Growth, Infrastructure and Fiscal Policy.

Durmuş Özdemir*
Istanbul Bilgi University

June 10, 2003

Abstract

This paper presents a small open economy model of endogenous growth and analyse the effect of public investment as an infrastructure and the debt/GDP ratio on long run growth. Part of capital stock is allocated to public investment as a form of Infrastructure. The model is calibrated to fit data for Turkey, a small open economy which is trapped in a Ponzi-style finance of its high public debt and the inadequate and inefficient accumulation of public capital. Simulations suggest that the infrastructure and fiscal policy can significantly affect the long run optimal growth rate. Hence a better infrastructure and a lower government debt/GDP ratio could improve Turkish long run economic growth.

JEL Classification: O41, E62, O52, C61, F43

To be presented at the EcoMod, Economic Modelling Annual Conference, 3-5th July, 2003, istanbul, Turkey.

*Department of Economics, İstanbul Bilgi University, Kuştepe Kampüsü: İnönü Cad. No:28 Şişli 80310 İstanbul. E-mail address: dozdemir@bilgi.edu.tr

1 Introduction

'When infrastructure is missing, productivity of all factors will be lower'.

There has been a resurgence in the debate about the productivity effects of infrastructure on long run economic growth. As Gramlich (1994) emphasized that there are difficulties of accurately pinning down the contributions of infrastructure to growth.

Empirical studies of growth and government spending indicates that there is a negative correlation between growth and government consumption/GDP ratio. However, if government spending is for productive purposes the correlation becomes positive but not as strong as total investment effect (Barro 1990 and Diamond, 1989). Diamond finds overall government expenditure is negatively correlated to economic growth but the productive current government expenditures and human capital have positive correlation.

Most urgent infrastructural problems in NIC's are public transport, roads, railways, ports, airports, energy, communication, provision of water and sanitation. After the earlier study of Aschauer (1989), Esterly and Rebelo (1993) supported the link between investment in transport and communication and growth. Canning, Fay and Perotti (1994) also argued in favour of the link between telecommunication and economic growth. In contrast, (Hulten and Schwab (1991), Tatom (1993), Holtz-Eaking (1994), Holtz-Eaking and Schawrtz (1995), Garcia-Mila, Mc guire and Porter (1996) suggest that there is a little evidence of an effect from infrastructure to income growth. It is clear that there is a dispute over this issue and the verdict is out. Main objections to the argument stems from the fact that the effect of public expenditure on long-run growth. Exclusion of public consumption from the public investment clearly show that the public investments cause long term economic growth. In the model of this paper the public expenditures mean that the public investment-infrastructure.

The recent surveys reveal some instructive results about the link between long-run economic growth and public infrastructure. Sanches-Robles (1998) finds the positive link between the length of roads and energy with economic growth. Canning and Pedroni (1999) takes the research further and argues an optimal level of infrastructure which maximises the growth rate. As Bougheas, Demetriades and Mamuneas (1999) concluded, infrastructure accumulation, especially for NIC's are important for economic growth.

In this paper an open economy model of endogenous growth driven by capital externalities, such as private capital and public infrastructure examined. First question is to be answered: Does an inadequate accumulation of public capital as a form of infrastructure cause lower long run economic growth? The developed model constructs the part of capital stock as public capital, which link the infrastructure with productivity growth. The model is calibrated to fit data for Turkey, which is trapped with high debt/GDP ratio and poor infrastructure. The model in this paper will be closest to that of Krichel, T. and Levine, P. (1995), which introduced liquidity constraints to a closed economy for India. In contrast to their work the model in this paper will consider an open, not closed, economy. The context of an open economy would enable fiscal policy to be examined in more open export oriented Turkey. There is a clear link between productivity and economic growth in the theoretical part of the study. Theoretical part generalizes Romer (1986) and Barro (1990) endogenous growth study. Simulations suggest that the infrastructure and fiscal policy can significantly affect the long run growth rate and a better infrastructure and a government policy could improve Turkish economic growth. In general, it is considered that the private capital and public infrastructure (public capital) raises the labour productivity.

The objective of this study is to clarify the effects of public infrastructure on the optimum level of economic growth in Turkey.The growth performance of Turkey's economy in the last decade has been one of mini boom-and bust cycles. Turkey's prospects for sustained growth has become more uncertain and chaotic. Hence issues regarding the effect of openness, liquidity constraints, infrastructure and fiscal policy on economic growth have become even more crucial.

The paper is organised as follows. Section 2 proposed a small open economy model of Turkey. The model will be based on an overlapping generation framework Non-ricardian effects of government debt are important in this paper and occur for 4 reasons; Firstly, households leave no anticipated bequest for their heirs (Yaari, 1965 and Blanchard, 1985), secondly, debt neutrality breaks down due to existence of population growth (Weil, 1985), Thirdly, the government finances public expenditure on goods and services by distortionary taxation or borrowing (Yaari-Blanchard-Weil consumption function). Finally the existence of liquidity constraints. A key feature of this model is its explicit recognition of both liquidity constrained and non-liquidity constrained consumers. Unconstrained consumers consists of overlapping generation, but apart from age, are identical (Krickel and Levine 1995). Turkish earnings distribution is very much skewed towards low income earners. As Vaidyanathan (1993) concluded 72% of Turkish people are liquidity constrained (unable to borrow) and only 28% of the population consists of unconstrained consumers. With this in mind it can be seen that the effect of any macroeconomic policy, in particular fiscal policy, would significantly different if the liquidity constrained consumers were not considered.

Section 3 examines the effect of fiscal policy and infrastructure on long run growth. Section 4 clarify further the cponcept of optimal growth for fiscal policy and Infrastructure. Section 5 offers some conclusions.

2 The Model

A challenging model for this purpose has been developed by the following authors: Yaari (1965), Blanchard, O. (1985), Buiter, W. H. (1988) and Weil, P. (1985), Levine, P. and Pearlman, J. (1992), Rebelo, S. (1992), Levine, P. and Brociner, A. (1994), Krichel, T and Levine, P. (1995). Our model here will be closer to that of Krichel, T and Levine, P. (1995) which was taken as a closed economy example and applied to India. Here we will use similar setting but consider a small open, not closed, economy. Consumers are divided into two groups: constrained and unconstrained households. Unconstrained households behave as Yaari-Blanchard-Weil consumers and constrained households behave as Keynesian consumers. The consumption of constrained households is equal to their labour income but unconstrained consumers own all the financial and private physical wealth. Unconstrained consumers maximize an intertemporal utility function, subject to budget constraint. Firms also maximize an intertemporal profit function. The population growth and the labour supply is given. The domestic country's consumer who born in period s has the following intertemporal expected utility function at time t $\geq s$ and there is no uncertainty apart from the probability of death. The aggregate utility function is determined by $C_{di,s}$(Consumption of domestically produced good), $C_{im,s}$(Consumption of imported good), $G_{di,s}$(Government provided domestic good), $G_{im,s}$(Government provided imported good) and $\frac{M_{i-1,s}}{P_t}$ is the real money stock. All variables are at time i which is the beginning of the period.

$$U_{t,s} = \sum_{i=t}^{\infty} \left[\frac{1-p}{1+\theta}\right]^{i-t}$$
$$[\alpha_1 \log C_{di,s} + \alpha_2 \log C_{im,s} + \alpha_3 \log G_{di,s} + \alpha_4 \log G_{im,s} + \alpha_5 \log \frac{M_{i-1,s}}{P_t}] \quad (2.1)$$

where $P_t$denotes the price of domestic output, $M_{i-1,s}$is nominal (high powered) money stock and the θ is consumer's pure rate of time preference.

Total consumption $(C_{t,s})$includes forgone expected interest payments on money balances and is expressed with the following equation

$$C_{t,s} = C_{dt,s} + E_t C_{mt,s} + (R_{nt-1}(1 - t_{t-1}) + t_{t-1}\pi^e_{t,t-1})\frac{M_{t-1,s}}{P_{t-1}} \quad (2.2)$$

where E_t =real exchange rate

The expected asset return (taxed) is $R_t(1 - t_t)$where $t_t = \frac{T_t}{Y_t}$(tax ratio)

Assume real returns are taxed thus the effective expected nominal rate is $R_{nt}(1 - t_t) + t_t\pi^e_{t+1,t}$where $R_{nt}$is the nominal interest rate and $\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}}$ is the domestic inflation.

Consumption of domestically produced and imported goods is given by

$$C_{dt,s} = a_1 C_{t,s}, \qquad C_{mt,s} = a_2 \frac{C_{t,s}}{E_t}$$

The demand for money is given by

$$\frac{M_{t-1}}{P_{t-1}} = \frac{(a_5 + a_6)C^e_{t,t-1}}{(R_{nt-1}(1 - TR_{t-1}) + TR_{t-1}\pi^e_{t,t-1})}$$

The exante real interest rate $R^e_t = R_{nt} - \pi^e_{t+1,t}$

This differs from the real interest rate (R_t),which appears in the budget identities and refers to expost rate. because of the credibility issue this distinction is important.

Real consumer wealth at the end of period t is:
$W_{t,s} = \frac{M_{t,s}}{P_t} + D_{t,s} + F_{t,s} + K_{t,s}$ (2.3)

where $D_{t,s}i$ is the government debt held by domestic or foreign consumers, $F_{t,s}$denotes net foreign assets denominated in home country and $K_{t,s}$is the domestic capital stock.

All assets measured at the end of the period.

The consumer budget identity is given by $\Delta W_{t,s} = R_{t-1}W_{t-1,s} + w_{t,s} - T_{t,s} - C_{t,s}$ (2.4)
where $\Delta X_t = X_t - X_{t-1}$, $w_{t,s}$is the labour income, $T_{t,s}$denotes taxes
Maximizing $U_{t,s}$ (equation 2.1) subject to the consumer budget constraint corresponding to (2.4) provides Blanchard (1985) results.

Expected aggregate consumption ($C^e_{t+1,t}$) consists of the liquidity constrained consumer's consumption and the non-liquidity constrained consumer's consumption.

$C^e_{t+1,t} = (1 + R^e_t(1-t) - \theta + n)C_t - (p+n)(p+\theta)W_{t-1} + \lambda(\Delta w_{rt}(1-t_t) - \theta - n)w_{rt}$(2.5)

where λ is the proportion of the liquidity constraint consumers and n is the GDP growth ratio.
In (2.5), $C^e_{t+1,t}$denotes rational expectatıons of C_{t+1}formed at time t. Assumed perfect foresight $C^e_{t+1,t} = C_{t+1}$

The Government: The domestic country budget identity is given by
$\frac{\triangle M_t}{P_t} + \triangle D_t = R_{t-1}D_{t-1} + G_t - T_t$ (2.6)

In terms of ratio
$DR_t = (1 + R_{t-1} - n_t)DR_{t-1} + PDR - (\pi_t + n_t)[\frac{\nabla M_t}{P_t Y_t}]$ (2.7)
where $DR_t = \frac{D_t}{Y_t}, MR_t = \frac{M_t}{P_t Y_t}$ and the primary deficit - GDP ratio is PDR_t is given by
$PDR_t = GR_t - t_t = \frac{G_t}{Y_t} - \frac{T_t}{Y_t}$
The growth rate is $n_t = \frac{Y_t - Y_{t-1}}{Y_{t-1}}$
Solving the budget identity forward on time gives the solvency constraint:
$DR_t = -\sum_{i=0}^{\infty} \frac{PD_{t+i+1}}{(1+R_t-n_{t+1})((1+R_{t+1}-n_{t+2})............((1+R_{t+i}-n_{t+i+1})}$ (2.8)

No ponzi game condition implies:
$\lim_{i\to\infty} \frac{PD_{t+i+1}}{(1+R_t-n_{t+1})((1+R_{t+1}-n_{t+2})............((1+R_{t+i}-n_{t+i+1})} = 0$ (2.9)

Assume no dynamic inefficiency

The debt accumulation:

$$DR_{t+1} = (1 + R_t - n_{t-1})[1 - m_t(\pi_t - \pi_t^e)]DR_t + G_t - T_t \qquad (2.10)$$

where
π_t^e = the rational expectations of inflation
m_t =proportion of inflation sensitive debt (i.e. nominal long-term debt in domestic currency)

Foreign asset accumulation is defined as
$\triangle F_t = R_{t-1}F_{t-1} + TB_t$ (2.11)
where $TB_t = C^*_{mt} - E_tC_{mt} + I^*_{mt} - E_tI_{mt} + G^*_{mt} - E_tG_{mt}$
I^*_{mt} =Foreign investment out of domestic output.
I_{mt} =Investment out of imported goods
Starred variables such as C^*_{mt} refer to the foreign.
In ratio form:
$FR_t = \left[\frac{1+R_{t-1}}{1+n_t}\right] FR_{t-1} + TBR_t$ (2.12)
where $FR_t = \frac{F_t}{Y_t}$ and $TBR_t = \frac{TB_t}{Y_t}$

Output, Private Sector, Infrastructure and Endogenous Growth:

Following production function is the representative firm i 's production function at time t, it is assumed that the production function is in Cobb-Douglass and constant returns to scale form.

$Y_{t,i} = F(K_{t,i}, \Psi_{t,i}) = K^{\alpha}_{t,i}\Psi^{1-\alpha}_{t,i}$ (2.13)

where $K_{i,t}$is private physical capital and $\Psi_{i,t}$is labour input in efficiency unit. The $\Psi_{t,i} = \phi L_{t,i}$ where $\phi$is a measure of the efficiency unit of row labour input L_t.The measure of ϕ is determined exogenously as a function of economy wide capital labour ratio. (See Buiter, 1991 and Levine and Krickel, 1995 for this type of formulation). Let $K_t$be the total aggregate private capital and determined by the capital stock accumulated by out of previous period's domestic output $K_{d,t-1}$and capital stock accumulated out of previous periods foreign output, K_{mt-1} The government affects labour efficiency by providing physical capital in the form of infrastructure, such as education, health, roads, railways etc. The efficiency measure ϕ is then dtermined by

$\phi_{t,i} = \Omega\ A_i \frac{(K^G_t)^{\gamma_1}(K_t)^{1-\gamma}}{L_t}$ (2.14)

The aggregation under the assumption of identical firms would provide folowing aggregate production function:

$Y_t = K^{\gamma_2}_t(K^G_t)^{1-\gamma_2}$ (2.15)

where $\gamma_2 = \alpha + (1 - \alpha)(1 - \gamma_1)$, and $\Omega = A^{1-\alpha}_t$

Harrod -neutral technical change is a special case of this representation where μ is the productivity growth. Then This becomes as:

$$\phi_{t,i} = (1 + \mu)\phi_{t-1,i}$$

Firms equate the net marginal product of capital to the marginal cost of capital. The first order conditions derived from the production function in terms of total capital stock/GDP ratio is as follows:

$$\frac{K_t}{Y_t} = \frac{\alpha_1}{R_t+\delta} \tag{2.16}$$

Total investment out of domestic and foreign output, I_{dt} and I_{mt}:

$$K_{dt} = (1-\delta)K_{dt-1} + I_{dt}$$

$$K_{mt} = (1-\delta)K_{mt-1} + I_{mt}$$

where $\delta =$ depreciation rate

Total private capital stock is $K_t = K_{dt} + E_t K_{mt}$

Gross investment: $I_t = K_{t+1} - (1-\delta)K_t$ (2.17)

The equilibrium in the output market: Determination of production

and the aggregate demand the economy is represented with both aggregate supply and demand which subject to government choice of fiscal policy variables such as the government consumption (G_t^c), Government investment (G_t^I) and the taxation ratio (t).

$$Y_t = (C_{dt} + E_t C_{mt}) + (I_{dt} + E_t I_{mt}) + (G_{dt} + E_t G_{mt}) + TB_t \tag{2.18}$$

where E_t^e denotes the expected relative price.

All stocks and flow variables will be taken as the ratio of GDP but for the the notational convenience they remain same i.e. $D_t = \frac{D_t}{Y_t}$.

Steady state: For a balanced growth steady state where all stocks and

flows grow at the same endogenous growth rate g (See Rebelo(1992)) for similar representation. This is determined by the following steady state functions and the steady state values will be denoted without a subscript t.

From the equation (2.5), the steady state form of the Yaari Blanchard consumption function is as follows:

$$((R(1-t)-\theta+n)C = (p+n)(p+\theta)(\tfrac{M}{P}+K+D+F)-\lambda(R(1-t)-\theta+n)w) \tag{2.19}$$

$$D(1+R-n)[1-m(\pi-\pi^e)\} = T-G = t(1-\delta K(R)-G \tag{2.20}$$

where total tax receipts in terms of GDP ratio is given by $T = t(1-\delta K)$.

$$K = \frac{\alpha}{R+\delta} = K(R) \tag{2.21}$$

$$\log(\Omega)+\gamma_2\log(K(R)+(1-\gamma_2)\log(\tfrac{G^I}{N+\delta}) = 0 \tag{2.22}$$

$$C = (1-(n+\delta)K(R)-\lambda\alpha(1-t) \tag{2.23}$$

3 Infrastructure, Fiscal Policy and Long-run Growth

Using the steady state variable equations (2.19 - 2.23) and assuming that the only form of capital is K [for simplification (K = (M/P) + F+K)] the elimination of C, K and G gives the following function which determines the Yaari-Blanchard consumption relationship in terms of R, n, D, t, γ and λ :

$f(n, R, D, \gamma, \lambda) = (R(1-t) - \theta + n)(1 - (n+\delta)K(R) + (R-n)D - t(1-$
$\delta)K(R) - \lambda(1-t)(1-\alpha)-$
$(p+n)(p+\theta)(K(R)+D) = 0$ (3.1)

Following Levine and Krickel, the equation (3.1) is upward sloping and describes the locus of interest and growth rates consistent with Yaari-Blanchard consumption behaviour, output equilibrium, private sector investment and the government budget constraint.

A similar solution of the production function of the equation (2.22) gives:
$g(n, R, D, t, \gamma) =$
$\gamma_2 \log K(R) + (1-\gamma_2)(\log A + \log \gamma + \log(t(1-\delta K(R) - (R-n)D) - \log(n+\delta)) =$
0 (3.2)

The downward sloping equation (3.2) is the locus consistent with balanced growth and private sector investment, the government budget constraint and the production technology.

The derivation of multipliers from the equation (3.1) provide the effect of debt/GDP and the tax/GDP and the infrastructure/GDP on long-run economic growth.

$$\left[\frac{dn}{dD}\right]_{t,\gamma fixed} = \frac{g_R f_D - g_D f_R}{f_r g_n - g_r f_n}, \qquad (3.3)$$

$$\left[\frac{dn}{dt}\right]_{D,\gamma fixed} = \frac{g_R f_t - g_t f_R}{f_r g_n - g_r f_n} \qquad (3.4)$$

$$\left[\frac{dn}{d\gamma}\right]_{D,t,fixed} = \frac{-g_\gamma f_R}{f_r g_n - g_r f_n} \qquad (3.5)$$

where
$g_R = \gamma_2 \frac{K'(R)}{K(R)} - (1-\gamma_2)(\frac{G}{D} + \frac{t\delta K'(R)}{G}),$ $\quad g_t = -\frac{(1-\gamma_2)(1-\delta K)}{G},$
$g_D = -\frac{(1-\gamma_2)(R-n)}{G},$ $\quad g_n = (1-\gamma_2)(\frac{D}{G} - \frac{1}{n+\delta}),$

$g_\gamma = \frac{(1-\gamma_2)}{\gamma}$
$f_D = (R(1-t) - \theta + g - n)(R-n)(p+g)(p+\theta)$
$f_t = -RC - (R(1-t) - \theta + g - n)(1 - \delta K + \lambda(1-\alpha))$
$f_R = (R(1-t) - \theta + g - n)(D - (n + \delta(1-t))K'(R)) + C(1-t) - (p+g)(p+$
$\theta)K'(R)$
$f_n = -C - (R(1-t) - \theta + g - n)(K+D)$

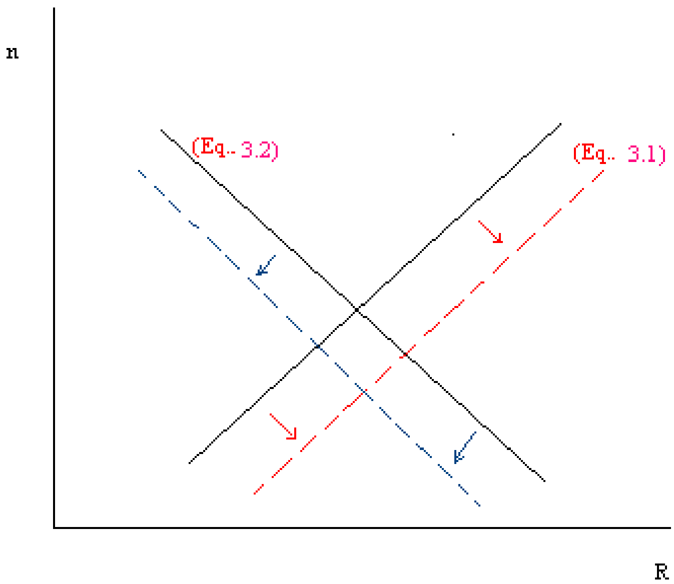
Keeping fiscal policy fixed, the effect of R on growth from the derivation of the (3.1)($\frac{\partial n}{\partial R})_{f=0}$ has a positive sign: as R increases the steady state growth increases too. Indicates an upward slope between the steady state growth and the rate of interest in Yaari Blanchard consumers.

Keeping fiscal policy fixed the effect of interest rates on growth from the derivation of the (3.1)($\frac{\partial n}{\partial R})_{g=0}$ provides a negative sign as R decreases n increases.

The effect of an increase in debt (D) on the steady state growth (n), where t and γ are fixed is negative. That is $(\frac{\partial n}{\partial D})_{t,\gamma fixed} < 0$. This result has interesting suggestions: Steady state growth can be increased by reducing the debt/GDP ratio.

Figure 3 indicates the effect of D/Y change on growth. Curve (3.2) shifts

right (R and t fixed) as a result of increase on debt/GDP ratio. Similarly keeping R, t and γ fixed in the equation (3.3): an increase of D/Y on growth shifts the equation (3.3) left. hence an increase on debt/GDP ration decrease the long run growth but has an unambiguous effect on R.



For example an increase in tax ratio (when D/Y and the production technology are constant) on long run growth in this model is ambiguous too. That is $(\frac{\partial n}{\partial t})_{D,\gamma fixed} =?$. hence we will leave this effect for calibration.

Calibrations of these multipliers for the Turkish economy are present in the simulation results section. For a further details of the models' derived multipliers see Levine and Krichel (1995)

4 The Model simulation

In this part we will be altering some parameters of the model and will assess the likely impacts of various fiscal policies on growth. Our calibration strategy begins by calibrating the steady state values of selected variables. These variables are presented below in the summary of calibration such that the government expenditure, capital stock and debts are taken as the ratios of output. The deep parameter values such as θ are chosen by calibrating the steady state values of selected parameters. There are a number of studies which have estimated consumption functions with liquidity constraints. We have taken 0.72 for the proportion of liquidity constrained consumers from the Turkish example. This estimate, as we have discussed differs for different economies and is rather higher for LDC's therefore we will examine some different levels of λ in our simulation analysis. Some of our fundamental parameters' steady state values are taken from State Institute of Statistics (SIS) data source of Turkey. Our microeconomic foundation model in which consumer maximise utility and producers maximise profits, is consistent with observed data. The rates of return, i.e. R+δ, is equal to 0.17 which is the real interest rate plus the depreciation rate. The average probability of death per year is taken as 1/40, as it is consistent with Turkish life expectancy. The OECD figure for K/GDP average is taken as 2.5. The rest of the parameters and sources are presented in the summary of calibration as follows.

The model parameters are divided into two groups; fundamental parameters and the derived parameters. These are as follows:

Fundamental parameters and their source: 1. Marg. prod. Capital

$\overline{R}+\delta=0.17$ Turkish average reel rates of interest for 1990-2000, SIS.

2. p= 1/life-expectancy for working age = 1/40 (Average life expectancy of last 3 decades in Turkey, SIS)
3. $\delta = 0.07$ (Average of 1990-2000, SIS, Turkey)
4. $\beta = 0.3$ OECD
5. λ =0.72 (Vaidyanathan, G. (1993)Turkey)
6. $\frac{\overline{G}}{\overline{Y}}$ =0.2 (Average of 1990-2000, SIS, Turkey)
7. $\frac{\overline{K}}{\overline{Y}}$ = 2.5 OECD
8. $\frac{\overline{D}}{\overline{Y}}$ =0.6 (Average of 1990-2000) SIS, Turkey)
9. $\pi = 2$ (Average population growth, 1965-2000, SIS)

10. n =4 (GDP growth, 1990-2001, SIS
11. DIS 0.95 (Myopic government, assumed)

Derived parameters 12.$\frac{\overline{C}}{\overline{Y}} = 1 - \frac{\overline{G}}{\overline{Y}} = 0.8$

13.$\frac{\overline{T}}{\overline{Y}} = \overline{R}\frac{\overline{D}}{\overline{Y}} + \frac{\overline{G}}{\overline{Y}}. = 0.26$
14. $\theta = \frac{\overline{R}(1-\overline{G}/\overline{Y})(1-\lambda)+\overline{W}/\overline{Y}(\lambda\overline{R}^2-p^2)}{(1-\overline{G}/\overline{Y})(1-\lambda)+\overline{W}/\overline{Y}(\lambda\overline{R}+pR)} = 0.041$
15. $\frac{\overline{W}}{\overline{C}} = 4.429$
16. $\frac{\overline{w}}{\overline{C}} = 0.921$
17. $\frac{\overline{C}^{YB}}{C} = 0.816$
18. $\frac{\overline{w}}{\overline{Y}} = 0.645$
19. $\frac{\overline{K}}{\overline{W}} = 0.806$
20. $\frac{\overline{D}}{\overline{W}} = 0.194$
21. $\frac{(1-p)}{(1+\theta)} = 0.908$(Government discount rate).
22. $\hat{C} = 100$ 23. $\hat{g} = 100$ 24. $\hat{t} = -23$
25. $\hat{d} = -60$ 26. $\alpha = 0.3$ 27.$\gamma_2 = \alpha + (1-\alpha)(1-\gamma_1) = 0.65$
28. $G^I/G = \gamma = 0.35$(Minstry of finance data) 29. γ_1 =0.5(Capital externality-imposed)

If DIS = 1, in the equation, then the government in effect chooses the same discount factor as the private sector. If DIS <1 , then the government is more myopic.

4.1 Optimal Growth, Calibration and Numerical Results for Turkey

The key question is that the effect of Debt/GDP, T/Y and liquidity constraints on optimal growth. We have examined the effect of D/Y, t and λ on growth and concluded that the higher is the λ lower is the level of optimal growth for different levels of tax ratios. Furthermore higher is the debt/GDP ratio lower is the optimal growth rate is. Currently high level of debt/GDP ratio for Turkey may indicates a lower optimal level of economic growth in the long run. After the substitution of the calibration multipliers (3.3) to (3.5) of the Turkish economy, following values are obtained:
$g_R = -2.2468$, $g_t = -3.0938$, $g_D = -0.2250$, $g_n = -4.5682$, $g_\gamma =$ 1,
$f_D = -0.0022$, $f_t = -0.0961$, $f_R = 0.5994$, $f_n = -0.8403$
$\left[\frac{dn}{dD}\right]_{t,\gamma fixed} = \frac{g_R f_D - g_D f_R}{f_r g_n - g_r f_n}, = -0.0302$

As debt/GDP ratio decreases long run growth increases. Further more, the calibrated model suggest that 10% decrease in the government debt(domestic)/GDP ratio from its present 75% will increase the growth rate of Turkey by 0.3%.

$\left[\frac{dn}{dt}\right]_{D,\gamma fixed} = \frac{g_R f_t - g_t f_R}{f_r g_n - g_r f_n} = -0.4475$

A 10 % increase in the proportion of tax ratio from t = 26% to about 36% will decrease the growth rate of Turkey by 4%.

Turkish Ministry of Finance data source provide that the share of Government Investments in Government expenditures are about 35%. (1990 - 1997 Average) therefore we can choose $G_t^I = 0.35G_t$. The externality effect of private

and public capital is assumed to be equal, hence $\gamma_1 = 0.5$. Looking into the effect of infrastructure on economic growth where D/Y and T/Y are fixed as follows:

$[\frac{dn}{d\gamma}]_{D,t,fixed} = \frac{-g_\gamma f_R}{f_r g_n - g_r f_n} = 0.136$

According to this calibration, raising the proportion of infrastructure spending by 10% (i.e. from present value of 35% to 45%)will rise growth by more than 13%. This result again highlight the issue of public infrastructure in Turkey.

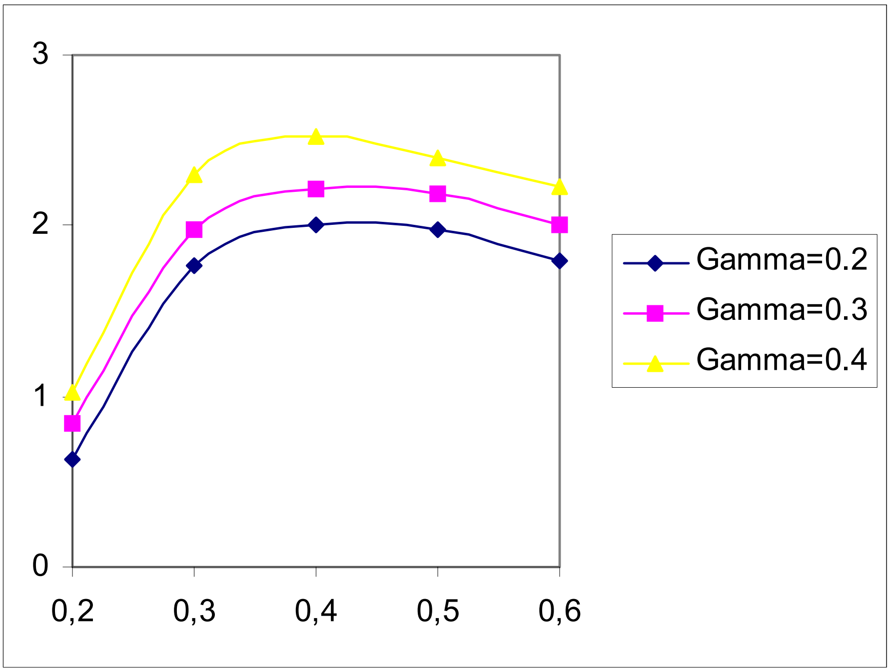
An optimal tax ratio, the optimal debt/GDP ratio and the optimal public infrastructure level needs to be determined.

Figure 2 shows how growth rates increase to their maxima for different values of gamma (γ) .

5 Conclusion

The central theme of this paper is to examine the effect of fiscal policy and public sector investment on economic growth. In this simulation study, various levels of taxes and public investment in an open economy of Turkey are examined.

In this paper we firstly compiled the model for open economy of Turkey. Secondly, we derived multipliers. The calibration provided some fiscal policy implications. We have particularly focused on the different levels of taxes for different levels of infrastructure. This analysis provided different levels of growth for the slected levels of infrastructure expenditures. The results of the simulation certainly suggests that for an open economy both, fiscal policy, the taxation rate and the public investments matter. Fiscal policy certainly affects the optimal level of growth. The simulation results suggest that the higher proportion of infrastructure expenditures in the total government expenditure means higher economic growth. The higher the proportion of public investment is, the higher the optimal growth but there is an optimal level of infrastructure expenditures for each infrastructure share in the total government expenditure.



6 References

Alagoskoufis, G.S. and van der Ploeg, F. (1991) 'On budgetary policies, growth, and external deficits in an
interdependent world' Journal of the Japanese International Economies, 5, 305-324.

Aschauer, D. (1989) 'Is Public Expenditure Productive? Journal of Monetary Economics.

Barro, R.J. (1990) 'Government spending in a simple model of endogenous growth' Journal of Political economy, Vol. 98, No. 5, pp103-125.

Blanchard, O. J. (1985) " Debt, Deficit and Finite Horizons" Journal of Political Economy, 93: 223-47.

Blanchard, O. J and Fischer, S. (1989). "Lectures on Macroeconomics" The MIT Press, London.

Bougheas, S., Demetriades, P.O. and Mamuneas, T.P. (1999) 'Infrastructure, Specialization and Economic Growth' University of Cyprus, Department of Economics. Discussion Paper No. 99-10.

Buiter, W. H. (1988), "Death, Birth, Productivity Growth and Debt Neutrality", Economic Journal,

98:279-93.

Buiter, W.H. (1991) 'Savings and Endogenous Growth: A survey of Theory and Policy' CEPR Discussion paper No. 606.

Canning, D., Fay, M. and Perotti R. (1994) 'Infrastructure and Groeth' In International Differences in Growth Rates, edited by M. Baldassarri, M. Paganaetto and E.S. Phelps, NewYork, St. Martins Press.

Canning, D., and Pedroni, P. (1999) 'Infrastructure and Long Run Economic Growth' Mimeo.

Diamond, J. (1989) 'Government Expenditure and Economic Growth: An Empirical Investigation'. IMF WP 89/45.

Esterly W. and Rebelo, S. (1993) 'Fiscal Policy and Economic Growth: An Empirical Investigation', Journal of Monetary Economics, Vol. 32, pp 417-458.

Garcia-Mila T., McGuire T.J. and Porter R. H. (1996) 'The Effect of Public Capital in State Level Production Functions Reconsidered', Review of Economics and Statistics, pp. 177-180.

Gramlich, E.M. (1994) 'Infrastructure Investment: A review Essay,' Journal of Economic Literature, Volume32, pp. 1176-1196.

Holtz-Eakin, D. (1994) 'Public Sector Capital and the Productivity Puzzle,' Review of Economics and Statistics, Vol 76, pp. 12-21.

Holtz-Eakin, D. and Schwartz, A. E., (1995) 'Infrastructure in a Structural Model of Economic Growth,' Regional Science and Urban Economics, Vol. 25. pp. 131-151.

Hulten, C.R. and Schwab R.M. (1991) 'It is there Too Little Public capital? Infrastructure and Economic Growth' Discussion paper, SAmerican Enterprise Institute.

Kemball-Cook, D. , Levine, P. and Pearlman, J. (1993) "Simulations and policy analysis using ACES".

Mimeo.

Krichel, T. and Levine, P. (1995) "Growth, Debt and Public Infrastructure". Economics of Planning, Vol. 28,

No. 2-3, pp.119-146.

Levine, P. and Brociner, A. (1994) 'Fiscal Policy Coordination Under EMU: A dynamic game approach'

Journal of Economics Dynamics and Control. Vol. 18, pp. 699-729.

Levine, P. and Pearlman, J. (1992) "Fiscal and Monetary Policy Under EMU: Credible Inflation Targets or

Unpleasant Monetary Arithmetic?" CEPR Discussion Paper Series, No: 701.

Rebelo, S. (1992) ' Growth in Open Economies' CEPR Discussion paper Series. No 667.

Romer, P. (1986) 'Increasing Returns and Long Run Growth' Journal of Political Economy, 94. pp. 1002-1037.

Sanchez-Robles B. (1998) Infrastructure Investment and Growth: Some Empirical Evidence'. Contemporary Economic Policy, Vol. 16., pp.98-108.

Tatom, J.A. (1993) 'The Spurious Effect of Public Capital Formation on Private Sector Productivity' Policy Studies Journal, Vol. 21, pp 391-395.

Vaidyanatan, G. (1993) 'Consumption, Liquidity constraints and Economic Development', Journal of

Macroeconomics, 15, 3, pp. 591-610.

Weil, P. (1985) "Essays on The Valuation of Unbacked Assets". PhD Thesis, Harvard University.

Yaari, M. E. (1965) "Uncertain Lifetime, Life insurance, and the theory of the consumer". Review of

Economic Studies. 32; 137-50.