COMPOSITION OF PUBLIC EXPENDITURES AND ECONOMIC GROWTH:

A DYNAMIC ANALYSIS

By

Shaheen Naseer

Supervised by

Dr. Musleh ud Din

PAKISTAN INSTITUTE OF DEVELOPMENT ECONOMICS

ISLAMABAD

CERTIFICATE

This is to certify that the dissertation of Ms. Shaheen Naseer is accepted in its present form by Pakistan Institute of Development Economics (PIDE), Islamabad. It satisfies the dissertion requirement for the degree of M.Phil.

Internal Supervisor: _____ (Dr. Musleh ud Din)

External Examiner: _____ ( )

Head of Department _____ (Dr. Ejaz Ghani)

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Looking back to the things and trying to connect the dots, I remember how one decision of doing MPhil Economics from Pakistan Institute Of Development Economics shaped my mind and developed my ability to think independently --- though the journey was aided by several detours, long hallways and unforeseen stairwells --- eventually putting me in the place where I am now.

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Abstract

This study explores how the composition of public spending including utility enhancing and productivity enhancing expenditures impacts economic growth. The study develops an analytical framework that first looks at the case where fiscal policy is chosen by a benevolent government. Second, the study focuses on a case when fiscal policy is chosen by politicians based on voter preferences in a game-theoretic setting. We find the equilibrium condition and steady state growth rate of consumption where consumer's utility not only depends on private consumption but also on public consumption. A key feature in our framework is the explicit incorporation of elastic labor supply in the model which allows us to study the role of fiscal policy in a setting where fiscal policy can alter the incentives of workers towards work and leisure.

The study has come up with some interesting findings. First, the study shows that there is a tradeoff between utility enhancing and productivity enhancing expenditures, and that when positive externalities in the form of technological spillovers are present, it may be optimal to allocate more funds to productivity enhancing expenditures. Second, in the presence of elastic labor supply more of labor income tax will be growth enhancing when the economy is below its balanced growth path. It will help finance an increase in the provision of publically provided utility enhancing expenditures while causing a decline in private consumption. But if taxes are charged on a much higher rate on labor income it will have distortionary effects in the economy with potential negative impact on the overall growth rate of economy. Third, the choice of policy instruments whether by the benevolent government or by the voters has important implications for growth. Whereas a social planner can incorrectly determine the policy instrument that doesn't reflect the choice of citizens, voters too need to be careful in showing their preferences to the politicians because their choice has impact on the steady state growth rate of the economy. Finally while citizens may have a higher preference for utility enhancing expenditures, spending on productivity enhancing expenditures may still be more desirable due to technological spillover effects in the economy which can boost economic growth.

Chapter 1

INTRODUCTION

The role of public expenditure in the process of economic growth has been extensively studied in the fiscal policy literature. While the emphasis of most of the studies has been on exploring the linkages between public expenditure and economic growth, relatively little attention has been paid to the central issue of how public expenditures are determined. This question is important because growth outcomes depend on the decisions of politicians pertaining to the composition of public expenditures. As argued by Sibert and Rogoff (1988), there is a strong connection between the democratic elections and the composition of public expenditures and that political outcomes largely shape economic outcomes. For example, the political decisions on the allocation of public expenditures toward public productive services and public consumption services would have different impacts on economic growth.

This study draws on three strands of literature to develop a game theoretic setting that not only allows us to investigate how public expenditures are determined by the interplay of voter behavior and economics but also enables us to assess the impact of the two types of public expenditures on economic growth. More specifically, the model incorporates both types of public goods ---- public productive services and public consumption services --- in an endogenous based R&D model augmented with endogenous labor supply.

The first question addressed in this study is how the composition of public expenditures is determined. The literature has highlighted two mechanisms through which public expenditure policy is determined: either the government itself chooses the policy or the citizens choose the policy by giving their votes and showing their preferences. In the first case the government is considered as a benevolent dictator who tries to maximize society's welfare. However, the problem with this mechanism is that it is based on maximization of the objectives

alone without regard to the underlying structure of the economy and preference of the citizens [Hyun and Philippopoulos (2001)]. The second approach, advocated by Sibert and Rogoff (1988), is based on voter preferences explicitly incorporating how voter behavior can determine economic outcomes such as a particular composition of public expenditures. This study uses both these approaches to provide a comparative perspective on how different public expenditure determination mechanisms influence economic growth.

In a game theoretic setting, the political parties are assumed to make strategies that will allow them to win elections and the party with best strategy will win the electoral game. Though in a multiparty non cooperative game setting there can be multiple Nash equilibria, there could still be a point where there is no incentive for a party to move away from equilibrium and hence there may be at least one strategy where all parties come up with identical outcomes with same strategy. Reinhard Selten (2000) introduces the concept of perfect equilibrium which states that there comes a point where all players are playing same strategies and in the presence of threats linked with breaking of promises no player would find it optimal to deviate from his announced policy. The player plays the game bearing in mind that all players are playing the same game with same expenditures policies. Hence there is complete convergence and all parties come up with the same composition of public expenditures pertaining to the two types of public goods. In this study, we attempt to formulate a model incorporating the possible interactions between players regarding determination of public expenditures. We take the case in which economic policy is dictated by voter preferences and compare it with the case in which economic policy is chosen by a benevolent government.

The next question is that once the game is over and the parties are able to attract voters and come into power what is the impact of their promised policies. Political parties can attract voters in different ways. For example, they can promise to lower the tax rates, or they can promise to provide a certain share of public expenditure towards public production and public consumption services. All of these policies would have different implications for economic growth. But

to have real effects of government expenditure policy, endogeneity of labor supply is essential in the model as fiscal policy can influence economic agents' attitudes towards work and leisure. An essential point here is that even though a high level of average or marginal tax rates may discourage labor supply, tax financing of public expenditure on utility enhancing goods will apparently increase the quality of the labor force.

To elaborate our theoretical framework, we extend the growth model of Park and Philippopoulos (2000). It is assumed that total government expenditures are financed by labor income taxes, consumption tax and a user fee on excludable goods. The economy consists of a representative consumer who also acts as a voter, a representative producer and politician or government. Firstly the decentralized equilibrium when benevolent government chooses the economic policy with non-elastic labor supply is formulated. Following Park and Philippopoulos (2007), tax revenue, which is financed by distortionary taxes, is allocated between utility enhancing expenditures and productivity enhancing expenditures in an optimal policy that is derived from a politico-economic equilibrium based on voters'choice. The model is similar to the research and development model of endogenous growth along the lines expounded by Haruyam and Itaya (2006). Using this framework we investigate, first, the transitional dynamics of chosen allocative policies. Secondly, we analyze the possibility of uniqueness and dynamic indeterminacy. Indeterminacy occurs when multiple equilibrium growth paths come together to a single steady state solution thereby making economic system steady and stable. Finally, we use calibration techniques to get the numerical analysis of the model that provides insights into the optimal mix of these two types of public expenditures and how these affect the growth rate of the economy.

1.1 Background of the study

As argued above, different types of public expenditures can have different implication for long run growth. The productivity enhancing expenditures are

included in production function as a direct argument hence are considered as engine of growth while utility enhancing expenditures are taken as a direct argument in the utility function of the consumer thereby increasing the welfare of the consumer but not necessarily long run growth. The government has to choose between these two goals because it's not the just question of welfare and growth rather it is matter of incentive to remain in power as well. The growth of the country is not just related to the size of government spending rather the efficient composition of government expenditures is an equally important question. It is argued that fiscal instruments just have level effect on output or on equilibrium factor ratio but have no significant impact on long run growth.

Solow and Swan (1956) in their neoclassical growth models argue that taxation and composition of government expenditures do not affect the long run growth rate. Arrow and Kurz (1970) first described the far reaching scope of fiscal policy. Their argument is that utility of the consumer does not depend on private consumption alone but rather public consumption as well. However, they are of the opinion that all government services are productive. They incorporate neoclassical framework in their models and refine the analysis that government spending has only transitional effects and no growth and steady state effects.

Some variants of the endogenous growth models also incorporate the role of taxation and government expenditures on economic growth [Barro (1990), King and Rebelo (1990) and Lucas (1990)] showing that government spending may have an impact on transitional dynamics of the economy as well. However, government spending in these models is treated as only productive capital stock and productive services. In order to analyze the effects of fiscal policy, most of the studies in endogenous growth framework have classified elements of government budget into four categories. These are distortionary taxes which affect investment decisions, nondistortionary taxes, productive government expenditure which is used as a direct argument in production function and non-productive expenditure.According to Turnovsky there is no one mechanism that can give a clear cut answer as to how public expenditure should be categorized. But we can largely focus on two categories: public expenditures on goods and

services which are utility enhancing including social security programs, retirement allowances, unemployment allowances, national parks and in a sense national defense as well while expenditures on productivity enhancing services include education, law and order, research and development, and training and infrastructure. In the empirical studies of Landu (1983) and Barro (1990, 1991) government expenditures are taken as both productive and non-productive. These studies find that government consumption spending is non-productive while government investment spending has a positive impact on the long run growth.

Kneller et al (1999) and Glomm and Ravikumar (1997) argue that the optimal composition of productive and non-productive expenditures is of equal importance. These studies are based on variants of the neoclassical models. In order to find the optimal composition of government expenditures vis a vis productive and unproductive the studies use the relative elasticitiesof the two types of public spending.

Other studies have used different ways of categorizing public spending. For example, some studies use public goods as stock variable [Futagami et al (1993), Turnovsky (1997), Baxter and King (1993) and Glomm and Ravikumar (1994)] while others take publicly provided goods as flow variable for according to these studies it is not stock but flow of public goods that can influence economic growth [Aschauer (1989) Barro (1990), Barro and Sala-i-Martin (1992)] Furthermore,most of the studies introduce publicly provided goods as pure public goods having the quality of non-rivalry and non-excludability whereas some studies introduce the issue of congestion and debate on the importance of user fee to increase revenue collection[1].

In most of the existing literature the decision of composition of government expenditures is exogenously determined or is chosen by the benevolent government.However, a more plausible scenario is when citizens choose economic policies by casting their voteto their preferred policies through a

[1]see e.g. Barro and Sala-i-Martin (1992), Glomm and Ravikumar (1994, 1997), Turnovsky (1996, 1997).

democratic process.In this approach, policies about the composition of government expenditures are made on the basis of preferences of the citizens, for as voters they implicitly choose the policy in a political economy framework.In the extreme casewhen the competition for votes is strong enough that two opposing parties come to a moderate policy choice i.e. 'full policy convergence' just according to the choice of voters. In developed countries people choose the productive activities of the government like that of infrastructure, education and law and order. However, people in developing nations, being poor and lacking resources, are more concerned with social programmes, pension reliefs, unemployment allowances and redistributed transfers. As argued in our study, public expenditures by the government between these two categories of spending have different impacts on the growth rate of the economy.

Furthermore, the collection of revenue to finance the public expenditures greatly depends on the way the revenues are used because economic agents are rational and may respond differently to different allocations. Moreover, with few exceptions, previous studies treat labor supply as inelastic. This constrains certain aspects of fiscal policy especially it makes labor income tax as non-distortionary lump sum tax.Turnovsky (1995) argues that to have real effects of government expenditures policy, endogeneity of labor supply is essential for fiscal policy can modify economic agent attitudes towards work and leisure.

1.2 Objective of the Study

The major objective of this study is to analyze how the composition of public expenditure shapes the growth outcomes of the economy using a game theoretic setting in which composition of public spending is endogenous based on preference of the voters with an elastic labor supply. The study assumes that tax is financed by labor income tax and capital tax and a tax on the provision of publically provided goods.In utility function we assume that there are two types of consumption: one is private consumption while the second is public consumption.If there is tax on the labour income the objective of that tax is to

provide the public consumption services hence the more a consumer demands public consumption the less he will be having private consumption because tax on his labor wages will decrease his after tax income.How the economic policy pertaining to the composition of government expenditures is formulated on the basis of preference of the voters is the major scope of this study. More specifically the study will address the following questions:

- How preference parameter, which describes the citizens values to the utility enhancing expenditures and productivity enhancing expenditures, affects the long run equilibrium.
- How the composition of public expenditures affect the level and path of growth with endogenous labor supply.
- What are the channels and interactions of productive and non-productive spending on economic growth
- How public expenditures affect the level of welfare.
- How the economy can grow at a balanced growth rate.
- Does indeterminacy become more likely due to the introduction of public expenditure composition into productive and non-productive expenditures
- Assessment of calibration results

1.3 Organization of the Study

The rest of the study is organized as follows. Chapter two provides a brief review of the relevant literature. The theoretical framework of the study is specified in chapter three. In chapter four dynamic analysis of the model is discussed. The main query of this section is that whether the economy will be able to restore the equilibrium path when fiscal instruments (composition of government expenditures between productivity enhancing and utility enhancing) changes and does the economy fulfill the conditions for indeterminacy. In chapter four last section the policy parameters of the models are calibrated to further analyze the question of indeterminacy. Chapter five summarizes the study.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

A growing body of literature has explored the implications of public expenditures on economic growth. For expositional purposes, we divide this literature into four categories. First there are studies that examine the role of public expenditure in economic growth using variants of the neoclassical and endogenous growth models. Second, a significant body of literature makes the distinction between productive and non-productive public expenditures focusing on their impact on economic growth. The third strand of literature deals with productivity enhancing and utility enhancing public expenditures. Finally, a significant body of literature explores the composition of public spending using game-theoretic framework in which voters shape economic policies. In the following section, we provide a brief review of literature within each of the above categories. In addition, we review some studies dealing with the choice between growth and welfare as well as studies that incorporate elastic labor supply in their models of public spending.

2.2 Public Expenditure and Economic Growth

Neoclassical economists find no relationship between public expenditures and economic growth. Public spending plays no role in long run growth rates rather steady state growth rates are determined by exogenously determined technological shocks or population rate [Solow, 1956; Cass, 1965]. Arrow and Kurz (1970) first described the far reaching scope of public spending within a neoclassical framework in which utility of consumer depends not only on private consumption but only on public consumption. However, the study finds that government expenditures have transitional effects or level effects alone but do not havesteady state growth or dynamic effects. A key limitation of this study is that it treats all government services as productive alone.

Some studies using variants of the endogenous growth theory have extended the findings of Arrow and Kurz emphasizing that government spending may affect the transitional dynamics of the economy as well [Romer, 1986; Lucas, 1988; King, et al, 1988; Grossman and Helpman, 1989;Barro, 1990; Rebelo, 1991; Kocherlakota and Yi, 1996, 1997]. Unlike the neoclassical models, in the endogenous growth theory long run growth rates are directly affected by the government policies pertaining to the composition of expenditures.More precisely, in addition to technology, the growth rate depends on public productive activities according to these models.

2.3 Impact of Productive and non productive Public Expenditures on Growth

Departing from the earlier studies which consider government spending as productive alone, Landu (1983) and Barro (1990, 1991) distinguish between productive and non-productive government expenditures. These studies find that government consumption spending is non-productive and government investment spending has a positive impact on the long run growth. Glomm and Ravikumar (1997) and Kneller et al. (1999) determine the optimal composition of productive and non-productive expenditures. Chen (2006), using an endogenous growth model analyzes the optimal composition of government expenditures on the basis of structural and policy parameters. The study takes the case of benevolent government which divides government budget into optimal productive and optimal production services.In the same line within endogenous growth framework Ghosh and Roy (2004) analyze the optimal expenditure policy and argue that an ideal fiscal policy is based on how allocation is made for different components of public expenditures. Furthermore, the study introduces provision of public services both as stock and flow of public capital in production function.Carboni and Medda (2011) analyze optimal composition of government expenditures within a neoclassical framework. The study supposes that public expenditureis composed of two types: one leads to growth andsecond leads to welfare accumulation. The study also investigates which composition is optimal to maximize the long-run growth rate.Turnovsky (2000) examines the impact of

different types of the composition of government expenditures. The study analyzes the impact of public spending by introducing both leisure and consumption in the utility function and suggests that the possibility of dynamic equilibrium crucially depends upon the assumptions made on the fiscal policy. Devarajan et al, (1996), by considering two productive services one being more productive than the other, investigates the possible connection between the composition of public good and economic growth. In the theoretical model augmented with CES production function the study finds that if the initial and existing share is low on productive expenditures putting more on public productive services will not significantly boost economic growth. The study finds that in developing countries not capital but current public expenditures have a significant impact on economic growth rate. However the study takes expenditure determination as exogenous in contrast to the present study which incorporates how policy of public expenditures is determined rather than just taking it as exogenous.

According to Barro (1990), the most common distinction between productive and nonproductive expenditure is based on the premise that if government expenditures are included in the utility function of the consumer then it is non-productive because taxes will be required to finance these expenditures which are mostly distortionary. And expenditures which enter in the production function are considered productive. Aschauer and Greenwood (1985) also find similar findings. Since then there is a lot of debate on the fact that which kind of expenditures are productive and which are nonproductive. According to Easterly and Rebelo (1993) public expenditures on communication and transport are productive however this result does not hold if data are changed and one picks a different set of countries. On the other hand, it is generally believed that government expenditures on infrastructure increases growth because it provides better transport facilities that can be used as engine of growth in the economy.

Tullock (1987) and Summers and Heston (1988) argue that all expenditures on services that do not involve fees are non productive. In this vein,

even defence and education expenditures are considered as non productive because there is no user fee on these expenditures and there is a need for substantial revenues from distortionary taxes to finance these services. Zeng and Du (2003) endogenize the labor supply in utility function and provide a broader insight on the impact of public expenditures on economic growth. The study considers the allocation of government expenditures between lumpsum transfer and consumption expenditures and finds that consumption expenditures can be growth enhancing while lump sum expenditures can be growth hindering.

On the empirical front, studies have come up with different implications of the composition of government expenditures on economic growth. Aschauer (1989) and Diamond (1989) show that un-productive expenditures increase the burden on the economy but productive expenditures through their spillover effects in the economy boost the growth rate.

2.4 Impact of Productivity Enhancing and Utility Enhancing Expenditures on Economic Growth

Economic growth is not just related to the size of government spending rather the efficient composition of government expenditures is equally important.In the literature optimal structure of public expenditures is broadly discussed together with the optimal composition of expenditures.The composition of government expenditures affects long run growth differently with productive and non-productive compositions having different implications for growth [Devarajan et al. 1996; Kneller et al. 1999].

Another distinction is made in the literature between different types of public spending: utility enhancing and productivity enhancing. Public spending that is included in the utility function is considered as non-productive while public spending in the production function is assumed to increase the productivity and hence economic growth [Turnovsky and Fisher, 1995; Turnovsky, 2004]. Furthermore in the production sector of the economy there are two factors: one is accumulated --- physical capital --- while the other is non-accumulated --- human

capital --- and it is shown that growth increases with increase of the accumulated factor.

In case the Government is benevolent and there are no electoral constraints on it, then government expenditure can take the form of productive expenditure in AK model and it is a close substitute of private investment which is assumed to play a crucial role in increasing the productivity of the firm. Barro (1990) introduces government productive service in the production function as an input.The study defines government productive services as a pure public good. Barro and Salai-Martin (1991) introduce three different types of government productive services as inputs in the production function. The first one is excludable and rival, second as non-excludable and non- rival along the lines of Samuelson (1954) , while the third also has the property of congestion along with being rival and non-excludability ---- for example if more a producer uses it then it is less available for the next producer. The study compares the private return and social return and types of taxes that can produce less distortionary effect in all of the three cases. Furthermore if the public good is subject to congestion that means income tax can work as a user fee. And the impact of government productive services would be higher if the spillover effects and learning by doing create more private returns than social cost of providing these services.Barro(1990) empirically tests the impact of government productive services which are included in the production function on economic growth and finds a negative relationship between the two. This result is surprising for it finds a negative or no impact of government investment services on economic growth.

There are some studies which investigate the link between private production and public expenditures focusing on the optimal composition of public expenditures [Ratner 1983, 1994, 1999; Aschauer 1989, 2000; Chen, 2007]. Following Lucas (1988) and Card and Krueger (1992), Glomm and Ravikumar (1994) introduce public spending as human capital input which is financed through income tax. The more the preferences of the citizens are for the public education the more will be the investment of government on the education. Hence it is a political process where the politicians care about the choices of their voters

that what kind of policy they actually want to be implemented. The study shows that in a homogenous society private schooling will give more returns if most of the people in the economy have income which is above average. However if the society is heterogeneous and income of agent is below average then public education will help decrease income inequality ultimately boosting economic growth.

In another study Barro (1990) introduces a second type of government expenditure which is not included in the production function but rather in the utility function of the consumer as a public service which is assumed to be financed by income tax. In this case even if the social rate of return on investment were expected to be higher than private returns in the production sector, the distortionary taxation decreases the private return which may hamper causing the growth rate of the economy. Barro (1991) empirically testes the impact of government consumption services on growth and finds significant negative relation between government consumption services and economic growth. Barro and Salai-Martin (1992) and Glomm and Ravikumar (1994) also analyze the role of government expenditures but these studies ignore unproductive expenditure and just consider the productive government spending. In contrast to these studies, Brier and Glomm (2001) develop an extended model where they consider both productive and unproductive types of public spending.

Some studies introduce public spending into utility function as public consumption services that increase the utility of the representative agent and hence are directly utility enhancing expenditures [Bailey, 1971; Aschauer, 1988; Barro, 1989; Devereux and Wen, 1998].

Musgrave (1997) argues that Public expenditures are either growth enhancing, for example infrastructure, or expenditures that do not directly affect growth in a significant manner such as spending on law and order, pensions, and defence. Along similar lines, Cassou and Lansing (1998) look at the role of public spending on economic growth taking the former as exogenously determined while Marrero and Novales (2005 & 2007) consider public spending as endogenous.

Using a Ramsey type model, Economides et al (2007) analyze the role of productive and unproductive expenditures by assuming that productive expenditures are productivity enhancing while non productive expenditures are utility enhancing. The study solves the second best optimal policy with public goods subject to congestion and inelastic laborsupply. The more the citizen values the utility enhancing expenditures the more resources will be allocated to these expenditures and less to productivity enhancing expenditures. The study raises another very important question that whether government expenditures are flow or a stock variable and argues that productive expenditures should be considered as stock variable while non-productive should be taken as flow variable.

Devarajan et al. (1996) focus on the question of how the composition of public expenditures affects the growth rate of the economy. The study finds that growth increases with an increase in the current expenditures of the government while it declines with an increase in the stock expenditures of the government. This result questions the policy of giving more attention to capital expenditures rather than current expenditures especially in the context of developing economies. The study argues that the mix of government expenditure should be such that there be an optimal combination of expenditures that can promote growth because by and large the purpose of every government is to increase the productivity of the economy and hence economic growth. However a limitation of this study is that government decisions pertaining to the allocation of public spending are taken as exogenous. Along similar lines, Parkand Philippopoulos (2003, 2004) also consider a model of two types of public expenditures but the study does not focus on endogenous policy issues.Gosh and Gregoriou (2006) also have similar limitations though they consider two types of public goods and solve for decentralized equilibrium by making a few extensions in the Devarajan et al (1996) model.

2.5 Expenditure Composition in Politico-economic Models: The Median Voter Channel

The starting point in this area of research is that the government has to take care of the composition of expenditures because it's not just a question of welfare and growth rather it is a matter of incentive to remain in power as well. The classic studies in this area take government as benevolent whose aim is to improve the efficiency and welfare of the economy. Ramsey (1927) is of the opinion that all forms of government are benevolent in that the government caresabout the welfare and efficiency of the society while at the same time having no or little personal interests. Barro (1979), Lucas and Stokey (1983), and Chamley (1986) pronounce that there is convergence of interest in the economy with each government aiming to increase the growth rate of the economy. Benhabib and Rostrichini (1991) develop a game theoretic model in which individuals extract benefits from the society for their own benefits. Ghosh and Gregoriu (2008) extend this analysis by assuming that a benevolent government introduces such policies which are welfare enhancing through the maximization of the representative agent utility. The study derives a model in which tax rate, government expenditure composition and growth rate all are endogenous, and in which social planner not only chooses fiscal instruments but also chooses private consumption and private investment.

Devereux and Wen (1998) develop a model of political instability where policy is formulated with a constant fear of losing the power. The study introduces two types of public goods: one is introduced in the utility of consumer as a direct argument, so consumer's utility depends not only on private good but also on public good. The decisions of agents are not influenced by inclusion of public good as it is introduced using the assumption of preference separability, which also ensure the same level of saving and consumption among all households. The tax use for revenue is capital tax with no supply of labour.The study argues that when there is political instability governments tend to have conflicting aims often spending more on consumption goods while caring little about the debt burden being put on the future governments. In this setup, the

composition of expenditures is based on the desires of voters for governments care more about the re-election than about the growth rate of the economy. The evidence is very similar to Barro and Salai Martin (1995) who maintain that when there is government instability there will be a lesser chance of growth because the composition of government expenditures is not aimed at growth but rather will be spent selfishly caring little about debt burden.

The Median voter theorem is central in the decision making process pertaining to the composition of government expenditures in models of political instability. Even in dictatorship the person in power cannot rule out the preferences of the individuals completely because he might be thrown out. Hence whatever policies are formulated largely represent the wishes of voters in the economy. However the literature mostly focuses on the static models that explore the influence of the majority voting on the government tax policy but is largely silent on dynamic impact of economic policy as well as on the issue of the impact of individual choice on social choice. Also, little attention is paid on the impact of majority voting on the composition of government expenditures as well as on the distributional consequences of economic policy [Romer, 1975; Mayer, 1988].

Karasa and Polborn (2009) explore the impact of median voter on policy determination; however the policy is not endogenous in their model and hence it remains unclear as to how the preferences of the citizens are determined.This is an important question because if a party is not incorporating the citizens preference it has a lesser chance to be reelected as people can choose to join politics on the basis of their preferences. Lee et al (2004) examine how voters elect the policies. The study empirically tests the US data focusing on the role of elections and shows that there can be full policy convergence as in Downs (1957) or there can be partial convergence or complete divergence. It may be possible that politicians act on their decided policies or they can change the policies altogether. Because once the candidates are in the office they may have an incentive to renege on their announced policies. In this context, credibility becomes a real issue [Alesina; 1988; Besley and Case, 2003].

Alisenia and Rodrick (1994) introduce inelastic supply of labor using government productive services as a direct argument in the production function. The government collects tax revenue through capital income which through productive services of government will increase the income and wealth of the agents. The study argues that in an economy with income inequality distortionary redistributive policies may be growth enhancing. Persson et al (2007) investigate the impact of different forms of government and role of voting. However the study focuses on total expenditures of government and does not distinguish between different forms of public goods. Hence the analysis is confined to the size of expenditures and voting. Economides et al (2001) develop a game theoretic framework and derive Markov perfect strategies that shed light on how electoral uncertainty has an impact on fiscal policy which in turn shapes the incentive to work and invest and hence influences economic growth. Myles (1999) argues that in a multiparty system, as opposed to the case of a benevolent government, the presence of distortions can outweigh the benefits of public expenditures.

2.6 Choice between Growth and Welfare

In the growth literature the famous optimizing models of Ramsey (1928), Cass (1965) and Koopmans (1965) were aimed at studying the required savings rate to move the economy on balanced steady state growth rates. However, these models are very much silent on the issue of the role of composition of government expenditures in the context of welfare and growth. These issues have been addressed in studies using political economy channel to determine the optimal composition of government spending required for growth. Government expenditures that are aimed at increasing the redistribution of resources in the society include social security programs, housing facilities, pensions, and schooling and health. It must be noted here that redistributive policies to enhance welfare also create distortions in the work incentives. In this context, studies have largely focused on the issue of how taxes affect the incentive to work but little

attention has been paid to how redistribution policies can create distortions in the economy. Sandmo (1995) addresses the question of the tradeoff between equity and efficiency. It is shown that while taxes have a negative impact on the labor supply decision but the impact of social goods can offset the former because the disincentive of taxation can be compensated through the provision of social goods that can be used to increase the health and quality of leisure that on the whole can have a positive impact on the efficiency of the labor force through better education and health.

KinaiYukuske (2010) argues that the choice between growth and welfare becomes more interesting when allocative decisions take a political dimension. This issue is of particular importance for developing economies as the policymakers have to make some political compromise between the growth promoting policies and welfare enhancing or distributional policies for they have to take care of reelection as well.Very few papers have considered the role of political influence in policy determination and mostly studies are confined to the impact of economic policies in OLG models [Yakita (2008)].However, Kass(2003) incorporates the idea that the policy determination is carried out by the power of majority voting leading to the possibility of multiple equilibriums for each tax rate.

Muller (1989) argues that that the purpose of government is to provide public goods which are traditionally public consumption services or public production services. He explains that government should aim to provide redistribution activities so government budget should provide transfers. Atkinson (1999) on the other hand raises the issue of equity and efficiency. The study argues that tax policy and government expenditures composition should be aimed at enhancing efficiency as fiscal policy can modify the incentive of labor force and at the same time can also provide an efficient labor force as well. Kinai (2010) introduces public investment in the OLG model without bequest motive of government and explains that how policy determination between pension and public investment is made by majority voting. The study incorporates Shepsle

(1979) structure induced equilibrium model for explaining to explain how policy is endogenized.

2.7 Endogenous Labor Supply

A key limitation of most of the research dealing with the composition of public expenditures is that, with few exceptions, these models treat labor supply as inelastic. In this case the substitution between leisure and work is not so evident because both consumption and income taxes are taken as non-distortionary.To analyze the growth as well as welfare effects of fiscal policy in detail it is needed that labor supply should be taken as endogenous. In such case all income taxes become distortionary and we are in a better position to look closely at how fiscal policy modifies the behavior of the economic agents.The labor supply reduces due to increase in income tax because it reduces the take home wage hence brings a negative incentive to work. Turnovsky, in an extension of Barro (1990), explores the idea that what will be the impact of productive public expenditures if labor supply is elastic, and concludes that taxes should not be levied to the extent that these cause welfare to decline [Turnovsky (2000) Chamley (1985)].

Furthermore, the real effects of policy on output and capital can only arise if labor supply is taken as elastic. More specifically, the full impact of government consumption expenditures can only be assessed when labour leisure choice is incorporated in the intertemporal Ramsey-type models [Turnovsky, 1995]. Building on Lucas 1988 model of endogenous growth framework, Benhabib and Perli (1994) show that elastic labour supply ensures existence of equilibrium under fairly plausible assumptions. Other studies, that have incorporated elastic labor supply in variants of endogenous growth models include Rebelo (1991) and Stokey and Rebelo (1995).

Chapter 3

ANALYTICAL FRAMEWORK

In this section we develop an analytical framework that helps to answer six questions.

1. How the economy reacts when a benevolent government chooses expenditure allocation policy between productivity enhancing expenditures and utility enhancing expenditures
2. What is the impact of these policies on production and growth rate of the economy
3. How voters select economic policy in Nash Equilibrium (Complete Convergence case)
4. How does labor supply react when public consumption services enter in the utility function of consumer in continuous time framework
5. Does growth rate of consumption converge to steady state
6. How growth rate of innovation drives the dynamic properties of the model.

The model is developed along the lines of Park and Philoppopoulaos[2] (2003). However contrary to their model this study assumes public expenditure composition policy as the only policy variable and composition of public expenditures is assumed to include utility enhancing expenditures and productivity enhancing expenditures.

There are private agents acting as consumers and producers and a government in a decentralized economy. The government acts selflessly in benevolent government equilibrium while in endogenous policy equilibrium politicians follow their self-interest. Their ultimate desire is to come into power and sustain their repute by adopting expenditure composition policy which is in

[2] In Park and Philoppopoulaos (2003) with public expenditure composition tax policy is also included in the model of benevolent government and individual voter equilibrium. Government expenditure composition includes productive, non productive and transfer payments. Their study gives insight for distributive issues in the economy. While in Park and Philoppopoulaos (2000) the only policy instrument is tax policy.

accord with the desires of voters. Hence the study in section two defines composition of public expenditures as a policy issue which is chosen by the voters through casting their votes for their most preferred policy. In section three initial capital endowments are different for each consumer. The government collects revenue by levying taxes on labor income, capital income and charges a consumption tax and a user fee to finance public production services.

In section 3.1 we find decentralized equilibrium where benevolent government selects the policy instruments of public expenditures including utility enhancing expenditures and productivity enhancing expenditures with inelastic labor supply. In the next section the voters are assumed to choose public expenditures composition policy. This section also derives steady state growth rate of consumption and innovation.

3.1 The Role of Economic Policy in Decentralized Equilibrium when Benevolent Government Chooses the Economic Policy with Inelastic Labor Supply

3.1.1 The Model

There can be two conditions for the formulation of public expenditure composition policy. Either the policy is endogenous or exogenous. When a policy is exogenous, as in the present case, the economy follows a static process because the model consists of stock variables only [Sargent (1987, chapters 1 and 3].

The government revenue is financed by $''\sigma''$ which is the tax on capital income because labor supply is inelastic there is no way to tax labor income[3].

$$\sigma r(t)k(t) = (T_k)$$

Where $0 \leq \sigma < 1$

3 The results in the study will be same even if we consider labor services. But if labor leisure choice is considered result will certainly change in our model. Detail of this issue is available in [park and philippooulos(1998) Alesina and Rodrcrik(1994)]. Public transfer payments are discussed in detail in paper of Benabou (1996). The question of how transfer turn into negative externalities is discussed in Atkison (1999)

The government plans to finance its expenditures through σ to allocate its expenditures between utility enhancing expenditures and productivity enhancing expenditures. Government productive services "G'' are considered as productivity enhancing while non-productive expenditures "E" are assumed to be utility enhancing expenditures. Furthermore we assume perfect foresight and a continuous time with infinite horizon. There is no population growth and no depreciation of capital.

$$\mathrm{G} + \mathrm{E} = \sum_{i=1}^{N} \sigma \mathrm{r}k \quad \ldots\ldots (1a)$$

$$\mathrm{G} = \mathrm{b} \sum_{i=1}^{N} \sigma \mathrm{r}k \ldots \quad .. \ (2a)$$

$$\mathrm{E} = (1 - \mathrm{b}) \sum_{i=1}^{N} \sigma \mathrm{r}k \quad \ldots . (3a)$$

Here "b" denotes share of public expenditure used to finance productivity enhancing expenditures while "1-b" denotes share of public expenditure used to finance utility enhancing expenditures of the government.

3.1.2 Consumer Problem

$$Max\ U \ = \int_{o}^{\infty} u(C(t), E)\, e^{-pt} dt \ldots \ldots (4a)$$

Turnovasky (2000) and Barro (1989) define public consumption services as providing direct utility to the consumers without altering their marginal utility of private consumption. Baxter and king (1993) define public consumption services as providing resources to the consumer without harming his private utility and input prices.

The budget constraint of household is:

$$\mathrm{C(t)+K} = (1 - \sigma)\mathrm{r(t)k(t)} + \pi \ldots \ldots (5\mathrm{a})$$

Where C denotes private consumption while "E" denotes public consumption. The utility function is assumed to fulfill Inada conditions: it is

increasing, concave and bounded[4] while the parameter "ρ" is time preference. Public goods are assumed to be pure public goods; there is no congestion issue on public consumption services and public production services.

The term $(1-\sigma)r(t)k(t)$ denotes after tax capital income and π denotes the profit share that household gets from capital. Hamiltonian method is used to solve maximum problem of consumer, which takes public goods and prices as given. Where consumption and capital stock are control variables. The first order condition can be derived and presented in the form of Euler equation.

$$\text{Max U} = \int_o^{\infty} u(C(t), E)e^{-\rho t}dt$$

$$U(C, E) = logc + qlogE \quad \ldots\ldots\ldots (5.1a)$$

Where "q" is a measure that evaluates the relative substitution of household preference for private and public consumption services.

$J = \int_o^{\infty} u(C, E)e^{-\rho t}dt + \boldsymbol{\lambda}[(1-\sigma)r(t)k(t)+\pi]$

$\frac{\partial J}{\partial C} = U'(C)e^{-\rho t} - \lambda = 0$…… *(a)*

Or

$\lambda = U'(C)e^{-\rho t}$

$\frac{\partial J}{\partial \lambda}=(1-\sigma)r(t)k(t)+\pi$…… *(b)*

$\frac{\partial J}{\partial k} = \boldsymbol{\lambda}[(1-\sigma)r(t)$

$\boldsymbol{\lambda}[(1-\sigma)r(t) = 0$

$\boldsymbol{\lambda_0} = \boldsymbol{\lambda_t}[(1-\sigma)r$……..…..(c)

By taking the derivative of above equations with respect to time

[4] The equation (5a) and (6a) describe that with transversality conditions the necessary conditions are also fulfilled. Hence we can find the unique solution of the underlying problem.

$$\frac{\partial V}{\partial t} = U''(C)e^{-\rho t} - \rho U'(C)e^{-\rho t} \ldots\ldots(d)$$

$$\frac{\partial V}{\partial t} = \boldsymbol{\lambda_0}$$

$$-\boldsymbol{\lambda_t}[(1-\ \sigma)\mathrm{r} = U''(C)e^{-\rho t} - \rho U'(C)e^{-\rho t}$$

$$-U'(C)e^{-\rho t}(1-\ \sigma)\mathrm{r} = e^{-\rho t}[U''(C) - \rho U'(C)]$$

$$-U'(C)(1-\ \sigma)\mathrm{r} = [U''(C) - \rho U'(C)]$$

$$(1-\ \sigma)\mathrm{r} = -\frac{U''(C)}{U'(C)} - \frac{\rho U'(C)}{U'(C)}$$

$$(1-\ \sigma)\mathrm{r} = \frac{1}{c^i} + \rho$$

$$c^{\cdot i} = c^i[1-\ \sigma)\mathrm{r}-p] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6a)$$

3.1.3 The production function

According to Alesina and Rodrick (1994) production function is in Cobb-Douglas form. Hence for a single firm the production function will take this form.

$$Y = \mathrm{G}^{1-\beta}\mathrm{K}^{\beta} \ldots\ldots(6.1a)$$

$0 < \beta < 1$ is a parameter, G is the productive expenditures of government while K is capital endowments of a single firm.

$$\pi = \mathrm{Y} - \mathrm{C}$$

By puting the value of Y in above equation we find first order condition for profit maximization

$$\pi = \mathrm{G}^{1-\beta}\mathrm{K}^{\beta} - \mathrm{rK}$$

$$\mathrm{r} = \beta\,\mathrm{K}^{\beta-1}\mathrm{G}^{1-\beta} \ldots\ldots\ldots(7a)$$

Here marginal product of capital is equal to rate of return

3.1.4 Feasible Economic Policy in Decentralized Equilibrium

Here the study assumes that the benevolent government chooses productive public expenditures. Hence decentralized equilibrium has been derived in terms of public expenditure share for productivity enhancing expenditures. Taking equation (2a) and using in (7a) we get return to capital in the presence of productive activities of government.

$$r = \beta \mathrm{K}^{\beta-1}(\mathrm{b}\sigma\mathrm{rk})^{1-\beta}$$

$$r = \beta \mathrm{K}^{\beta-1}\mathrm{K}^{1-\beta}(\mathrm{b}\sigma\mathrm{r})^{1-\beta}$$

$$\frac{\mathrm{r}}{\mathrm{r}^{1-\beta}} = \beta(\mathrm{b}\sigma)^{1-\beta}$$

Or $\mathrm{r} = \beta^{1/\beta}(\mathrm{b}\sigma)^{1-\beta/\beta} \equiv \Delta(\mathrm{b})$ ... ... (8a)

Where rate of interest determines the consumption and the saving decisions of consumer. When there are no externalities of the public production services these returns are lesser than the one in the presence of public expenditures.

Here due to productive externalities government productive expenditures affect the production function of the economy. For it increases knowledge and through learning by doing it causes spillover effects just as technological progress. Hence the returns in the presence of public productive expenditures are higher in the overall economy than the one perceived by the individual firms [Dixit and Stiglits(1977) and Romer (1990, 1987)].

Now putting the value of r from (8a) into (2a) and (3a) respectively—

$$G = b\sigma\Delta(b)k$$

$$G = b\sum_{i=1}^{n} \sigma\beta^{1/\beta}(\mathrm{b}\sigma)^{1-\beta/\beta}\,K$$

$$G = (\beta b\sigma)^{1/\beta}k \ldots \ldots \ldots (9a)$$

$$E = (1-b)\sigma\Delta(b)k \ldots \ldots (10a)\ or$$

$$E = (1-b)\sigma\beta^{1/\beta}(\mathrm{b}\sigma)^{1-\beta/\beta}\mathrm{k}$$

Now putting 9(a) into 6(b) we obtain:

$$Y = (\beta b\sigma)^{1-\beta/\beta}k \ldots\ldots(11a)$$

For calculating aggregate profit we need to look at how much capital is exhausted. Here realized profits and capital accumulation absorb total output. Where $y = RK + \pi$

$\frac{dY}{dK} = (\beta b\sigma)^{1-\beta/\beta}$ Hence the total profit is zero

$$\pi = 0 \ldots\ldots(11b)$$

3.1.5 A Brief Summary of this Section

In this section a decentralized equilibrium is derived. There is no profit for private producer because Rebolo AK model is incorporated hence according to (11a) since profit and capital accumulation is all exhausted for total output. Here $0 < \beta < 1$ while b is the share of revenue given to productivity enhancing expenditures and $\sigma > 0$ is the return for individual producer available for private consumption or saving.There is nothing left for profit or labor demands the results are similar with the finding of Barro and Sala-i-Martin (1995). This is the only optimal economic policy. These results are evident in this equilibrium.

Market clearing holds in equilibrium. Equations (9a) and (10a) show that budget constraint is satisfied while equation (5a), (6a) and (7a) show that in decentralized equilibrium utility of consumer is maximum and profit of producer is maximum. Hence private agents maximize the utility and profit of firm.

Preposition 1

When economic policy is exogenous, growth rate of the economy will increase at low tax rate. If productive expenditures are financed at by high tax rate growth rate will decline

$$\frac{\partial \mathrm{G}}{\partial \mathrm{b}} < 0 \; if \; 1 - \beta < \mathrm{b} < 1$$

$$\frac{\partial \mathrm{G}}{\partial \sigma} < 0 \; if \; 1 - \beta < \sigma < 1$$

$$\frac{\partial \mathrm{G}}{\partial \sigma} > 0 \; if \; 0 < \sigma \; < 1 - \beta < 1$$

$$\frac{\partial \mathrm{G}}{\partial \mathrm{b}} > 0 \; if \; 0 < b \; < 1 - \beta < 1$$

To derive the growth rate of the economy we put equation (8a) into (6a)

$$G = [(1-\sigma)\Delta(b) - \rho] \ldots\ldots \text{(12a)}$$

$$= \left[(1-\sigma)\beta^{1/\beta}(\mathrm{b}\sigma)^{1-\beta/\beta} - \rho\right]$$

$$\frac{dG}{db} = \beta^{1/\beta}(\mathrm{b}\sigma)^{1-\beta/\beta}\left[\frac{1-\sigma-b}{\beta b}\right] = \Delta(b)\left[\frac{1-\sigma-\beta}{\beta b}\right] \ldots\ldots\ldots\ldots \text{(13a) 0r}$$

$$\left[(1-b)\beta^{1/\beta}(\mathrm{b}\sigma)^{1-\beta/\beta} - \rho\right] = \Delta(b)\left[\frac{1-\sigma-b}{\beta b}\right] \ldots\ldots (14a)$$

The effect of Government productive activities on growth is positive. Here change in growth with respect to public productive activities will be greater than zero if the tax provision is greater than zero and less than one-----$\frac{\partial G}{\partial b} > 0 \; if \; 0 < \sigma < 1$

According to Barro (1990) when benevolent government chooses the economic policy at low taxes there will be increase growth rate with an increase in the productive expenditures of government.

3.2 Endogenous Public Expenditure Composition Policy and Politico-economic Equilibrium

3.2.1 A Game Theoretic Setting

In this section we develop a game-theoretic framework assuming a two party system in which voters choose economic policy of public expenditure composition. In the extreme case, the competition for votes is strong enough that two opposing parties come to a moderate policy choice 'full policy convergence'

just according to the choice of voters.[5] According to Down (1957) this assumption is only true when candidates always follow their decided policies for they have fear of losing reputation. The study assumes commitment equilibria, and does not take into account the one shot game where politicians involve in status quo in pre-election days.

The timing of the game is as follows:

1 The parties in government set policy of public expenditure composition according to the preferences of voter in period " t "

2 The household and production function react differently, exploring effect of economic policy in terms of welfare and long-run economic growth.

3 Game then repeats for period t+1.

We assume that expectations are made in time t, before the election regarding the policies of the representative parties. Suppose there are two parties, the expected policy of party A is ' m' and expected policy of B is 'n'. Furthermore when these expectations are made the outcome of elections uncertain to all agents in the model. The probability of part A will win is P, P(m,n) is a function of x and y and by supposition

When $m > n$

$$\frac{\partial \mathrm{P}}{\partial \mathrm{m}} < 0$$

$$\frac{\partial \mathrm{P}}{\partial \mathrm{n}} < 0$$

[5] More realistically, it can be assumed that candidates do not come on identical platform but choose moderate policy --- partial convergence [Wittman (1983), Calvert (1985).

These notations explain that more voters can be added when the policy of a party is in moderating position. Rational expectation is supposed all the way through.

Game is then repeated for period t+1.The efficient frontier is specified by

$m^* = n^* = \lambda c$

$$\lambda \in (0,1)$$

For concavity of preferences.

The explanation is that both parties are certain about fair bet and prefer a moderate policy.

There can be the possibility of three Nash equilibriums:

- Complete convergence

  $m^* = n^* = \lambda c$

- Partial convergence

  $0 \leq m^* \leq n^* \leq c$

- Complete divergence

  $m^* = c$

  $n^* = 0$

Complete Convergence

$$\boldsymbol{m^* = n^* = \lambda c}$$

In this study we consider only the case of complete convergence, where on efficient frontier moderate policy is chose which in a sense narrates that implicitly voters are choosing economic policy. We assume that the allocation of

government expenditures is between utility enhancing expenditures and productivity enhancing expenditures, and this is decided indirectly by voters because political candidate is concerned about maintaining his reputation.

3.2.2 Assumptions of the Model

The economy is assumed to consist of identical individuals 'N'. Population is assumed to be fixed over time. Representative individual chooses optimal consumption path which is further divided into private consumption and government provided consumption good. According to Devarajan et al. (1996) public expenditures composition between productive and non-productive expenditures can have different implications for growth rate of the economy. Kneller et al. (1999) have similar findings. In a politico-economic model the impact of composition of public expenditures on economic growth has been studied by Persson and Tabellini (1994).

In the following a dynamic general equilibrium is set up where public expenditures are financed through tax on capital. Rational voters choose the allocation of revenue between productive and non- productive expenditures.

3.2.3 The Economic Rational of Economic Policy when Voters Play Nash with each other to Maximize their Own Utility

The first property of such policy is we can find transitional dynamics since it also includes non-productive or utility enhancing expenditures which changes over time so the model can enrich the existing fiscal policy[6] models which say fiscal policy does not have transitional dynamics. Second property is since government taxes capital to finance its expenditures, if output of productivity enhancing expenditures is higher than growth of tax rate, the economy can afford to lower the tax rate which is good for the growth. Furthermore since government expenditure composition is between utility enhancing and productivity enhancing

[6] For details of existing fiscal policy models see Barro (1990) and Barro and Sala-i-Martin (1992

expenditures the policy instrument of public expenditure allocation should be higher than the production sector of the economy.

3.2.4 Consumer Problem

The voters play with each maximizing their own utility taking others' as given, giving rise to Nash Equilibrium. Equation (4a) and (5b) subject to optimal decision rule in decentralized equilibrium (5a) and (6a) in combination with (8a) and (11b) while the motion of public good here as in decentralized equilibrium is (9a) and (10a). Hence the Hamiltonian of the ith voter is

$$H = [\, C, E[(1-b)\Delta(b)k] \ldots\ldots\ldots (1b)$$

Where we assume utility enhancing expenditures are $\sigma(1-\mathrm{b})\mathrm{Y}$ where $\mathrm{Y} = \mathrm{G}^{1-\beta}\mathrm{K}^{\beta}$ Hence $\mathrm{UE} = \sigma(1-\mathrm{b})\mathrm{G}^{1-\beta}\mathrm{K}^{\beta}$ while productivity enhancing expenditures are $\mathrm{PE} = \sigma(\mathrm{b})\mathrm{G}^{1-\beta}\mathrm{K}^{\beta}$

$$H = \log c + qlogE + \delta(\mathrm{c}) + \gamma(\mathrm{k}) \ldots\ldots\ldots (2b)$$

$$\delta_1(\mathrm{C}) + \delta_2(\mathrm{UE}) = \delta(\mathrm{c}) \ldots\ldots\ldots (3b)$$

$$\gamma_1(\mathrm{K}) + \gamma_2(\mathrm{PE}) = \gamma(k) \ldots\ldots\ldots (4b)$$

where for simplicity we assume consumption includes both kinds of consumption (private and public) while capital accumulation includes both kind of consumptions (private and public)

$$H = \log c + qlog\big((1-b)\Delta(b)k\big) + \delta c^{\cdot i}\big((1-\sigma)\Delta(b) - \rho\big) + \gamma(\,(1 - \sigma)\Delta(b)\mathrm{k(t)}$$

The first order conditions are-------

$$\frac{E\sigma K(1-b)\Delta_b(b) - \Delta(b)k}{(1-b)\sigma\Delta(b)k} + \big(\delta c^{\cdot i} + \gamma k\big)(1-b)\Delta_b(b) \ldots\ldots\ldots (5b)$$

$$c = c^{.i}\big((1-\sigma)\Delta(b) - \rho\big) \dots\dots\dots (6b)$$

$$\delta = \rho\delta - \frac{1}{c} - \delta\big((1-\sigma)\Delta(b) - \rho\big) + \gamma \dots\dots\dots\dots (7b)$$

$$k = (1 - \sigma)\Delta(b)\mathrm{k(t)} - \mathrm{c}) \dots (8\mathrm{b})$$

$$\gamma = \rho\gamma - \frac{E\sigma(1-b)\Delta(b) - \Delta(b)k}{(1-b)\sigma\Delta(b)k} - \gamma[(1 - \sigma)\Delta(b)\mathrm{k(t)}] \dots\dots (9b)$$

$$(1-\sigma)\Delta(b) - \rho < \rho \dots\dots\dots (10b)$$

Equation (10b) satisfies the transversality condition with bounded utility.

Here $1-\beta$ is the public expenditure on the production sector of the economy. When there are more production expenditures growth will be higher through spill over effect but government is also financing non-productive expenditures hence Equation (2a) implies that $(1-\beta-\sigma) > 1$ which means that to increase the growth rate a higher tax is downward sloping. It will have more distortionary impacts. Furthermore when E=0 it means $1-\beta = \sigma$

$1-\beta-\sigma = 0$ which means when public consumption services are not providing any utility to consumers it is optimal to not spend any money on it rather all money should be spent on the productive expenditures of government. The findings of the study are similar with Barro (1990) [7]

3.2.5 Findings of Endogenous Policy

Equations from (5b) to (10b) necessitate the following five properties of public expenditures policy. Firstly Eq. (5b) entails $(1-\beta-\mathrm{b}) < 0$. Hence the optimal share for productivity enhancing expenditures is between the subset$0 < 1-\beta < \mathrm{b} < 1$. Here in this set up the tax rate is higher than 1- β which is the

[7] Barro and Sala-i-Martin (1995) show similar finding that all consumption expenditures of government are non-productive.

efficiency of productivity enhancing public expenditures in the production function. Tax rate is higher than earlier because here government has also to provide the utility enhancing expenditures to the consumers. Hence the provision of public expenditures will not be optimal when the following situation holds $0 < b < 1 - \beta$.

Secondly in the special case when utility enhancing expenditures provide no utility q=0 equation (5b) implies b=$1 - \beta$ here the results are just similar to Barro (1990) who argues that optimal tax rate should be equal to the productive services of government. Hence government productive services are constant over time, so it will be optimal for government to allocate all revenue on the productivity enhancing expenditures alone because consumer is not getting any utility from utility enhancing expenditures. Thirdly when utility enhancing expenditures provide no utility (q=0) there will be a constant b and constant capital return. Fourthly when utility enhancing expenditures are zero equation (6b) implies there will be no transitional dynamics and the economy will immediately return to its balanced growth path or steady state. Fifthly when both of public expenditures are not providing any utility or productivity then $\beta = 1$ and long run equilibrium is not optimal.

3.3 Transitional Dynamics of Utility Enhancing Expenditures

According to Devereux and Wen (1998) government consumption services provide direct utility to household which changes over time. For it is not considered as stock variable rather as a flow variable. So it is not static rather changes over time. Hence we can find the transitional dynamics of public consumption expenditures.

$$\frac{G}{G} = \frac{G_C}{G} + \frac{G_P}{G}$$

$$\hat{G_c} + \hat{G_P}$$

G_C = utility enhancing expenditures

G_P = productivity enhancing expenditures

$$G_C = UE$$

$$G_P = PE$$

$$1 = UE + PE$$

Or

$$1 - PE = UE$$

The government collects revenue to finance UE + PE, by levying a tax on capital, labor income and usage of productive expenditure spending. We assume that there is no congestion issue hence UE is pure public good. Furthermore we assume no debt financing of government spending and fixed government budget.

$$T\ (0 < T < 1)$$

$$UE + PE = TY$$

$\phi\ (1 - \phi)$ is the share of Public expenditure allocated to PE

$$PE = \phi\, TY$$

$$UE = (1 - \phi)\, TY$$

$$U = \int_o^\infty \frac{C^{1-\sigma}}{1-\sigma} e^{-pt} dt$$

The welfare of the representative individual is denoted by isoelastic utility function.

$$U = \int_o^\infty (c^{1-\sigma}, N^{1-\theta}, (1 - l(t))^{1-\eta})$$

Where C denotes private consumption denotes utility enhancing expenditures, and "$(1-l)$" describes labor supply. The parameters σ, θ and η measure the impact of consumption, utility enhancing expenditures and of labor supply on the welfare of the consumer. We assume that all three provide positive utility to the consumer.

$$N = f(UE)$$

$$U = \int_o^{\infty} \frac{C^{1-\sigma}}{1-\sigma}\left(1-l(t)\right)^{1-\eta}(1-PE)_{e\ pt}^{1-\theta}$$

$$0 \leq l \leq 1$$

For strict concavity we impose some restrictions.

$\sigma > 1-\eta > 0$ Which denotes the inverse of the intertemporal elasticity of substitution in consumption and elasticity of labor supply respectively? The consumer has a limited time that can be allocated between leisure, l, and work 1-l, [0 <l< 1]. Both types of consumptions are financed by labor income. Hence the more consumer supplies labor the more will be his take home income. The government allocates its budget between productive government expenditures and public consumption.

Where $1-\theta > 0$ is the elasticity of government expenditures composition between UE and PE.

Budget Constraint that the household faces is….

$$^{\circ}K(t) = (1-T_w)\,w(t)\,l(t) + (1-T_k)r(t)K(t)$$

$$-(1+T_c)C(t) - (1+T_{PE})PE$$

Where w,r,c[8] and PE represents real wage rate, the interest rate ,consumption and productivity enhancing expenditures.*where the variables* T_w , T_k ,

[8] Note that the utility function has the same functional form as in Haruyama and Itaya (2005).

T_c , T_{PE} Explain tax rate on real wage,tax on capital, tax on consumption and tax on PE respectively.

Maximization Problem;

$$\mathcal{L} = \frac{C^{1-\sigma}}{1-\sigma}(1 - l(t)^{1-\eta}\big(1 - PE(t)\big)^{1-\theta}_{\text{ϱ−pt}_{\text{dt}}}$$

$$+ \lambda\,[K^{\circ} - (1 - Tw)\,W(t)\,l(t) - (1 - T_k)$$

$$\gamma_t K(t) + (1 + T_c)C(t) + (1 + T_{PE})PE(t)$$

The intertemporal utility maximization of the household which chooses consumption, labor supply and preference for utility enhancing expenditures involves the first order condition.

3.3.1 First Order Condition with respect to Consumption

$$C_{(t)}^{-\sigma}(1 - l(t))^{1-\eta}(1 - PE)^{1-\theta}$$

$$\lambda\,(1 + T_c) = 0$$

$$C_{(t)}^{-\sigma}(1 - l(t)^{1-\eta}(1 - PE)^{1-\theta} = \lambda\,(1 + T_c) \qquad (1c)$$

Where λ denotes shadow price. The above shows that consumption is affected negatively by taxes on consumption goods.

3.3.2 First order Condition with respect to Labor Supply

$$\frac{C_{(t)}{}^{1-\sigma}}{1-\sigma}(1 - l(t)^{-\eta}(-1)\ \ (1 - \eta)(1 - \mathrm{PE(t)}^{1-\theta}$$

$$+\lambda\,(1 + T_w)w(t) = 0$$

Multiplying by -1 on both sides

$$\frac{C^{1-\sigma}}{1-\sigma}(1 - \eta)(1 - l(t)^{-\eta}(1 - PE)^{1-\theta} = \lambda\,(1 + T_w)W_t \qquad (2c)$$

Taxes on wage rate have distortionary effect as it reduces take home wage and directly influences the labor supply decision. However, depending on the relative importance of substitution and income effects, tax on income leads to a rise (or fall) in the time spent on leisure activities, which in turn increases (reduces) the size of the negative effect on growth. The same is true if only labor income is taxed. However, contrary to the case without a labor-leisure choice, a tax on capital income may have a positive effect on the long-run growth rate. This occurs mainly when the elasticity of intertemporal substitution is small, since in that case the income effect tis (relatively) strong, implying that agents tend to work more and/or invest more time in human capital accumulation - the main engine of growth – in response to an increase in the tax rate. This reduction in leisure time then is reinforced as, compared to a tax on income, a tax on capital income induces more time spent on production and human capital accumulation, because labor (time) is not taxed.

3.*3.3 First order condition with respect to productivity enhancing expenditures*

$$\frac{C^{1-\sigma}}{1-\sigma}(1-l(t)^{1-\eta}(1-\theta)(1-PE)^{-\theta}+\lambda\,(1+T_{PE})\,PE=0$$

$$\frac{C^{1-\sigma}}{1-\sigma}(1-l(t)^{1-\eta}(1-\theta)(1-PE)^{-\theta}=\lambda\,(1+T_{PE})\,PE \ldots\ldots\ldots\ldots(3c)$$

To achieve the balanced growth path the government should allocate its revenue for utility enhancing expenditures by leving more tax on productivity enhancing expenditures.Productivty enhancing expenditure will be higher when taxes or user fee is higher as more revenue will be available which in turn will increase the externality of productive expenditure. Hence increase in productivity can give an economy more finances to allocate more of utility enhancing expenditures. Hence growing economies can afford more utility enhancing expenditures while non-growing economies cannot afford higher public consumption services. This gives an important finding that in a more “socialist” economies there will be more public consumption services, and to achieve that it

will focus more on growth-promoting policies. In such economies the policies will be formulated that will increase investment. On the other hand if there are strong preferences of utitly enhancing expenditures, the government will increase taxes to finance public consumption so much that will create distortions. The more the policy makers give consideration to increase public consumption lesser will be growth.

w. r. t k

Applying current value Hamiltonion

State Variable = K

State Variable = λ

State Variable = °K

$\frac{dk}{dk^{\circ}} = (1 - T_k)\gamma\lambda$ *(i)*

$\frac{dk}{dk^{\circ}} = P\lambda - \lambda^{\circ} = 0$ *(ii)*

(i) = (ii)

$(1 - T)_k\, \gamma(t) = P\lambda - \lambda^{\circ}$

$\lambda^{\circ} - P\lambda = -(1 - T)_k\, \gamma(t)\, \lambda \ldots\ldots\ldots\ldots (iii)$

3.3.4 Transversality Condition

$\varrho^{-pt} \lambda\, k(t) = 0$

Time derivative of (1)

$c^{-\sigma}(1 - \ell(t))^{1-\eta}(1 - PE)^{1-\theta} = \lambda(1 + T_c)$

$-\sigma\ \log c(t) + (1 - \eta)\ \log(1 - \ell(t)) + (1 - \theta)\ \log(1 - PE) = \lambda \log + \log(1 + \mathrm{T_c})$

$-\sigma\ \frac{c^{\circ}(t)}{c(t)} + (1 - \eta)\frac{-\ell^{\circ}}{1-\ell(t)} + (1 - \theta)\frac{(1-PE)^{\circ}}{(1-PE)} = \frac{\lambda^{\circ}}{\lambda}$ ..... *(iv)*

Substituting *(iii)*

$$\lambda^{\circ} - \rho\lambda = -(1 - T)_k\, \gamma(t)\lambda$$

Multiplying by λ on both sides

$$\frac{\lambda^{\circ}}{\lambda} - \rho\frac{\lambda}{\lambda} = \frac{-(1 - T_k)\, \gamma(t)\lambda}{\lambda}$$

$$\frac{\lambda}{\lambda} = (1 - T_k)\, \gamma(t) - \rho$$

This shows that growth is negatively affected by capital income tax while all other forms of taxes have indirect negative effects on growth.

Substituting in (iv)

$$-\sigma\, \frac{c^{\circ}(t)}{c(t)} + (1 - \eta)\frac{-\ell^{\circ}}{1 - \ell(t)} + (1 - \theta)\frac{(1 - PE)^{\circ}}{(1 - PE)}$$
$$= (1 - T_k)\, r(t) - \rho \ldots \ldots . (x)$$

Taking log and time derivate of equation (3c)

$$\frac{C^{1-\sigma}}{1 - \sigma}\big(1 - \ell(t)\big)^{1-\eta}(1 - \theta)(1 - PE)^{-\theta}$$

$$1 - \sigma\ \log c(t) \log(1 - \sigma)$$
$$+ (1 - \eta)\log(1 - \ell) - \ \theta\ \log(1 - PE) + \log(1 - \theta)$$
$$= \ \lambda\ \log + \log(1 - T_{PE})$$

$$(1 - \sigma)\, \frac{^{\circ}C(t)}{c(t)} + \frac{(1 - \eta)\ (-1)\ \ell^{\circ}}{1 - \ell(t)} + \log(1 - \theta)$$

$$-\theta\frac{(1 - PE)^{\circ}}{(1 - PE} = \frac{\lambda^{\circ}}{\lambda}$$

$$(1 - \sigma)\frac{^{\circ}C(t)}{c(t)} + \frac{(1 - \eta)\ (-1)\ \ell^{\circ}}{1 - \ell(t)} - \frac{\theta(1 - PE)^{\circ}}{(1 - PE)}$$

$$= (1 - T_k)\,\gamma - \rho$$

$$-(1-\sigma)\frac{c^{\circ}}{c} + (1-\eta)\frac{\ell^{\circ}}{(1-\ell)} - \theta\frac{(1-PE)^{\circ}}{(1-PE)}$$
$$= (1 - T_k)\,\gamma_t - \rho \ldots\ldots (y)$$

3.3.5 MR's Between Consumption and Leisure

$$\frac{C^{1-\sigma}}{1-\sigma}(1-\eta)\big(1-\ell(t)\big)^{-\eta}(1-PE)^{1-\theta}$$

$$c^{-\sigma}\big(1-\ell(t)\big)^{1-\eta}(1-PE)^{1-\theta}$$

$$= \frac{\lambda(t)(1-T_w)\,w(t)}{\lambda(t)(1-T_c)}$$

$$c^{1-\sigma+\sigma}(1-\eta)(1-\ell)^{-\eta-1+\eta}$$

$$\frac{c(t)}{1-\sigma}\frac{(1-\eta)}{(1-\ell(t))} = \frac{1-T_w}{1+T_c}w(t)$$

$$\frac{c(t)}{1-\sigma}\frac{(1-\eta)}{(1-\ell(t))} = \frac{1-T_w}{1+T_c}w(t)$$

$$\frac{(1-\eta)}{\big(1-\ell(t)\big)}\frac{c(t)}{1-\sigma} = \frac{1-T_w}{1+T_c}\,w(t) \ldots\ldots (4c)$$

This equation explains that at each point in time the MRS between leisure and consumption be equated with consumption tax and tax rate and real wage rate. A raise in the taxes on labor income will induce the substitution from consumption to leisure because it causes a decline in take home wage that would have bad implications for growth. Tax on consumption have same implications; it will increase after tax price of consumption the opportunity cost of leisure will decline causing distortionary effect on labor supply.

3.3.6 MR's between Consumption and PE

$$\frac{C(t)^{1-\sigma+\sigma}}{1-\sigma}\frac{\left(1-\ell(t)\right)^{1-\eta}(1-\theta)(1-PE)^{-\theta}}{\left(1-\ell(t)\right)^{1-\eta}(1-PE)^{1-\theta}}=\frac{\lambda(1+T_{PE})^{PE}}{\lambda(1+T_c)}$$

$$\frac{C(t)}{1-\sigma}(1-\theta)(1-PE)^{-\theta+1+\theta}=\frac{(1+T_{PE})}{(1+T_c)}PE$$

$$\frac{\mathrm{C(t)}}{\frac{1-\mathrm{PE}}{1-\sigma}}(1-\theta)=\frac{(1+\mathrm{T_{PE}})}{(1+\mathrm{T_c})}\mathrm{PE}\ldots\ldots\ (5\mathrm{c})$$

This equation shows that at each point in time the MRS between consumption and utility enhancing expenditures must be equated with the productivity enhancing expenditures adjusted for consumption and utility enhancing expenditures. With an increase in after tax price of consumption and substitution from private consumption to utility enhancing expenditures there will need of higher tax rate on productivity enhancing expenditures and a higher consumption tax .But at the same time an increase in tax rate on PE increases the tax base but decreases the demand for public consumption because now it becomes expensive.

3.3.7 MR's between PE and ℓ

$$\frac{\frac{C^{1-\sigma}}{1-\sigma}\frac{(1-\eta)\left(1-\ell(t)\right)^{-\eta}(1-PE)^{1-\theta}}{\left(1-\ell(t)\right)^{1-\eta}(1-\theta)(1-PE)^{-\theta}}}{\frac{C^{1-\sigma}}{1-\sigma}}$$

$$=\frac{\lambda(1-T_w)\,wt}{\lambda(1+T_{PE})\,PE}$$

$$\frac{(1-PE)}{(1-\ell(t))}\frac{(1-\eta)}{(1-\theta)}=\frac{(1-T_w)\,wt}{(1+T_{PE})\,PE}\ \ldots\ldots\ldots\ldots\ldots(6c)$$

This equation depicts that marginal rate of substitution between utility enhancing expenditures and leisure should be equated to the real wage rate and provision of productivity enhancing expenditures adjusted for the wage tax and PE tax at each point in time. A higher labor income tax will create a disincentive to work. Similarly a higher tax rate on PE will make provision of UE difficult

because it will create a disincentive for growth led activities resulting in lesser revenue available for the provision of public consumption activities. An increase in wage tax however will increase UE for according to shopping time model social benefits are measured as a percentage of wage rate; when wage rate increases social benefits increase as well. Furthermore increase in PE will increase leisure for productivity enhancing expenditures will increase entrepreneurial activities, innovations and growth that will enhance return on labor supply. The most interesting finding is that when tax rate on wage rate increases it leads to a decline in take home wage hence demand for private consumption goes down with lesser labor supply while demand for UE increases with adverse effect on growth.

3.3.8 The Technology

Assumptions

We assume three production sectors in the economy. There is perfect competition in all sectors, but monopoly prevails in the intermediate production sector. Our economy in the model is a closed one. The population is taken as constant. Assume final output Y is produced using cobb-douglas form. According to Alesina and Rodrick (1994) Barro and sala-i-Martin (1995) technology takes Cobb Douglas form at firm level and.

The Budget constraint of government is

$$G(t) = T_w w(t) l(t) + T_c c(t) + T_k r(t) k(t)$$

We have extended the model of Zeng and Due (2003) and assume that unlike their model production of final good depends on intermediate good and labor supply [Park and Philippopoulas (2000)]

$$\mathrm{y(t)} = \mathrm{l}^{1-\infty} \int_{\circ}^{\infty(\mathrm{t})} \mathrm{Vi\,(t)}^{\infty} \mathrm{di} \;\; 0 < \infty < 1 \ldots\ldots\ldots\ldots (a)$$

Where $''\infty''$ expresses the part of intermediate good in the production of final good.

Where y is final output. Vi is intermediate capital good and l denotes labor supply.

$$w = MPC$$

$$(t) = (1 - \infty) l^{1-\infty-1} \int_{0}^{\infty(t)} vi^{\infty}\, di$$

$$p = (1 - \infty) l^{-\infty} \int_{\circ}^{\infty(t)} vi^{\infty}\, di$$

Multiplying and dividing RHS by ℓ

$$w(t) = \frac{(1 - \infty) l^{1-\infty}}{l} \int_{\circ}^{\infty(t)} vi^{\infty}\, di$$

There are different numbers of intermediate goods that are produced with the help of technological progress. Firm maximizes the profit where it is meeting its first order conditions.

$$= \frac{(1 - \infty) l^{1-\infty} \int_{\circ}^{\infty(t)} vi^{\infty}}{l(t)}$$

$$l^{1-\infty} \int_{\circ}^{\infty(t)} vi^{\infty} = Yt$$

$$P(t) = (1 - \infty) \frac{Y_t}{l_{(t)}} \qquad (7c)$$

Here P represents the Price of intermediate good that is being charged as rental price.

Derivative w.r.t vi

$$pi = l^{1-\infty} \infty vi^{\infty-1}$$

pi = $l^{1-\infty} \infty vi^{\infty-1}$ ..... (8c)

$$Intermediate\ capital\ goods$$

$$\pi = pi - r(t)vi$$

$$\pi = pi\ - r(t)vi\ \ \ldots\ldots\ \ (9c)$$

In intermediate goods sector monopoly prevails and each producer is producing according to his access to the new technology and innovation. Each producer takes Equation (8c) as the demand function and using capital as the only input maximizing his monopoly profit [Equation (9c)]

$$Now\ pick\ equation\ (8c)$$

$$pi = \ \infty\ l^{1-\infty} vi(t)^{\infty-1} \ldots\ldots b$$

$$Rearrange\ equation\ (8c)$$

$$(vi^{\infty-1}) = (\frac{pi}{\infty l^{1-\infty}})$$

$$Multilying\ both\ side\ of\ eqation\ (8c) by\ \frac{1}{\infty-1}$$

$$(vi^{\infty-1})^{\frac{1}{\infty-1}} = (\ \frac{pi}{\infty l^{1-\infty}})^{\frac{1}{\infty-1}}$$

$$vi = \frac{(pi^{\frac{1}{\infty-1}})}{(\infty l^{1-\infty})^{\frac{1}{\infty-1}}}$$

$$simplifying\ the\ equation$$

$$vi = \frac{pi^{1-\infty}}{(\infty l^{1-\infty})^{1-\infty}} \ldots\ldots\ldots\ldots (10c)$$

$$Now\ put\ the\ value\ of\ Pi\ from\ eqation\ (8c) into\ eqation\ (9c)$$

$$\overline{vi} = \infty l^{1-\infty} vi^{\infty-1} - rvi$$

$$= \infty l^{1-\infty} vi^{\infty-1+1} - rvi$$

$$\overline{vi} = \infty l^{1-\infty} vi^{\infty} - rvi$$

$$Now\ take\ derivative\ with\ respect\ to\ vi$$

$$\infty l^{1-\infty} \infty vi^{\infty-1} - r = 0$$

$$\infty . \infty l^{1-\infty} vi^{\infty-1} - rt$$

$$Put\ the\ value\ of\ pi\ from\ equation\ (8c)$$

$$\infty pi = r(t)$$

$$\overline{p} = pi = \frac{rt}{\infty} \qquad (11c)$$

$$Now\ put\ (11c)\ in\ (9c)\ \pi = pi\ - r(t)vi$$

$$= \frac{rt}{\infty} - r(t)vi$$

$$= \frac{rt}{\infty} - \infty r(t)vi$$

$$\overline{\pi} = \frac{(1-\infty)}{\infty} r(t)vi \qquad (12c)$$

In (12c)the parameter ∞ inversely represents the monopoly power of the owner of the intermediate good.

3.3.9 Research and Development

Here we assume; with a one unit of Q or final good $\frac{1}{\Psi}$ unitsof intermidiate good are poduced

$$m(t) = \frac{Q(t)}{\Psi} \dots\dots (13c)$$

Here perfect compitition prevails anyone can get the knowledge Ψ. There is no monopoly here.Any producer who wants to avail the new technology can do so by freely entering in R and D market. There is a specific net present value of return Ψ for each producer who discovers new technology or design.

$$s(t) = \Psi \qquad (14c)$$

$$rt = \frac{\pi(t)}{S(t)} + \frac{S^{\circ}(t)}{S(t)} \qquad (15c)$$

Now put the equations (12c) and (13c) in (15c)

$$rt = \frac{\frac{1-\infty}{\infty}\, r(t)\, vi}{\Psi} + \frac{\Psi^{\circ}}{\Psi^{\circ}}$$

$$rt = \frac{\frac{1-\infty}{\infty}\, r(t) vi}{\Psi} + 0$$

$$\Psi = \frac{1-\infty}{\infty} vi$$

$$\frac{\Psi\infty}{1-\infty} = vi$$

$$vi = \frac{\infty\Psi}{(1-\infty)} = \overline{vi} \ldots\ldots\ldots (16c)$$

Each producer who is carrying a new design in intermediate goods market is charging a price s(t).As there is a price related to each intermediate goods.(16c)implies that vi or intermediate capital good is independently set for all firms and same for all producers of the firms.

3.*3.10 Equilibrium of the system*

The assumption here is perfect foresight and zero depreciation. Capital stock is equal to physical stock here.

$k(t) = \int_0^{\infty(t)} vi(t)di = mvi \ldots . (17c)$

$$\frac{k^0}{k} = \frac{m^0}{m}$$

$$y(t) = l(t)^{1-\infty} \int_0^{\infty(t)} vi^{\infty} di \ \ldots . . (a)$$

$$w(t) = 1 - \infty \frac{y(t)}{l(t)} \ldots\ldots (7c)$$

$$\frac{\infty}{1-\infty}\Psi = vi \ldots . (16c)$$

$$by\ puting\ (a) into\ (7c)$$

$$w(t) = \frac{1-\infty}{l(t)} l(t)^{1-\infty} \int_0^{\infty(t)} vi^{\infty} di$$

$$(1-\infty)n(t)l(t)^{-\infty} vi^{\infty}$$

$$w(t) = (1-\infty)n(t)(\frac{vi}{l})^{\infty} \ldots\ldots (18c)$$

$$Now\ put\ (18c) into\ (3c)$$

$$consumption\ of\ private\ good\ to\ capital\ ratio$$

$$\frac{(1-\eta)}{1-\sigma} \frac{c(t)}{\big(1-\ell(t)\big)} = \frac{1-T_w}{1+T_c} (1-\infty)m(t)(\frac{vi}{l})^{\infty}$$

$$\frac{c(t)}{m(t)} = \frac{1-T_w(1-\infty)1-\sigma}{1+T_c(1-\eta)} \frac{vi^{\infty}\big(1-\ell(t)\big)}{l(t)^{\infty}}$$

Preposition 1

If there is higher labor supply a higher private consumption can be achived. Consumption cannot be higher than the labor supply $\eta > 1, \sigma > 1$. If $\eta < 1, \sigma > 1$ the system will be unstable. Hence only in the presence of higher labor supply the economy can afford more consumption.

And soΔ_1 is a constant.

$$\Delta_1 = \frac{1-T_w(1-\infty)1-\sigma vi^{\infty}}{1+T_c(1-\eta)} > 0$$

Now …..

$$\frac{c(t)}{m(t)} = \Delta_1 \frac{\big(1-\ell(t)\big)}{l(t)^{\infty}} \ldots. (19c)$$

$$now\ put\ (18c) into\ (6c)$$

$$\frac{(1-PE)}{(1-\ell(t))}\frac{(1-\eta)}{(1-\theta)} = \frac{(1-T_w)\,wt}{(1+T_{PE})\,PE} \quad \ldots\ldots\ldots\ldots(6c)$$

$$\frac{(1-PE)}{\big(1-\ell(t)\big)}\frac{(1-\eta)}{(1-\theta)} = \frac{(1-T_w)\,(1-\infty)m(t)}{(1+T_{PE})\,PE}\left(\frac{vi}{li}\right)^{\infty}$$

$$\frac{1-PE}{m(t)} = \frac{(1-T_w)\,(1-\theta)(1-\infty)vi^{\infty}}{(1+T_{PE})\,PE(1-\eta)}\frac{\big(1-\ell(t)\big)}{l(t)^{\infty}}$$

Preposition 2

If there is higher labor supply the provision of public services is higher. If provision of labor supply is less than the provision of public expenditures the system is unstable. Public expenditures without growth or employment can make balanced growth path determinate

$\boldsymbol{\eta} > 1, \theta > 1$**……for stability of system**

$$\boldsymbol{\eta} > 1, \sigma > 1 \ldots\ldots system\ will\ be\ unstable$$

Hence $\frac{(\mathbf{1}-\boldsymbol{\theta})(\mathbf{1}-\infty)}{(\mathbf{1}-\boldsymbol{\eta})} > 0$ **is a constant as explained in equation (20c)**

$$\frac{\mathbf{1-PE}}{\mathbf{m(t)}} = \Delta_{\mathbf{2}}\frac{\big(\mathbf{1}-\boldsymbol{\ell}(\mathbf{t})\big)}{\boldsymbol{l}(\mathbf{t})^{\infty}} > 0 \ldots..(20c)$$

<u>Clearing condition for final good</u>

$$K^0 = Y(t) - Q(t) - C - (1-PE)(t) \ldots..(21c)$$

$$y(t) = l(t)^{1-\infty}\int_0^{\infty(t)} vi^{\infty}di \ \ldots..(a)$$

$$m(t) = \frac{Q(t)}{\Psi} \ldots\ldots (13) or Q(t) = \Psi m(t)$$

$$put\ (a) and\ (13c) into\ (21c)$$

$$K^0 = -l(t)^{1-\infty} \int_0^{\infty(t)} vi^{\infty} di\ - \Psi m(t) - C - (1 - PE)(t) \ldots . (22c)$$

$$\frac{m^0}{m} vi = l(t)^{1-\infty} vi^{\infty} - \frac{m^0}{m} \Psi - \frac{c(t)}{m} - \frac{(1 - PE)(t)}{m(t)}$$

$$A(t)vi + A(t)\Psi = \frac{1}{(vi + \Psi)}$$

$$A(t)(vi + \Psi) = \frac{1}{(vi - \Psi)}$$

$$= \frac{1}{(vi + \Psi)} \left[l(t)^{1-\infty} vi^{\infty} - \frac{c(t)}{m} - \frac{(1 - PE)(t)}{m(t)} \right] \ldots . . (23c)$$

$$put\ the\ values\ from\ (19c) and\ (20c) into\ (23c)$$

Preposition 3

Regardless of whether the economy is in steady state or not equation (24c) must hold for it is basic condition for technology……$A(l), \frac{A(l)}{l} > 0$ that is the labor supply should always be positive for the production sector of economy.

$$A(t) = \frac{1}{(vi + \Psi)} \left[l(t)^{1-\infty} vi^{\infty} - \Delta_1 \frac{\left(1 - \ell(t)\right)}{l(t)^{\infty}} - \Delta_2 \frac{\left(1 - \ell(t)\right)}{l(t)^{\infty}} \right] \ldots\ldots (24c)$$

The Dynamic motion of the model needs the derivation of demand function so Now take equation (b)

$$pi = \infty l^{1-\infty} vi(t)^{\infty-1}$$

$$Now\ take\ equation\ (11c)$$

$$\overline{p} = pi = \frac{rt}{\infty}$$

$$Now\ equate\ to\ derive\ demand\ function$$

$$\infty l^{1-\infty} vi(t)^{\infty-1} = \frac{rt}{\infty}$$

$$r(t) = \infty^2 \left(\frac{l}{v}\right)^{1-\infty} = r(l) \ldots\ldots (25c)\ where\ \frac{dr}{dl} > 0$$

Where demand function of capital for a producer is decreasing in renatl prices for capital goods.

Mathematical operation; to drive Steady state growth rate of consumption

$$Now\ take\ equation\ (19c) and\ take\ its \log and\ time\ derivative$$

$$\frac{c(t)}{m(t)} = \Delta_1 \frac{(1-\ell(t))}{l(t)^{\infty}} \ldots (19c)$$

$$\frac{C(t)^0}{C(t)} = \frac{l(t)}{(1-l(t)} - \frac{\infty l(t)^0}{l} + \frac{m(t)}{m(t)} \ldots\ldots (26c)$$

$$\sigma \left[\frac{l(t)}{(1-l(t)} - \frac{\infty l(t)^0}{l} + \frac{m(t)}{m(t)}\right] + (1-\eta)\frac{\ell^{\circ}}{1-\ell(t)} - (1-\theta)\frac{(1-PE)^{\circ}}{(1-PE)} =$$

$$(1-T_k)\, r(t) - \rho \ldots (27)$$

$$Now\ take \log and\ time\ derivative\ of\ equation(19)\ \ and\ take\ (y) and\ put\ it\ there$$

$$-(1-\sigma)\frac{c^{\circ}}{c}+(1-\eta)\frac{\ell^{\circ}}{(1-\ell)}-\theta\left[\frac{l(t)}{(1-l(t)}-\frac{\infty l(t)^{0}}{l}+\frac{m(t)}{m(t)}\right]$$

$$=(1-T_k)\,\gamma_t-\rho\ldots..(28)$$

$$\frac{(1-PE)^{0}}{(1-PE)}=\frac{l(t)}{(1-l(t)}-\frac{\infty l(t)^{0}}{l}+\frac{m(t)}{m(t)}\ldots\ldots(s)$$

$$put\ now\ \frac{(1-PE)^{0}}{(1-PE)}\ and\frac{C(t)^{0}}{C(t)}\ into(x)$$

$$\sigma\left[\frac{l(t)}{(1-l(t)}-\frac{\infty l(t)^{0}}{l}+\frac{m(t)}{m(t)}\right]+(1-\eta)\frac{\ell^{\circ}}{1-\ell(t)}$$

$$-(1-\theta)\left[\frac{l(t)}{(1-l(t)}-\frac{\infty l(t)^{0}}{l}+\frac{m(t)}{m(t)}\right]$$

$$=(1-T_k)\,r(t)-\rho\ldots..(29)$$

$$[\sigma-(1-\theta)]\left[\frac{l(t)}{(1-l(t)}-\frac{\infty l(t)^{0}}{l}+\frac{m(t)}{m(t)}\right]+(1-\eta)\frac{\ell^{\circ}}{1-\ell(t)}$$

$$=(1-T_k)\,r(t)-\rho\ldots..(30c)$$

$$Now\ divide\ (30) by\ [\sigma\pm(1-\theta)] and\ denote\frac{m(t)}{m(t)}\ by\ Al(t) and\ r(t) as\ rl(t)$$

$$Al(t)-\frac{l(t)}{(1-l(t)}-\frac{\infty l(t)^{0}}{l}+\frac{1-\eta}{\sigma-(1-\theta)}\frac{\ell^{\circ}}{1-\ell(t)}$$

$$=\frac{(1-T_k)\,r(t)-\rho}{\sigma-(1-\theta)}\ldots..(31c)$$

$$\frac{l(t)}{(1-l(t)}\left[-1-\frac{\infty\left(1-l(t)\right)}{l(t)}+\frac{1-\eta}{\sigma-(1-\theta)}\right]$$

$$=\frac{(1-T_k)\,r(t)-\rho}{\sigma-(1-\theta)}-Al(t)\ldots..(32c)$$

$$solving\ for\ l(t)^0\ yields\ \frac{\left(1-l(t)\right)}{l(t)}$$

$$l(t)=\frac{\left(1-l(t)\right)}{D(l)}\left[Al(t)-\frac{(1-T_k)\,r(t)-\rho}{\sigma-(1-\theta)}\right]\ldots\ldots\ldots(33c)$$

Equation (33c) denotes the steady state growth rate of consumption. Hence the complete dynamic motion of the system has been obtained through the technology condition in all three production sectors of the economy.

Here $\frac{(1-T_k)\,r(t)-\rho}{\sigma-(1-\theta)}$ denotes the steady state growth of consumption. The system follows the strict condition of concavity here. Where σ is the elasticity of consumption while$(1-\theta)$ is the intertemporal elasticity of substitution between productivity enhancing and utility enhancing expenditures.

where $D(l)=\left[-1-\frac{\infty\left(1-l(t)\right)}{l(t)}+\frac{1-\eta}{\sigma-(1-\theta)}\right]>0$ this notation explains the strict condition of concavity. Hence in the study consumer get utility with private and public consumption. His utility is in aggregate consumption.

The equation (33c) explains that for feasible steady state growth rate of consumption elasticity of substitution between leisure and work should be settled on the level where leisure never get exceeded from the labor supply The time

devoted for leisure should be always lesser than the initial labor supply . When elasticity of public expenditure composition is greater than zero which is

$\theta > 0$ there can be more provision of utitly enhancing expenditures. Moreover these public consumption services increase the utility of leisure and reduce the incentive to work more.

$$\frac{dg}{d(1-PE)} < 0, \qquad \frac{l}{dg} > 0$$

Where increase in utility enhancing expenditures decreases the growth rate and increases the utility of public consumption services.

For stability of system labor supply should be equal to consumption of capital which in return should be equated with the price of output which is capital or innovation in our study. However with an increase in public consumption services the returns on capital lowers down conversely public consumption services provide direct or indirect utility to the consumer. Consequently the offsetting effect of private consumption is compensated with the utility that consumer gets from public consumption services. But the negative effect of utility enhancing expenditures is by decreasing the capital it increases consumption output ratio.

When $\theta = 0$ there is no provion of public expenditure it provides no externality to private firms which decreases production by decreasing productivity and the returns got from the capital. This brings a fall in consumption and necessitates marginal utility of capital to rise with a decline in the steady state growth rate of consumption.

$\frac{dg}{d(1-PE)} = 0 = \frac{l}{dg} < 0$

Where absence of public consumption services increases the labor supply leading to a fall in the steady state growth rate of consumption.

In summary, if provision of utility enhancing expenditures is positive it creates a offsetting impact where more utility in leisure causes lesser labor supply. But it decreases the provision of public consumption services as well .This fall in utility creates an incentive to provide more of the labor services, Hence private consumption falls and more is spent on investment that increases the growth rate of the economy [Turnovsky,1998].

The stability of the model is checked in the next chapter.

Chapter 4

TRANSITIONAL DYNAMICS AND CALIBRATOR OF THE MODEL

The aim of this chapter is to work out the steady state and the transition dynamics of the model. Besides providing insights into how the composition of public spending impacts economic growth, this analysis will allow us to study the dynamic properties of the model especially the question of how inclusion of these expenditures influences the potential for indeterminancy as well as the properties of stability and convergence to equilibrium in response to a shock..

To begin with, to obtain the steady state solution, we differentiate Equation (33) with respect to *l* to get the following:

$$\frac{d\dot{l}}{dl} = \frac{(1-\hat{l})}{D(\hat{l})}\left[\frac{dA\hat{l}}{dl} - \frac{(1-T_k)\frac{dr\hat{l}}{dl}}{\sigma-(1-\theta)}\right] \ldots\ldots.(4.1)$$

The term $\frac{(1-T_k)\frac{dr\hat{l}}{dl}}{\sigma-(1-\theta)}$ describes the steady state growth rate of consumption which includes private consumption and substitution between utility enhancing expenditure and productivity enhancing expenditures. The consumer gets utility not only through private but also from public consumption where it provides direct utility to consumer without any decrease in the marginal utility of private consumption. $\sigma > 0, (1-\theta) > 0$ Where $UE = (1-PE) > 0$ where we assume that consumer welfare is such that he always gets utility from utility enhancing expenditures. Furthermore we assume there are always fixed amount of expenditures which are allocated between utility enhancing and productivity enhancing expenditures. Hence there is no way that government provides productive expenditures alone as in Barro (1990) model.

Where $1 > PE + (1-PE)$ If government decides to spend more money on UE, it is left with the lesser resources to be allocated for PE.However if it allocates more resources to PE, it can still allocate higher amount on UE. Public

productive services generate a spillover effect, and in endogenous labor supply it creates a work incentive. With increase in labor supply more is available to tax the wage income that increases the revenue for public consumption. Furthermore an important question here is whether to treat public goods as flow variable or stock variable. In the literature productivity enhancing expenditures are treated as stock variable while utility enhancing expenditures are treated as flow variable. Here we assume

$(1 - PE) = -\beta^{(1-PE)}(1 - PE) + (1 - PE)\ where\ 0 \leq \beta^{(1-PE)}$
≤ 1 is the depreciation rate of utity enahncing expenditures if $\beta^{(1-\mathrm{PE})}$
$= 1$ utilty enahncing expenditures are flow variables

$(PE) = -\beta^{(PE)}(PE) + (PE)\ where\ 0 \leq \beta^{(PE)}$
≤ 1 is the depriciation rate of productivty enahncing expenditures if $\beta^{(\mathrm{PE})}$
$= 1$ productivity enahncing expenditures are flow variables

While the term $A(l) = \frac{dA(\hat{l})}{l} \equiv G$ is growth rate of innovation.

$$\frac{dG}{dPE} > 0 \ \frac{dG}{d(1 - PE)} < 0$$

In this study dynamics of model are growth rate of private and public consumption and growth rate of innovation. As the study assumes that the utility of a consumer is comprised of private consumption and public consumption. Here we just consider the case of balanced growth path (BCG) while ignore the possibility of multiple equilibrium.

Hence our objective here is to locate the unique path of consumption of private and public expenditure consumption services on a constant rate commonly known as long run equilibrium. This analysis will allow us to assess the impact of including public expenditure composition. Does inclusion of policy parameter makes convergence more probable or it makes the whole system diverge.

Slopes of both consumption and innovation will be steeper as consumer is also getting utility with the public consumption. In equation (4.1) the relative magnitudes of parameter determines the exact values of slopes which in turn will determine the signs of derivatives of the equation.

Preposition 1 Assume that government taxes capital income then $\frac{dl}{dt} < 0$ $\frac{dl}{d(\theta)} > 0$ $\frac{dl}{\sigma} > 0$ which means marginal product of labor decreases with an increase in taxes while marginal product of labor increases with increase in public consumption.

4.1 Stability properties of the BGP according to derivate $\frac{d\dot{l}}{dl}$;

Preposition 2; when derivate of labor $\frac{d\dot{l}}{dl}$ is positive a unique path is adopted. There is no transition in dynamic equilibrium

Proof;

$$\frac{dA(\hat{l})}{l} > \frac{(1-T_k)\frac{dr\hat{l}}{dl}}{\sigma-(1-\theta)} \; than \; \frac{d\dot{l}}{dl} > 0$$

When growth rate of innovation is higher than the growth rate of consumption of private and public goods then derivative of labor supply is positive. There is determinacy on balanced growth path and the system will diverge. When there is non-existence of balanced growth path wage rate is not large enough to create an incentive to supply more labor.

Preposition 3; when derivate of labor $\frac{d\dot{l}}{dl}$ is negative there are transitional dynamics system will converge to balanced growth path.

Proof;

When $\eta < 1$ labor supply will diverge to infinity when employment converges to zero because of decreasing marginal product of labor. Hence at this point is firm is offering a wage that keeps labor supply positive so balnced

equilibrium is achieved. When $\eta = 0$ MPL is constant, balanced growth path will only exist when MPL is larger than take home wage to keep labor supply positive.

$$\frac{dA(\hat{l})}{l} < \frac{(1-T_k)\frac{dr\hat{l}}{dl}}{\sigma-(1-\theta)} \; than \frac{d\dot{l}}{dl} < 0$$

When growth rate of innovation is less than the growth rate of consumption of private and public goods then derivative of labor supply is negative. There is indeterminacy on balanced growth path and the system will converge. When $\sigma = 0 \; or \; \theta = 0$ there cannot be indeterminacy.

Conditions for indeterminacy

- The utility is derived from private and public consumption
- The substitution between productive and utility enhancing expenditures modifies the agent's welfare.
- Capital income tax is larger.

Reasons are as follows. When a consumer decides to increase his saving, less is left for present consumption. Consumer can increase saving and get balanced growth path only if the reduction in present consumption is compensated by the increase in the provision of utility enhancing public expenditures which increase the consumption growth rates. However these conditions can be fulfilled only if there is a positive supply of labor. Interest rate increases with decrease in tax on capital and there is increase in the growth rate of consumption. Benhabib and Farmer (1994) argue that indeterminacy will arise due to increasing returns of labor. There can be indeterminacy even with the constant returns of labor if public goods are introduced in the system [Cazzavillan (1996)]. However our work is different from existing literature because our claim is that there exists

indeterminacy without increasing returns but due to inclusion of public goods substitution between utility enhancing and productivity enhancing expenditures.

4.2 Mathematical Proof of Indeterminacy and Transitional Dynamics

In order to find the indeterminacy of the system we ignore $\frac{(1-l(t))}{D(l)}$ from equation (4) and set $l(t) = o$.By taking derivativ of growth rate of innovationwith respect to labor and substitutingΔ_1 and Δ_2 we find slope of growth rate of innovation

$$\frac{dA(l)}{dl} = (vi + \Psi)^{-1}\left[\{(1-\infty)vi^{-\infty}l^{-\infty}\} - \Delta_1\frac{\left(\hat{l}^{\infty}(-1) - \left(1-\hat{l}\right)\beta l^{\infty-1}\right)}{(\hat{l}^{\infty})^{\infty}} - \Delta_2\frac{\left(\hat{l}^{\infty}(-1) - \left(1-\hat{l}\right)\infty l^{\infty-1}\right)}{(\hat{l}^{\infty})^{\infty}}\right] \ldots\ldots (4.2)$$

Now after the rearrangement we substitute the value of Δ_1 and Δ_2

$$\frac{dA(\hat{l})}{dl} = (\bar{v}i + \Psi)^{-1}\left[(1-\infty)vi^{-\infty}\,\hat{l}^{-\infty} - \frac{(1-t_w)(1-\infty)(1-\sigma)\bar{v}i^{\infty}}{(1+t_c)(1-\infty)} - \frac{1-t_w)(1-\infty)(1-\theta)\bar{v}i^{-\infty}}{(1-\eta)(1+T_{PE})}\left(-\hat{l}^{-\infty} - \left(1-\hat{l}\right)\infty\hat{l}^{-\infty-1}\right)\right] \ldots\ldots (4.3)$$

Taking $(\bar{v}i + \Psi)^{-1}(1-\infty)(\frac{l}{vi})^{-\infty}$*common*

$$\frac{dA(\hat{l})}{dl} = (\bar{v}i + \Psi)^{-1}(1-\infty)x^{-\infty}\hat{l}^{-\infty}1 + \left(\frac{1-\sigma}{1+t_c} + \frac{(1-\theta}{(1+T_{PE})}\right)\frac{1-t_w}{1-\eta}\{(1-\infty) + \infty\hat{l}^{-1})\} \ldots (4.4)$$

4.3 Slope of Growth Rate of Innovation is

$$\frac{dA(\hat{l})}{dl} = \frac{(\bar{v}i + \Psi)^{-1}(1-\infty)vi^{-\infty}\hat{l}^{-\infty}}{(1-\eta)(1+t_c)(1-PE)}[(1-\eta)(1+t_c)(1+T_{PE}) + (1-t_w)(1-\sigma)(1+t_c)(1-\infty+l^{-1}) + (1-t_w)(1-\theta)(1+T_{PE})(1-\infty)+\infty\hat{l}^{-1})$$

4.4 Slope of Growth Rate of Consumption *(Private and Public Consumption*)

To complete the dynamic motion of the system We take the derivative of the equation of (25) with respect to l which is given as:

$$\frac{dr(\hat{l})}{dl} = \infty^2(1-\infty)\hat{l}^{1-\infty-1}\bar{v}i^{\infty-1}$$

$$\frac{dr(l)}{dl} = \infty^2(1-\infty)\left[\frac{\hat{l}}{\bar{v}}\right]^{-\infty}\frac{1}{vi} \ldots\ldots\ldots (4.6)$$

4.5 Outcomes of the system

In Equation growth rate of innovation and growth rate of consumption both the slopes are positive which means if there is one percent increase in labor supply it will increase growth rate of innovation and growth rate of private and public consumption.

Substituting equation (4.6) in equation (4.1)

$$\frac{dA(\hat{l})}{dl} - \frac{(1-t_k)dr(\hat{l})}{\sigma-(1-\theta)} =$$

$$\frac{vi+\Psi^{-1}(1-\infty)l^{-\infty}vi^{-\infty}}{(1-\eta)(1+t_c)(1+T_{PE})}[(1-\eta)(1+t_c)(1+T_{PE})+(1-t_w)(1-\theta)(1$$
$$+T_{PE})(1-\infty+\infty l^{-1})$$
$$+(1-t_w)(1+t_c)(1-\sigma)(1-\infty+\infty l^{-1})]$$
$$-\frac{(1-t_k)}{\sigma-(1-\theta)}\left[\infty^2(1-\infty)\frac{l^{\infty}}{vi}\left(\frac{1}{vi}\right)\right]\ldots..(4.7)$$

$(\text{vi}+\Psi)^{-1}$ as common will yield---

$$\frac{dA(\hat{l})}{dl}-\frac{(1-t_k)\frac{dr(l)}{dl}}{\sigma-(1-\theta)}=$$

$$\frac{(vi+\Psi)^{-1}}{(1-\eta)(1+t_c)(1+T_{PE})}\left[(1-\eta)(1+t_c)(1+T_{PE})+(1-t_w)(1-\sigma)(1\right.$$
$$+T_{PE})(1-\infty+\infty l^{-1})$$
$$\left.+(1-t_w)(1+t_c)(1-\theta)\left((1-\infty+\infty l^{-1})\right)\right]$$
$$-\frac{(1-t_k)}{\sigma-(1-\theta)}\infty \qquad \ldots\ldots(4.8)$$

Or

$$\frac{dA(\hat{l})}{dl}-\frac{(1-t_k)dr(\hat{l})}{\sigma-(1-\theta)}$$

$$=(vi+\Psi)^{-1}\left[1+\frac{(1-\sigma)(1-t_w)}{(1-\eta)(1+t_c)}(1-\infty+\infty l^{-1})\right.$$
$$\left.+\frac{(1-t_w)\,(1-\theta)}{(1-\eta)(1+T_{PE})}(1-\infty+\infty l^{-1})-\frac{(1-t_k)\infty}{\sigma-(1-\theta)}\right]$$

For simplicity suppose-----

$$\left[1+\frac{(1-\sigma)(1-\mathrm{t_w})}{(1-\eta)(1+\mathrm{t_c})}(1-\infty+\infty \mathrm{l}^{-1})\right.$$
$$\left.+\frac{(1-\mathrm{t_w})\,(1-\theta)}{(1-\eta)(1+T_{PE})}(1-\infty+\infty \mathrm{l}^{-1})\right]=\varphi_1$$

Type equation here.

$$\frac{(1-t_k)\infty}{\sigma-(1-\theta)}=\varphi_2$$

4.4 Proposition 4

There exist values of parameter (θ,σ,η) in φ_1 and φ_2 in such that for some values of θ, and σ $\varphi_1 < \varphi_2$ only iff $\theta+\sigma>1$ the system is stable and for some values of θ, and σ $\varphi_1 > \varphi_2$ only iff $\theta+\sigma<1$ the system stability condition is not be meet.

When $\varphi_1=\varphi_2$ when $\theta+\sigma=0$ .Hence when $\theta+\sigma<1$ only then $C^{1-\sigma} and\ 1-PE^{1-\theta}$ will be increasing providing positive marginal utility to consumers.

Explanation

When current level of employment is less than the balanced growth path level of employment it means level of consumption (private and public) is greater than steady state level of consumption while present level of production is less than the production at balanced growth path. Its implications are that higher aggregate consumption and leisure are being carried out while less is provided for research and development activities. So present growth rate of innovation is less than the steady state growth rate of innovation at BGP. Whereas optimal allocation of productivity enhancing expenditures depends upon the revenue allocated to utility enhancing expenditures relative to its optimum. At optimal level

$$(1-\mathrm{PE})=\overline{(1-PE)}, PE=\theta\ ,$$

$$(1-\mathrm{PE})<\overline{(1-PE)},\quad \mathrm{PE}>\theta$$

Hence growth level of productivity enhancing expenditures is equal to

welfare maximizing level of public expenditure composition only if $\overline{(1-PE)}$=0

Thus in our study the condition that decides whether the economy will converge or diverge depends on the proposition 4 which sets out the fact that inequality holds or not depends on the condition $\frac{dr\hat{l}}{dl}\frac{dA(\hat{l})}{dl}$ which explains that what is the response of *A (l)* and *r (l*) to change in *l*. If labor supply is more sensitive to *A(l)* than *r(l),* with a initial level of *l* lower than its balanced growth path growth rate of consumption is higher than growth rate of technological progress. If labor supply is more sensitive to *r (l)* than *A (l),* with a initial level of *l* lower than its balanced growth path growth rate of consumption is lower than growth rate of technological progress.

Preposition 5:

When labor supply is more sensitive to *A (l)* than *r (l) consumption to capital ratio* $\frac{c}{m}$ will increase because there is increase in m or growth rate, labor demand will increase and at the same time due to increase in consumption labor supply will also increase.

Labor demand in equation (18)

$$\frac{w(t)}{m(t)} = (1-\infty)(\frac{vi}{l})^{\infty} \dots \dots (4.10)$$

Where labor demand increases with increase in per capita intermediate goods.

Labor supply in equation (3) for private goods--- dividing it by m(t)

$$\frac{w(t)}{m(t)} = \frac{(1-\eta)}{\big(1-\ell(t)\big)}\frac{1+T_c}{(1-T_w)(1-\sigma)} = \frac{c(t)}{m(t)}$$

Hence labor supply will go down with an increase in private consumption ratio to capital goods.system unstable or local determinate

Labor supply in equation (6) for public consumption services is-- dividing it by *m(t)*

$$\frac{w(t)}{m(t)} = \frac{(1-PE)(1+T_{PE})}{(1-T_w)(1-\ell(t))}\frac{(1-\eta)}{(1-\theta)}$$

Hence labor supply will go down with an increase in public consumption ratio to capital goods. System unstable determinate.

Preposition 6:

If labor supply is more sensitive to *r (l)* than *A (l)*, with a initial level of *l* lower than its balanced growth path growth rate of consumption is lower than growth rate of technological progress system achieves balnced growth path. Labor demand increases with increase in per capita intermediate goods. Labor supply will go up with a decrease in private consumption ratio to capital goods and public consumption to capital ratio.

4.6 Conclusion of chapter 4

When slope of consumption is higher than steady state innovation and consumption growth is lower than innovation growth rate there is a decrease in public and private consumption to capital goods ratio making system stable or indeterminate. Hence due to inclusion of public expenditures composition the system can get move to the BGP more quickly because of the positive utility that it provides to consumer and externality that it provides to the private firm. Accordingly when slope of innovation is less than the slope of aggregate consumption it makes the term$\frac{dA(l)}{l}$ negative. Hence there will be indeterminacy and system will converge to the steady state balnced growth path.This is according to Raurich (2003). Growth rate of innovation means there is increase in the productive activities together with productive expenditures of the government which makes system equilibrium path as determinate----more growth means more employment opportunities which in turn mean economy grows at much higher level and consumption is less which makes system divergent to steady state growth path.

In a nutshell the study has included substitution of composition of public expenditures in elastic labor supply in the analysis. This allows us to conclude

that when labor supply is more sensitive to rate of interest and growth rate of consumption is lower than the growth rate of innovation, it is optimal for the policy makers to allocate more revenue on utility enhancing expenditures because system has some capacity left to exhaust these consumption expenditures. While if growth rate of consumption is higher than the growth rate of innovation it is optimal to spend more on productivity enhancing expenditures so that system can come out of unstable area. Earlier studies has compared between consumption and capital ratio alone. This study has shed new light on how economies can use composition of public expenditures as an important tool to achieve balanced growth path. Public expenditures have two way implications in our analysis: these can affect the consumption output ratio or can have implications for growth rate of innovation through externality channel.

Hence composition of public expenditures provides us very interesting insights about the transitional dynamics of public expenditures. The inclusion of depreciation in our analysis has allowed us to treat both productive and non productive expenditures as flow variable that expanded the area of transitional dynamics in fiscal literature.[9] In chapter 3 we have mentioned that how citizens play their role in selection of public expenditure composition, this chapter explains how their choices have important consequences for transitional dynamics and growth rate of the economy.

The next section is planned to check the numerical results of the system.

4.7 Calibrations of the model

> "No attempt is made to determine the true model. All models are abstractions and are, by definition, false"
>
> *[Kydland and Prescott (1982)]*

> "... Calibration shows the trust a researcher has in an answer given by the model does not depend on a statistical measure of discrepancy, but on how

[9] For example, a related study is Arif (2011) which uses the same model but focuses on public goods alone, and provides a dynamic analysis of the tax and user fee.

much he believes in the economic theory used and in the measurement undertaken"

[Kydland and Prescott (1991)]

In order to derive the numerical analysis of the model we employ calibrations method here. In calibrations the numerical values are assumed for the parameters that have been derived from artificial economic world. The idea of employing calibration technique is that in this method relationship between theory and measurement is not unidirectional rather we can extract more information from data. Economic theory has been used in our calibration to restrict our general framework to get the results that display the desired properties. Loosely speaking calibration allows us for the mapping of our framework into measured data.

We try to answer two questions in our calibrations: first, what is the impact of public consumption services and how these affect the growth rate of consumption in steady state growth path and second, how parameter of utility enhancing public expenditures shape the demand of public services and how tax on productivity enhancing expenditures will change the stability properties of the system.

We use the benchmark economy and then calibrating the model using the parameters representative of Pakistan economy.

Firstly we take $\theta = 0$, $(1 - PE) = 0$ and $\left(1 + t_{(PE)}\right) = 0$ and compare it with the base article of calibration Haruyama and Itaya (2006)

First of all we take the values from existing literature

$$\eta = 0.9$$

$$\sigma = 0.21$$

$$\infty = 0.5$$

$$\rho = 0.03$$

For Ψ there is no value in existing literature .By taking (25) and assuming the value of r= 0.03 we can assume

$\Psi = 20,30,40$ where $l = [0,1]$

For concave utility function the following condition must hold.

$1 > \sigma > 1 - \eta > \theta > 0$. Hence we need to assume the elasticity of labor supply and value of $\frac{1}{\sigma}$ such that the above mentioned condition is fulfilled. There can be many values for these mentioned parameters but no such value exists that assures the indeterminacy of our model. Hence we have assumed many values for these parameters and determined that which one is closer to the indeterminacy.

4.9 Taxes

There are three taxes in our model. Taking equation(3)

Marginal rate of substitution between consumption and leisure

$$\frac{(1-\eta)}{\big(1-\ell(t)\big)}\frac{c(t)}{1-\sigma} = \frac{1-T_w}{1+T_c}\, w(t) - - - (5.1)$$

4.10 Mr's Between Consumption And PE

$$\frac{\frac{C(t)}{1-PE}(1-\theta)}{1-\sigma} = \frac{(1+T_{PE})}{(1+T_c)} PE - - - - - - (5.2)$$

4.11 MR's between PE and ℓ

$$\frac{(1-PE)}{(1-\ell(t))}\frac{(1-\eta)}{(1-\theta)} = \frac{(1-T_w)\, wt}{(1+T_{PE})\, PE} \quad - - - - - - (5.3)$$

The data show that if tax on labor income is more than the tax on consumption and tax on capital the economy can follow the path of indeterminacy

. $\boldsymbol{T_w = 0.7 \quad T_c = 0.3 \quad T_k = 0.1}$

Furthermore the data show that if tax on income is not very high the system will show instability

$$\boldsymbol{T_w} = 0.3 \quad T_c = 0.15 \quad T_k = 0.3$$

$$T_w = 0.3 \quad T_c = 0.15 \quad T_k = 0.2$$

$$T_w = 0.3 \quad T_c = 0.15 \quad T_k = 0.1$$

4.12 Value of Utility Enhancing Expenditures From Existing Literature Value of

$$1 > \sigma > 1 - \eta > \theta > 0 \; or \; \sigma + \eta + \theta > 2$$

$$\eta = 0.9$$

$$\sigma = 0.21$$

$$\theta = 0.9$$

As there is a tax levied on user fee of productivity enhancing expenditures. If there is no tax levied on public services the system will show instability because there can be a problem of congestion or moral hazard hence (1-PE)=0 but if even a small amount of tax is levied on public services the system will show stability.

$$T_w = 0.3 \quad T_c = 0 \quad T_k = 0.3 \quad T_{PE} = 0.3$$

$$T_w = 0.3 \quad T_c = 0.15 \quad T_k = 0.2 \quad T_{PE} = 0.7$$

$$T_w = 0.3 \quad T_c = 0.15 \quad T_k = 0.1 \quad T_{PE} = 0.2$$

The data show stability even when the tax on productive services of the government is higher than one. Hence because of the inclusion of taxes on productive sevices stability becomes possible because now government has more revenue to allocate between production and consumption services.

$$\eta = 0.9 \quad \sigma = 0.1 \quad \theta = 0 \; T_{PE} = 0.3$$

$$\eta = 0.9 \quad \sigma = 0.2 \quad \theta = 0 \; .8T_{PE} = 0.3$$

$$\eta = 0.9 \quad \sigma = 0.3 \quad \theta = 0.9 \; T_{PE} = 0.3$$

4.13 Results of calibrations

We started by taking some benchmark parameters for example Production parameters, Preference parameters and public expenditure composition parameters. The production parameters imply a (physical) capital-output ratio of around 3. We assume that the government spending is a pure public good ($\theta = 1$) the production elasticity of which is 0.10. The rate of time preference is 3%. The fraction of output devoted to the government production good is 0.10, with the Income tax being 0.10 and the consumption tax being zero. While these parameters are generally plausible, we view them as being largely illustrative. In this operation of numerical analysis is the tax on the labor-leisure choice. Our benchmark setting 0.3 reflects the average marginal personal income tax rate in the data we taken. Given the complex nature of capital income taxes, part of which may be taxed at a lower rate than wages, and part of which at a higher rate, we have chosen the common rate $T_k = 0.3 \quad T_{PE} = 0.3$ as the benchmark. The benchmark assumes a zero consumption tax. The value of public productive expenditures is 0.05 in the production function implies that government production spending are capital augmented.

Government expenditure parameters have been chosen so that the total Fraction of net national production devoted to government expenditure on goods and services equals 0.25 The breakdown between *UE*= 0.15 and *PE* = 0.09 is arbitrary, but plausible. Government investment expenditure is less than 0.09 and our choice of PE is motivated by the fact that a substantial fraction of government consumption expenditure, such as public health services, impacts as much on

productivity as they do on utility.Our calibrations describe various policy shocks from the benchmark, meaning that

these shocks lead to changes in the intertemporal public expenditures spending imbalance for example an increase in tax on capital has almost no direct effect on the consumption-leisure margin, and therefore on the fraction of time devoted to work. It has a significant adverse effect on the after-tax return to capital, inducing agents to devote a higher fraction of output to consumption, leading to a substantial reduction the growth rate. The government's intertemporal fiscal Imbalance now moves into surplus, and indeed zero balance can be achieved by a smaller increase in public consumption services. The effects of wage taxes are qualitatively similar, but smaller, with the exception of leisure which is the factor upon which the tax rate impacts directly. This shifts the consumption work trade off in favor of the latter, thus raising the fraction of time devoted to work, and with it the productivity of capital. Consequently, the equilibrium growth rate increases and private welfare improves. However, the lower tax revenues cause the intertemporal fiscal balance to deteriorate significantly.

We assumed introduces 0.14 to be public spending on consumption in our benchmark economy. Hence in a sense 46% can be the ideal combination of utilty enhancing expenditures and 56% for productivity enhancing expenditures because there are externalities of public productive spending creating a spill over effect. Both have comparable effects on work effort and on the consumption-income ratio. Not surprisingly, the former has a more adverse effect on the growth rate, but the latter has the more adverse effect on welfare.

Chapter 5

SUMMARY AND CONCLUSIONS

The composition of public spending has important implications for economic growth. This study has developed an analytical framework that allows us to study the role of the composition of public spending in the process of economic growth. The study has focused on two approaches to modeling the fiscal policy. First, following Park and Philippopoulos (2003) it is assumed that a benevolent government chooses the composition of public spending including utility enhancing and productivity enhancing expenditures. Second, we consider a framework where composition of public spending is determined endogenously on the basis of voter preferences in a game-theoretic setting. A key feature of our approach, as opposed to Haruyama and Itaya (2006), is that we introduce endogenous policy instrument of utility enhancing public expenditures into the utility function of the consumer. Using this model, we find the equilibrium condition and steady state growth rate of consumption where consumer's utility not only depends on private consumption but also on public consumption. An added feature in our framework is the explicit incorporation of elastic labor supply in the model. This allows us to study the role of fiscal policy in a setting where fiscal policy can alter the incentives of workers towards work and leisure.

The study has analyzed how economic policy of public expenditures composition is formulated and what are the allocative impacts of fiscal policy. When policy is chosen by a benevolent government, it chooses the composition of public spending to maximize growth while at the same time minimizing the distortions caused by taxation. However, when voters choose economic policy they selfishly decide that which component of public expenditure composition is going to give them maximum benefit. For them their own utility is more important than the overall impact of this choice on the economy, and their choice plays significant role in the determination of balanced growth path.

The study has come up with some interesting insights. First, the study shows that there is a tradeoff between utility enhancing and productivity enhancing expenditures. For example, higher spending on utility enhancing services may be accompanied by higher distortionary taxation thus retarding the process of economic growth. However if more revenue is allocated to productivity enhancing expenditures it will create externalities through technological spillover effects thereby boosting growth which in turn makes more revenue available for utility enhancing expenditures as well. In this case, it will be optimal to allocate more funding towards productivity enhancing expenditures. Second, when the steady state growth of innovation is less than the growth rate of consumption (private and public) then it is more difficult to achieve the balance growth path hence indeterminacy becomes more difficult. Third, in the presence of elastic labor supply more of labor income tax will be growth enhancing when economy is below its balanced growth path. It will help finance an increase in the provision of publically provided utility enhancing expenditures while causing a decline in private consumption. But if taxes are charged on a much higher rate on labor income it will have distortionary effects in the economy. Labor supply will decrease due to decrease in take home income which will have a negative impact on the overall growth rate of economy. If decrease in private consumption is compensated by increase in utility enhancing expenditures employment will not be affected by higher income tax. Furthermore in our analysis we introduce a tax on productive enhancing expenditures that are not provided freely but have some user fee. If tax on productivity enhancing expenditure is higher than the benefit that capital is getting out of it, this will make the system determinate or unstable.

A politico economic equilibrium has been articulated in game theoretic framework where voters choose composition of public expenditures into utility enhancing expenditures and productivity enhancing expenditures. Consequently the composition of public expenditures between these two components is considered as a policy issue which is formulated on the basis of preferences of citizens. Utility enhancing expenditures are included in the utility function of the consumer with elastic labor supply to identify the distortionary effect of

expenditure composition, whereas productivity enhancing expenditures are integrated in the production sector of the economy. The inclusion of both productivity enhancing expenditures and utility enhancing expenditures determine the growth impact of expenditure composition policy. It has different implications for long run growth than the case where public expenditures are considered without distinguishing between the compositions of public expenditures. Hence composition of public expenditures is determined not only by the politician but also voters who indirectly choose economic policy. Therefore they need to realize which one is good for long run economic growth and which component is affecting growth. This study suggest how much utility enhancing expenditures are productive and how much productivity enhancing is good for growth and what can be the ideal mix of these two expenditures for promoting economic growth.

We can conclude from the above discussion that the choice of policy instruments whether by the benevolent government or by the voters has important implications for growth. The choice of public expenditure composition is not a political issue alone rather the preferences of citizens play significant role in the determination of fiscal policy. Public expenditure will be growth enhancing as long as the system is indeterminate, whereas the optimal provision of public expenditure composition increases the chance of stability of the system. Whereas a social planner can incorrectly determine the policy instrument that doesn't reflect the choice of citizens, voters too need to be careful in showing their preferences to the politicians because their choice has impact on the steady state growth rate of the economy. It is important to emphasize here that while citizens may have a higher preference for utility enhancing expenditures, spending on productivity enhancing expenditures may still be more desirable due to technological spillover effects in the economy which can boost economic growth.

The study can be extended in several directions. For example, we have only considered the productive and non-productive expenditures. A possible extension of the study would be to include redistributive transfers in the model. This would allow the study of the welfare impacts of government spending on transfers to the poor, and can provide interesting insights into the choice between

welfare and growth issues. Second, we have solved the model for commitment equilibrium. Another useful extension here would be to include Markov perfect equilibria for the case where agents do not commit their promised policies. Furthermore we solve the dynamic motion of the model for unique equilibrium and this can be extended to the case of multiple equilibria.

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