GR and the negative affects of increase in υ_I through a cut in υ_H under PSR would simply be higher.

5 CONCLUSION

The purpose of this thesis was to examine the performance of alternative fiscal rules in an endogenous growth model with public capital and debt. In order to do so, after a short introduction in the first chapter, the second chapter of the study provided a brief review of the current debate on fiscal rules and the preceding endogenous growth literature that incorporates fiscal rules in their analysis, as well as outlining the main economic motivation and microeconomic evidence behind the analytical model. The third part presented the analytical framework, where in addition to investing in infrastructure, the government spends in health (which raises labor productivity). In turn, infrastructure affects the production of both commodities and health services. In this setting, under certain reasonable restrictions, the balanced budget rule delivers a positive growth rate and satisfies the transversality conditions but the model is also shown to be (globally) unstable under this rule. However, since the case of balanced budget is far from reality for a vast majority of countries, the chapter then considers two alternative rules—a "standard" golden rule where the government is allowed to borrow for infrsatructure spending, and a "standard" primary surplus rule where the government can only borrow to finance interest expenditures. Because the resulting models are too complex to prove stability and perform policy experiments analytically (as a result of the higher dimension added by public debt accumulation and high non-linearity involved), they are compared numerically.

This was done in Chapter 3 after discussing the calibration procedures. The performances of both rules were examined in response to a variety of shocks such as an increase in the shares of spending on infrastructure and health, a reallocation of unproductive spending to infrastructure spending and an increase in the tax rate. Under a range of plausible parameter configurations and spending shares, the numerical simulations showed that in response to these shocks golden rule performs better than primary surplus rule—in the sense of yielding higher steady-state growth, less volatility and more rapid convergence, despite performing slightly worse than primary surplus rule in terms of debt-output ratio through the transition to the new steady state. Moreover, the analysis also supported the idea that bias towards infrastructure could hamper growth if it leads to a decrease in other areas of potentially productive government spending such as health in this model. As was shown, borrowing for health through a modification in the rule delivers higer growth than borrowing for infrastructure under golden rule, and similarly increasing infrastructure spending through a decrease in health spending may reduce growth and increase debt-output ratio under the primary surplus rule.

One of the most importatnt policy lessons to be drawn from this analysis is that even modifying the golden ruledoes not provide a clear guide as to where one should "draw the line" on current spending. This is simply because one could always argue that education also strongly affects productivity and therefore that governments should be allowed to borrow for education by the rule. The reasoning can of course be pushed further; it could be argued that wages and salaries of public servants (a large share of public spending in most countries) are "productive" to some degree because they increase the productivity of these workers and facilitate private activity. Likewise, spending on defense and security, or the environment, could be viewed as being productive—feeling safer or breathing better may lead to higher productivity. Moreover, governments may have strong incentives to present various categories of spending as productive, even if the case is not clear. The implication therefore is that "drawing the line" becomes very difficult, making the practical specification of the rule extremely difficult as well.

At this point, it is important to note that one further extension of this research would be to incorporate the risk premium associated with the level of public debt. This is particularly valid for developing economies that are heavily dependent on external borrowing in order to close thier savings and investment gaps. The interest rate faced by these economies includes a risk premium that increases (in general in a convex way) with the worsening of public balances over the world interest rate. Therefore, in such a setting, the deviations from baseline debt-output ratio for instance, if it is regarded as an indicator of the position of public balances, may assume great importance. As Figure 6, Figure 7 and Figure 8 show, such a specification would clearly favour primary surplus rule against the golden rule, particularly through the transition process since the high negative deviations from baseline debt-output ratios would reduce the risk premium and further contribute to the improvement in public balances under the primary surplus rule. However, this would also come at a cost of even lower growth affect than golden rule due to a smaller tax base to finance productive spending. Apparently, one cannot assume a priori that the same parameter configurations would yield a balanced steady state growth when risk premium is accounted for. Excessive debt accumulation may always completely crowd out private investment and there may be no balanced equilibrium for a wide range of parameters.

A second important point is that as long as there exists heterogeneity among parameters and starting values, imposing uniform fiscal rules "across the board" to a group of countries because they share a common monetary arrangement makes little sense. In countries where stocks of public infrastructure assets are relatively low to begin with, borrowing for infrastructure projects creates greater opportunity and thus makes sense—as long as the investment is sufficiently efficient and productive. This may actually improve prospects for fiscal stability. However, in other cases, borrowing for other forms of potentially productive government spending may prove to be more beneficial in terms of growth. Even if the rule is slightly modified to allow borrowing to partially finance some productive current spending, the growth gains may be significantly high, sometimes even higher than additional spending in

infrastructure itself. This may particularly hold again for low and middle-income developing countries where the marginal product of health and education is relatively high due to low level of human and health capital accu-

mulation. However, as argued above, this again brings forward the question of drawing the line on current spending.

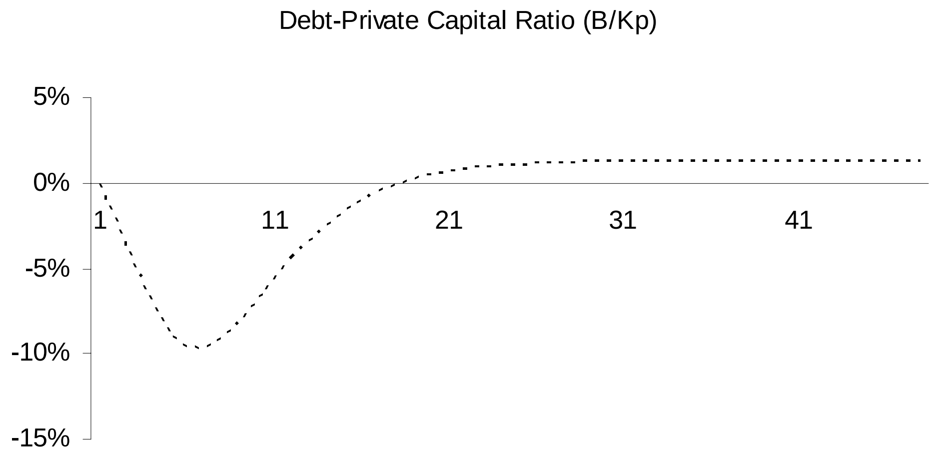
And finally, it must be noted that the focus on growth (and transitional dynamics) should not lead one to neglect the fact that fiscal rules are also imposed in order to prevent pro-cyclical government spending from fostering macroeconomic volatility. To the extent that such volatility is detrimental to growth (as shown in a number of recent studies), a potential trade-off may emerge, where if a "standard" fiscal rule lowers volatility significantly, constraining productive spending may ultimately prove to be beneficial to growth. [15] The nature of this trade-off would normally depend on a number of institutional factors, in addition the structural characteristics of the economy. In countries where political polarization is high, or the national legislature is fragmented across a large number of political parties, for instance, the propensity to engage in procyclical spending may be quite strong and tight rules may be inevitable. Moreover, volatility itself may have large welfare costs, as shown by Pallage and Robe (2003), independently of its impact on growth.

[15] This volatility may particularly hamper growth through an increase in the risk premium, or through various other channels in an open economy.

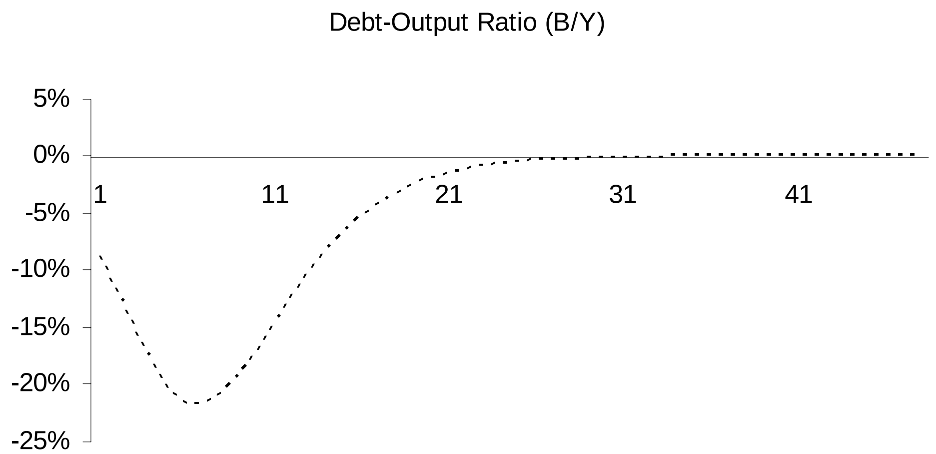
To conclude, it is vital to emphasize that although this thesis does not provide a clear-cut answer to where one should draw the line, it clearly shows that the question of how to draw the line cannot simply be addressed by imposing well-defined, strict fiscal regimes irrespective of each country's peculiar economic and political conditions. Attempts for such simple solutions neglect the complementarities between productive government spending and private capital, as well as totally ignoring the welfare consequences of strict budgetary regimes. Therefore, a more thorough country-specific analysis is required to correctly identify the growth affects of fiscal policy and balance the trade-off between growth and volatility.

Figure 1 Golden Rule- 5 % Increase in vI Through Borrowing

a)



b)



c)

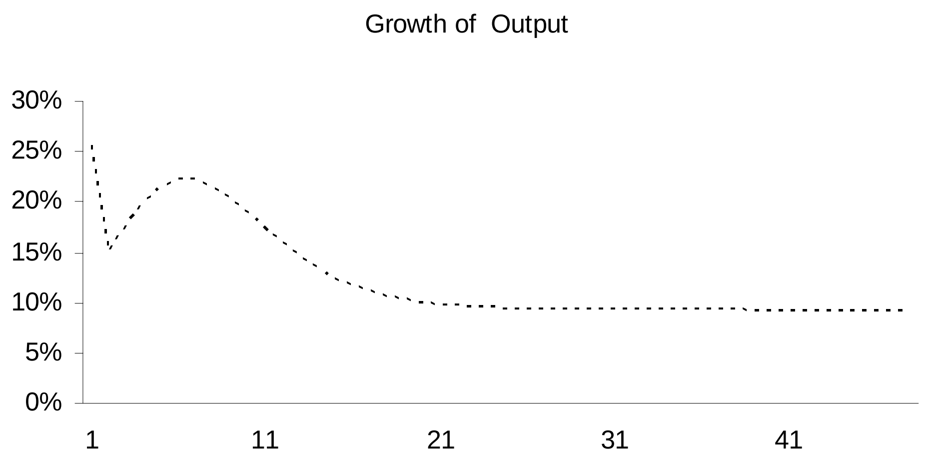
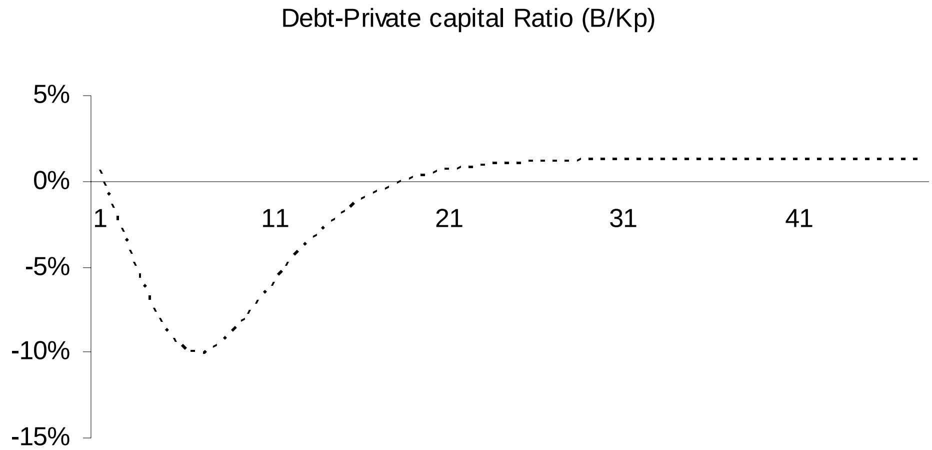
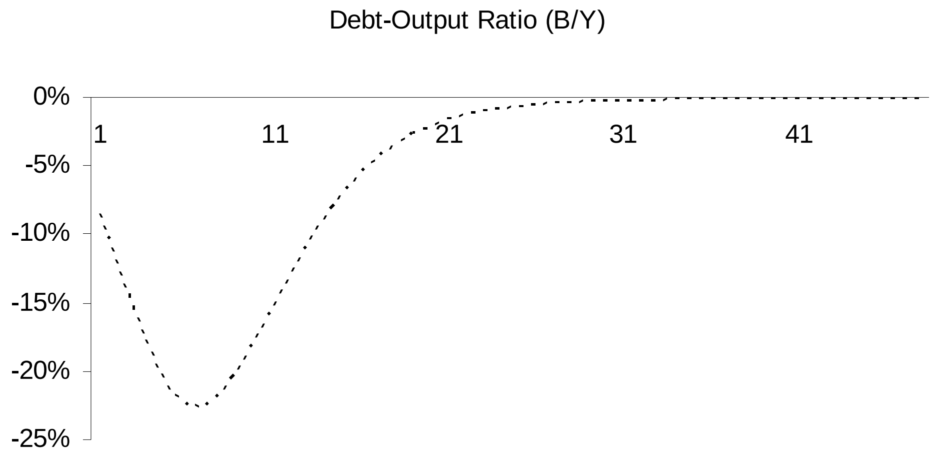


Figure 2 Golden Rule- 5 % Increase in vH Through Borrowing

a)



b)



c)

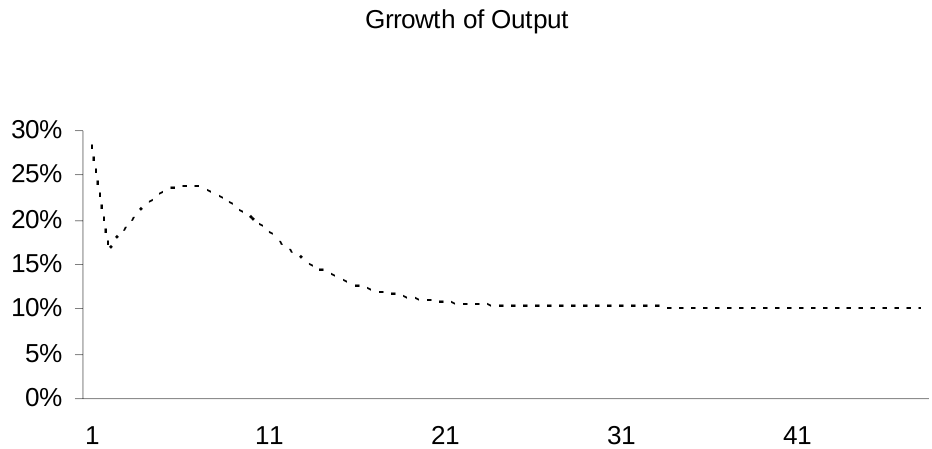
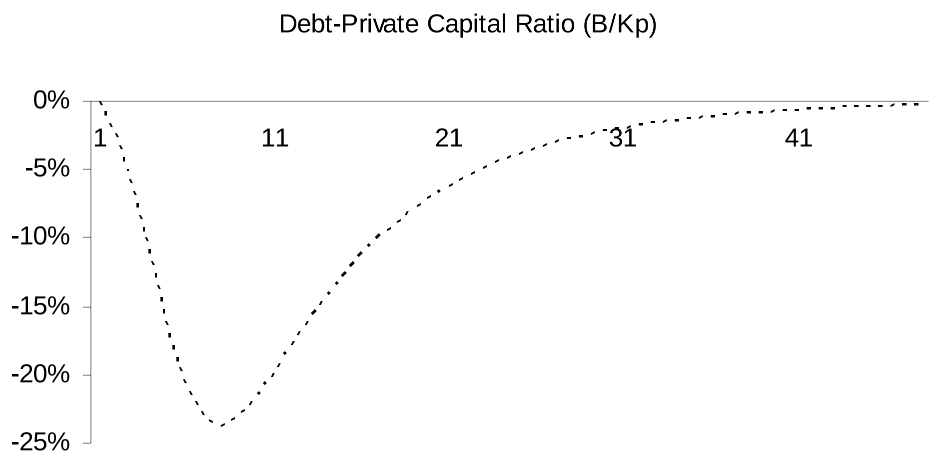
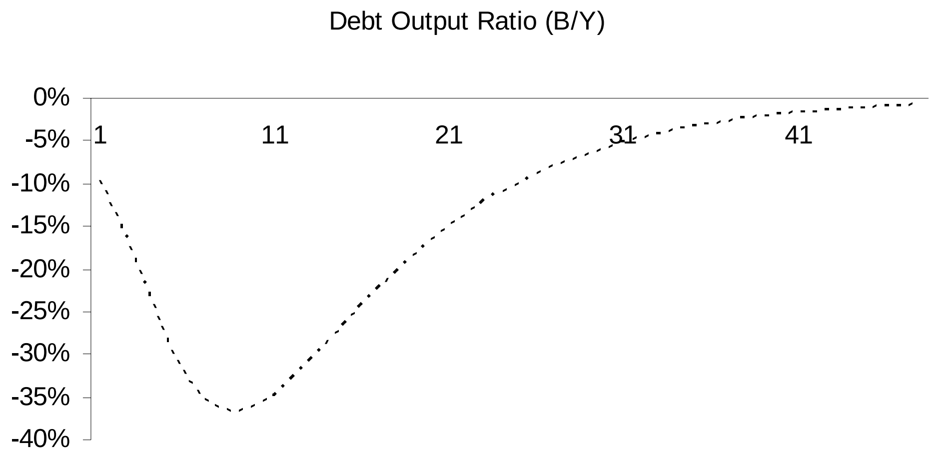


Figure 3 Pr. Surplus Rule- 5 % Increase in vI Through a Cut in vT

a)



b)



c)

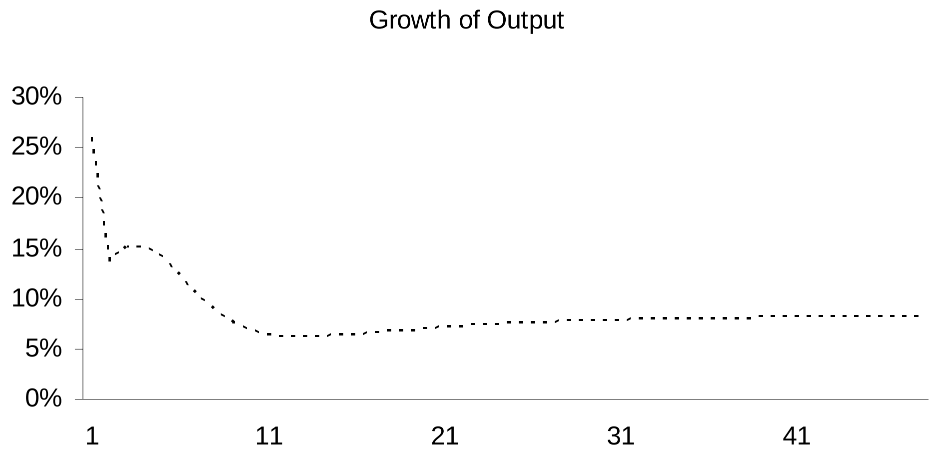
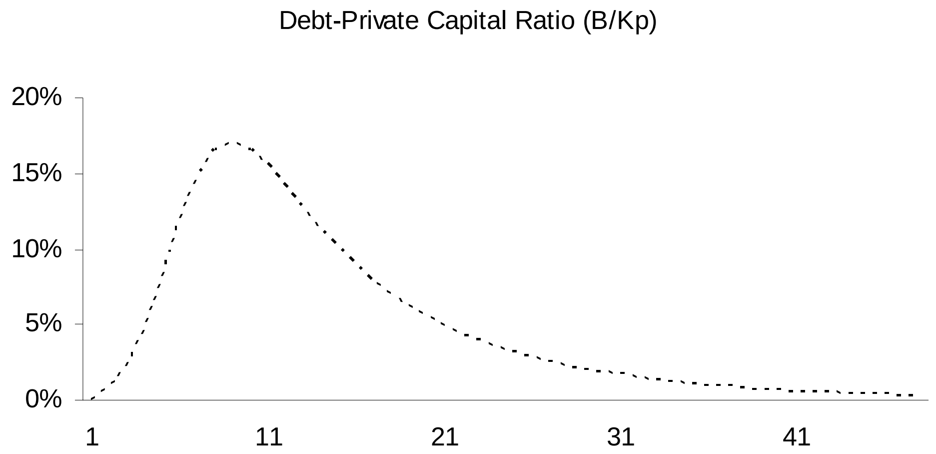
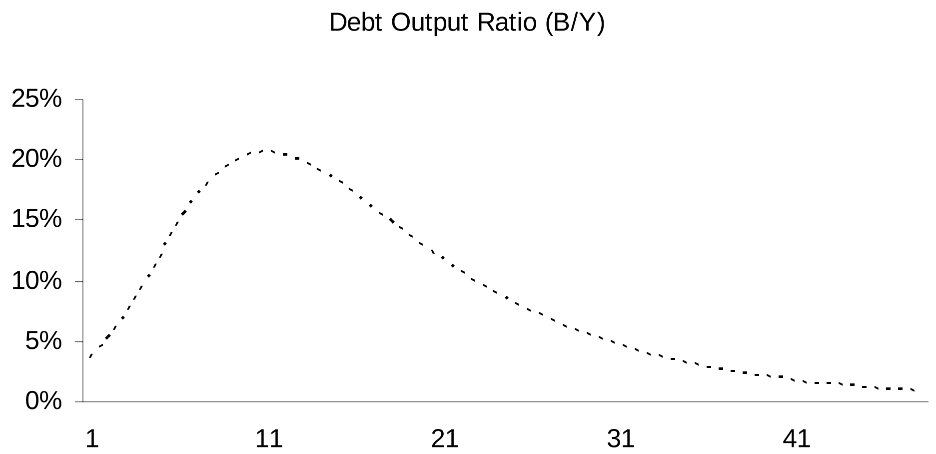


Figure 4: Pr Surplus Rule-5 % Increase in vI Through a Cut in vH

a)



b)



c)

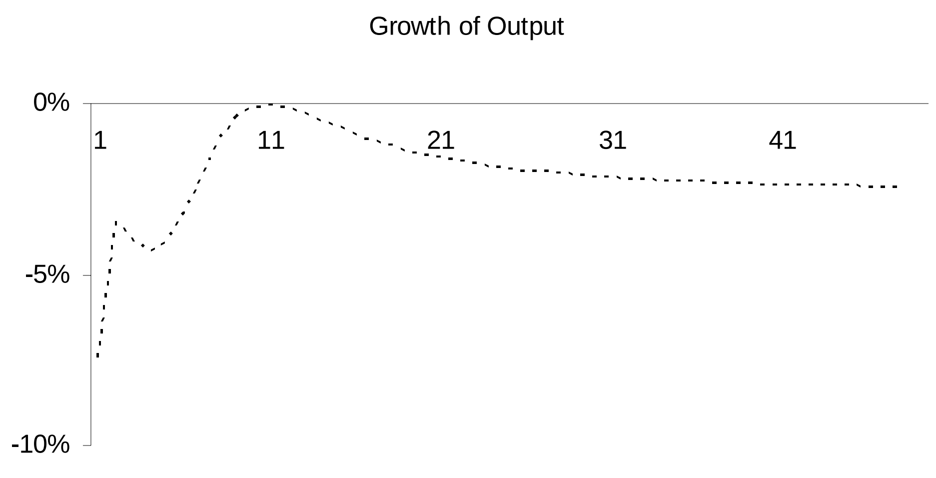


Figure 5. 5 per cent increase in vI

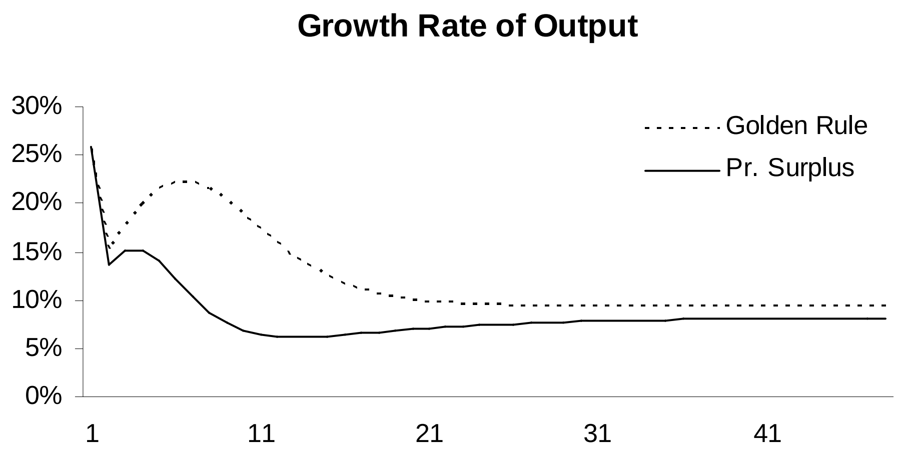
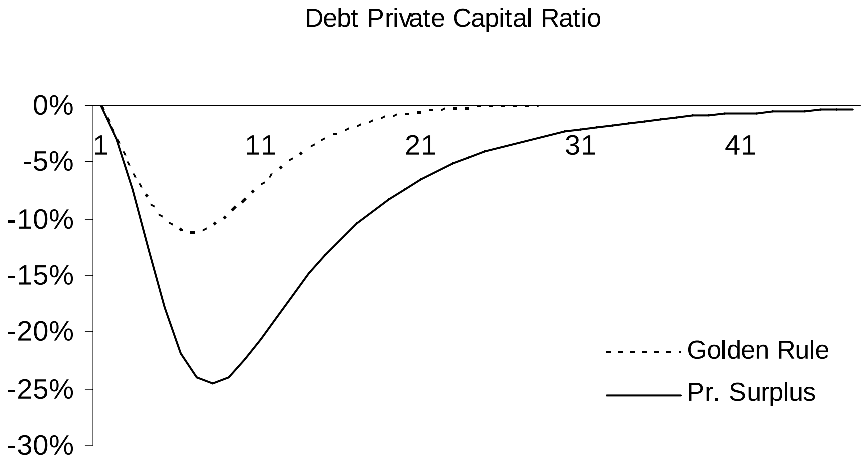
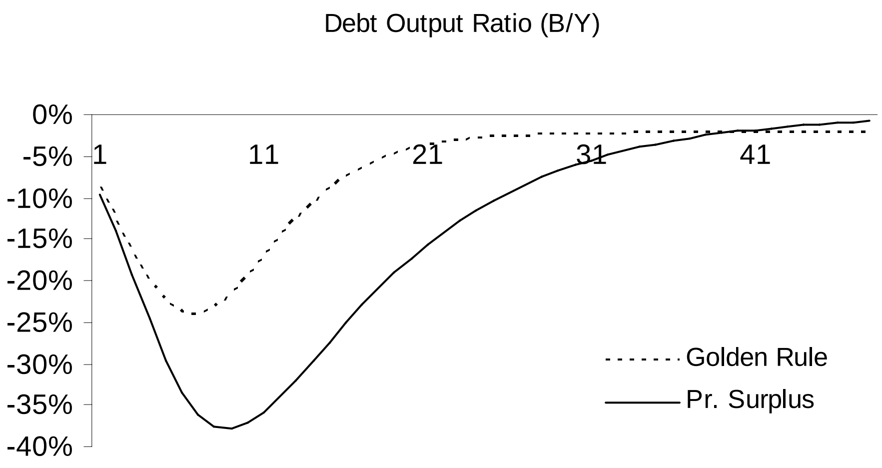


Figure 6: 5% Increase in vI Through a Cut in vU

a)



b)



c)

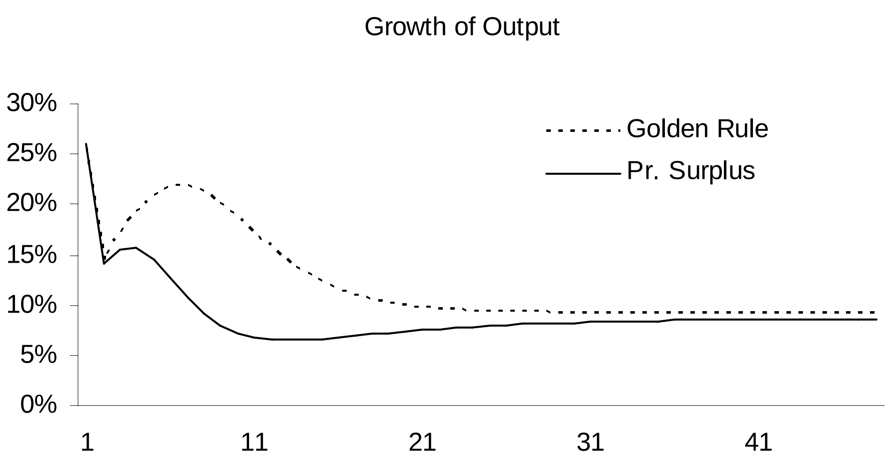
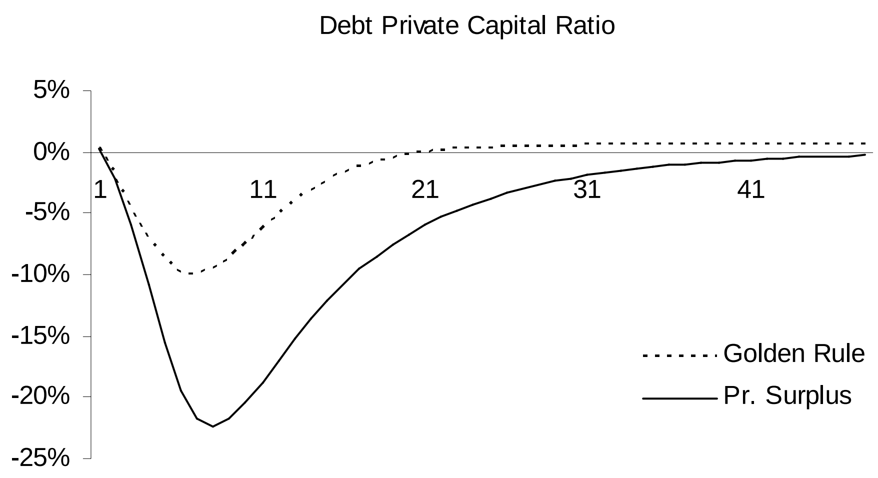
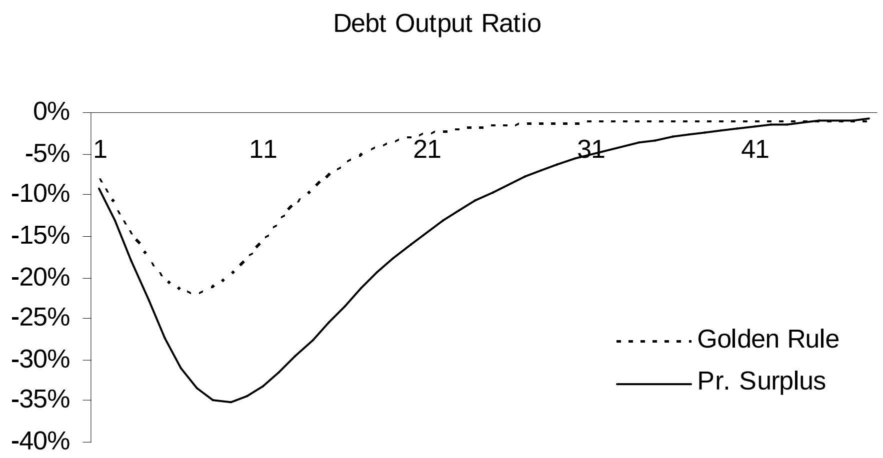


Figure 7: 2% Increase in Tax Rate

a)



b)



c)

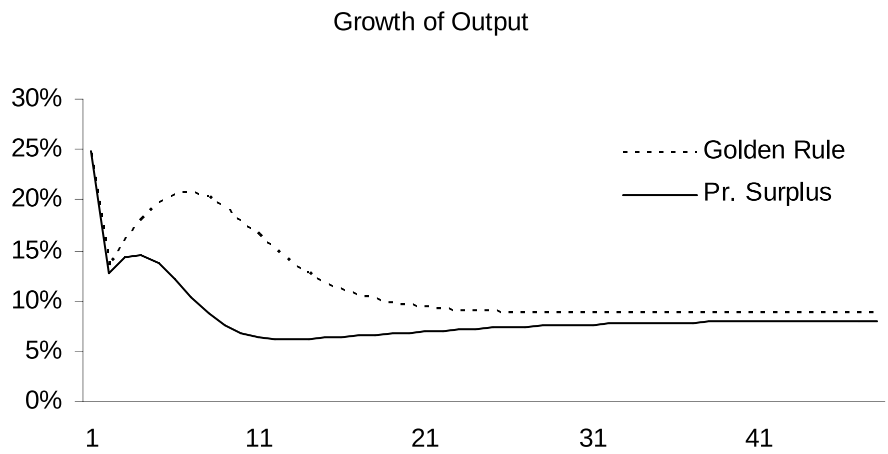
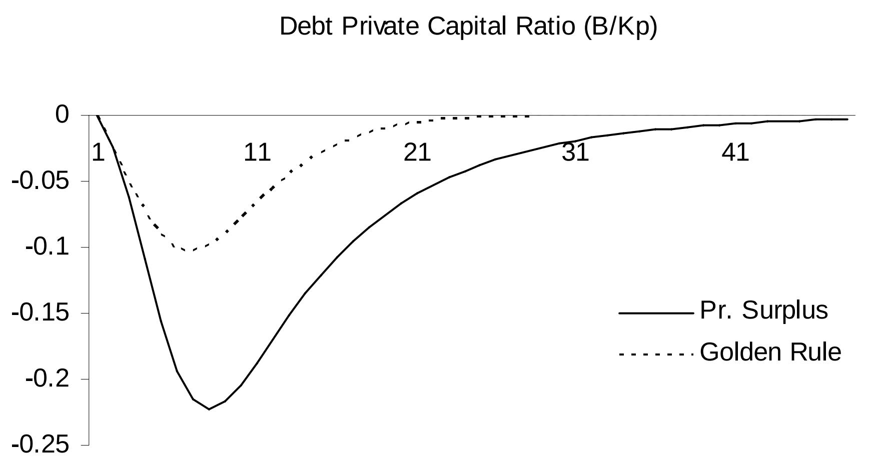
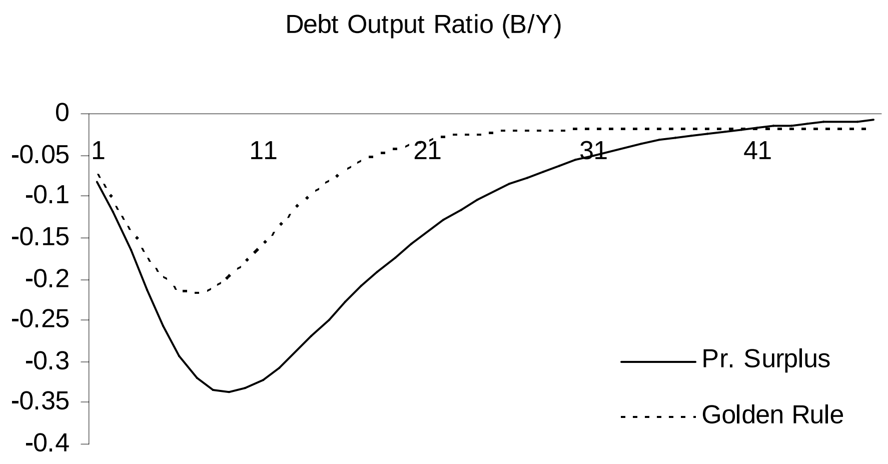


Figure 8: 5% Increase in vI Through a Cut in vU (μ=0.1)

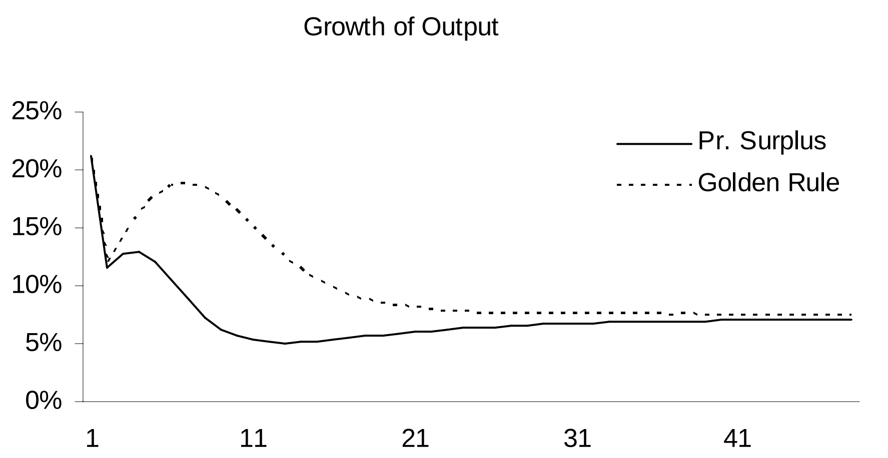
a)



b)



c)



REFERENCES

Agénor, Pierre-Richard, "Fiscal Policy and Endogenous Growth with Public Infrastructure," Working Paper No. 59, Centre for Growth and Business Cycle Research, University of Manchester (September 2005a).

Agénor, Pierre-Richard, "Schooling and Public Capital in a Model of Endogenous Growth," Working Paper No. 61, Centre for Growth and Business Cycle Research, University of Manchester (September 2005b).

Agénor, Pierre-Richard, "Health and Infrastructure in Models of Endogenous Growth," Working Paper No. 62, Centre for Growth and Business Cycle Research (September 2005c),

Agénor, Pierre-Richard, and Blanca Moreno-Dodson, "Public Infrastructure and Long-run Growth: New Channels and Policy Implications," unpublished, World Bank (February 2006).

Agénor, Pierre-Richard, and Kyriakos Neanidis, "The Allocation of Public Expenditure and Long-run Growth," working paper, University of Manchester, Centre for Growth and Business cycle Research (2006).

Annichiarico, Barbara, and Nicola Giammarioli, "Fiscal Rules and Sustainability of Public Finances in an Endogenous Growth Model," Working Paper No. 381, European Central Bank (August 2004).

Barro, Robert J., "Government Spending in a Simple Model of Endogenous Growth," Journal of Political Economy, 98 (October 1990), s103-s25.

Blanchard, Olivier J., and Francesco Giavazzi, "Improving the SGP through a Proper Accounting of Public Investment," Discussion Paper No. 4220, Centre for Economic Policy Research (February 2004).

Brauninger, Michael, "The Budget Deficit, Public Debt and Economic Growth," Journal of Public Economic Theory, 7 (December 2005), 827-.

BSB (2005) "On Economic and Social life in Turkey in Early 2005", www.bagimsizsosyalbilimciler.org

Buti, Marco, Sylvester Eijffinger, and Daniele Franco, "Revisiting the Stability and Growth Pact: Grand Design or Internal Adjustment?," Economic Paper No. 180, European Commission (January 2003).

Everaert, Gerdie, "Negative Economic Growth Externalitites from Crumbling Public Investment in Europe," unpublished, University of Ghent (July 1997).

Fair, Ray C., and John B. Taylor, "Solution and Maximum Likelihood Estimation of Dynamic Nonlinear Rational Expectations Models," Econometrica, 51 (July 1983), 1169-96.

Fernandez-Huertas, Moraga, and Jean-Pierre Vidal, "Fiscal Sustainability and Public Debt in an Endogenous Growth Model," Working Paper No. 395, European Central Bank (August 2004).

Flores, Elena, Gabriele Giudice, and Alessandro Turrini, "The Framework for Fiscal Policy in EMU: What Future after Five Years of Experience?," Economic Paper No. 223, European Commission (March 2005).

Ghosh, Sugata, and Iannis A. Mourmouras, "Endogenous Growth, Welfare and Budgetary Regimes," Journal of Macroeconomics, 26 (December 2004a), 623-35.

Ghosh, Sugata, and Charles Nolan, "The Impact of Simple Fiscal Rules in Growth Models with Public Goods and Congestion," Working Paper No. 05-2, Centre for Dynamic Macroeconomic Analysis, University of Saint Andrews (January 2005).

Ghosh, Sugata, and Udayan Roy, "Fiscal Policy, Long-run Growth, and Welfare in a Stock-Flow Model of Public Goods," Canadian Journal of Economics, 37 (August 2004b), 742-56.

Greiner, Alfred, and Willi Semmler, "Endogenous Growth, Government Debt, and Budgetary Regimes," Journal of Macroeconomics, 22 (- 2000), 363-84.

Kalaitzidakis, Pantelis, and Sarantis Kalyvitis, "On the Macroeconomic Implications of Maintenance in Public Capital," Journal of Public Economics, 88 (2004), 695-712.

Musgrave, Richard A., "The Nature of Budgetary Balance and the Case for a Capital Budget," American Economic Review, 29 (June 1939), 260-71.

Pallage, Stéphane, and Michel A. Robe, "On the Welfare Cost of Economic Fluctuations in Developing Countries," International Economic Review, 44 (May 2003), 677-98.

Sala-i-Martin, Xavier, Gernot Doppelhofer, and Ronald I. Miller, "Determinants of Long-Term Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach," American Economic Review, 94 (September 2004), 813-35.

Turrini, Alessandro, "Public Investment and the EU Fiscal Framework," Economic Paper No. 202, European Commission (May 2004).