CIDE

NÚMERO 63

David Mayer-Foulkes

SECTORIAL PUBLIC POWER AND ENDOGENOUS GROWTH

Sectorial public power and endogenous growth

David Mayer-Foulkes[1]

Centro de Investigación y Docencia Económicas

Abstract

The concept of sectorial political economy is defined using a model of fragmented perfect competition and introduced in an dynamic game in which the government is a Stackelberg leader and the representative families of each sector follow. Sectors produce different bundles of goods by means of production functions which imply different kinds of economic dependencies and which may involve public inputs on which the government takes strategic decisions. The political power of each sector is described in terms of its passive resistance (resistance to taxation), its organized resistance (an effective demand for minimum welfare), and its socially organized power (the presence of its objectives in the government objective function). The determinants of income distribution and growth, the mechanisms and incentives for the allocation of public goods, and the incentives for political organization, are functions of political power which are strikingly different if the economy is open or closed. The model analyzes long-term equilibria in political economy and tendencies for change in periods of political transition due to technical or trade policy changes.

1 Introduction

This article studies economies in which the amongst the main determinants of distribution and growth is the differentiated access of productive sectors to the economic benefits of power. Our interest is centered in market economies in which the political system is characterized by a stable balance of power established between various productive sectors, which determines the economic actions of the government.

[1]E-mail: mayerfou@disl.cide.mx

The role of public spending in an endogenous growth model was first studied by Barro (1990). Futagami, Morita and Shibata (1993) consider public investment instead of spending in an endogenous growth model. Jison Lee (1992) considers both in a model which finds two types of equilibria, each emphasizing one of the modes of government participation in the economy. The theoretical and empirical importance of public investment has been substantiated by several studies (see for the former Arrow and Kurz, 1970, for the latter Aschauer, 1988, Iwamoto, 1990), as well as the impact of institutional structures on the provision of specific public goods (e.g. Gorter and Zilberman (1990)). In this article we are concerned with the strategic nature of the government's participation in the economy, in the context of a balance of power between sectors. Such strategic activity is mainly reflected in investment decisions which affect distribution and growth.

The study of the political economy of growth in endogenous growth models is well established (see for example Verdier, 1994). In a survey on the recent literature on the political economy of growth, Alesina and Perotti (1994) find the main theoretical and empirical studies to be on the linkages between income distribution and growth; political rights, democracy and growth; savings, investment, and political instability. Our objective is to consider governments which embody a specific, stable balance of power between sectors based on branches of the economy. We find that the balance of power and whether the economy is open or closed characterize government economic action and determine sectorial income distribution and some aspects of growth as well as the mechanisms and criteria of public investment and the incentives for political organization.

In the context of our assumptions rent-seeking is structured in a given, non-competitive and non-democratic manner. Thus our study is somewhat more associated with corporativist than with decentralized, pluralist frameworks of interest intermediation (see Schmitter and Lehmbruch, 1992). The study of rent-seeking by specific interest groups is extensive (e.g. Riaz, Shogren and Johnson, 1995; Zhou, 1995; Congleton and Bennet, 1995; Sturzenegger and Tommasi, 1994; Hinich and Munger, 1994). In the endogenous theory of trade tariffs specific economic sectors (owners of industry-specific factors) act with political coherence to obtain the economic benefits of certain policies (e.g. Brainard and Verdier, 1994).

The analysis of economic history often involves sectors of the economy. Pipitone, 1994, uses the concept of economic sectors extensively in a comparative historical analysis of the success or the failure of the transition to development in England, Holand, Belgium, France, and especially in the case of the "late-comers" Sweden, Denmark, Japan, Italy, India, Nigeria, Brazil and Mexico. Evans, 1995, analyses a series of case histories of development by economic sectors.

Olson, 1982, applies the theory of collective action to analyze a wide variety of historical events, in terms of the presence of collusions and organizations. Olson analyses how these collusions and organizations come to have some of the properties we ascribe to sectors. "Stable societies with unchanged boundaries tend to accumulate more collusions and organizations for collective action over time." "Encompassing organizations have some incentives to make the society in which they operate more prosperous, and an incentive to redistribute income to their members with as little excess burden as possible ..." "Distributional coalitions, once big enough to succeed, are exclusive and seek to limit the diversity of incomes and values of their members." (Ibid, chapter 3).

We characterize our sectorial structure by the following assumptions, which must hold within the horizon of economic planning (to which we refer as the long term). Politically, each sector is coherent, and the balance of power between sectors determines government economic decisions. Economically, each sector specializes in some branch of production in which it has an advantage; thus inter-sectorial competition is weak while intra-sectorial competition is strong. Together these assumptions mean that the economic and political system is jointly structured in sectors, and that the structure is stable within the horizon of economic planning. Examples of such sectors could be the agrarian and urban sectors, industrial sectors such as large and small-scale industry, diverse special interest stable lobbying groups, or capital sectors such as financial versus productive capital. We shall talk of a sectorial economy (rather than political economy) for short.

The advantages each sector has in production could take many different forms, such as advantages in knowledge resulting from learning by doing, transaction costs, entry costs, imperfect credit, etc. For example, in the case of the agrarian and urban sectors, it is often the case that the access of capitalists or workers from each sector to the other sector may involve a great variety of economic difficulties. Similarly in the cases of large and small-scale industry, or financial versus productive capital, competition may be limited by problems with credit, knowledge, mobility of labor, scale, entry costs and market structure.

In the situations in which we are interested the government has the power to strategically influence capital accumulation. Public spending and investment are important components of production and consumption. Public investment may be in public goods, or it may be in the production of private goods which may be in the hands of the government. The government acts to further certain objectives (in our model by maximizing some function of the sector welfares) according to certain constraints. These objectives and constraints will derive from the political power of each sector. We consider for each sector three aspects of power which we shall call *the power of passive resistance, the power of organized resistance* and *socially organized power.* As we shall see below, these correspond to increasingly complex collective action. The first is a sector's capacity to oppose taxation, especially when the government transfers the proceeds to other sectors. The second is a sector's capacity to impose upon the government constraints guaranteeing it a minimum degree of welfare. The third is a sector's capacity to include its own welfare amongst the government's objectives.

An important note is that the concept of sectorial structure is quite distinct from the concept of class structure. If we proceeded to analyze the determinants of collective action which give rise to political organization and power, undoubtedly the identification between members of the same classes (by occupation, communality of economic and political interests, etc.) plays a central role. However the analysis of the space of income negotiation between labor and capital is impossible within the framework of competitive production, which allocates income shares according to the production function shares, except perhaps in the case of human capital, which can involve a public input. Thus the analysis of the dynamics of power including such bargaining possibilities is much more complex. Even to model class in simpler ways simultaneously with a sectorial structures would complicate the issues. Thus we have chosen to deal with the sectorial structure on its own. The approach taken in this study can be understood as an analysis of the dynamics of power amongst the dominant classes, as owners of different kinds of capital. Alternatively, our approach can model social sectors forming a coherent unit even if composed of different classes, when the capital owners play the leading roles.

We summarize here some of our main results. A sector's economic dependence on the government (through inputs to its production function) leads to its political dependence if it is not in power. Collective action of lower complexity in one sector (which may be less costly) may be able to limit the exercise of the power of collective action of higher complexity by other sectors. For example, tax resistance by one sector may frustrate transfers of wealth attempted by means of the socially organized power of another sector. Despite the assumption of productive advantages in each sector, the private allocation of capital in a steady state sectorial economy and the relative price between goods will be compatible with perfect competition and thus economically stable. Next, we find that whether the economy is closed or open deeply affects the mechanisms and incentives for the allocation of public goods, the determinants of income distribution between sectors, and the incentives for political organization. In the closed sectorial economy, the balance of power does not affect the allocation of public investment, while in the open economy it determines it directly. In the closed case allocation attempts to meet economic efficiency criteria while in the open case it attempts to meet political income distribution criteria. Sector income in the closed case depends on the market demand for goods (not on the initial intersectorial distribution of capital), adjusted by tax transfers, while in the open case it depends on a combination of the economic independence and political power of a sector. In a closed sectorial economy organized political demands for welfare beyond the market equilibrium can only be met with government services and subsidies. In an open economy organized political power not only uses public investment as a vehicle for increasing wealth, but is a prerequisite for the existence of sectors requiring such investment. Finally, as a direct application of well known results on the role of public inputs in trade, the comparative advantage of sectors requiring public inputs will be a function of their political power.

We analyse transitions involved in sectorial economies which open or close. Dependent sectors will find on opening that they need to organize politically to survive. In certain cases, opening or closing determines which sector of the economy will be the growth leading sector.

Section 2 analyses the hypotheses underlying the concept of a sectorial political economy and outlines a general model. Section 3 introduces a sectorial economy in an endogenous growth model. Sections 4 and 5 contain detailed statements of the results summarized above. Section 6 discusses the government as sector; transitions due to changes in trade policy or to technical change; fragmented perfect competition, which is the market structure of our model, and offers some comments on EC protectionism and the US Civil War. Section 7 has some final remarks. Sections 8 to 12, the Appendix, solve the mathematical model, considering the families' problem, the government's problem in the closed and open cases, and the model with taxation of sector 2's in the closed and open cases.

2 The politico-economic sectorial structure

2A Hypotheses of the model

We wish to model market economies in which the following scenario exists. *For the planning horizon, the political system is characterized by a stable balance of power established between various productive sectors, which determines the economic actions of the government.* To do so, we define the concept of *sectorial structure* as follows. A country has a (politico-economic) sectorial structure if it can be divided into sectors which satisfy two hypotheses:

1.- *Political coherence.* Each sector forms a politically coherent unit vis a vis other sectors in the government's spending decisions, which are a function of the resulting balance of power.

2.- *Productive specialization with economic advantage.* Each sector specializes in some branch of production within which it has certain economic advantages with respect to the other sectors.

We first show that our assumptions are the minimal set which will be compatible with our scenario. The main point is that if within some branch of production some subset of its firms can access government favor while the remainder cannot, the favored subset will out-compete the remainder, so that for any long-term steady state (compatible with the economic planning horizon) all of the firms in the productive branch must have equal access to the public investment goods *(political coherence)*. Hence, if there are to be several sectors, each must be identified with a specific good (or bundle of goods), each of which is necessary for the other sectors, either for consumption or production or both *(productive specialization)*. Moreover, since sectors are thought to be at least somewhat stable with respect to the process of economic competition, there must be barriers to the encroachment of their economic activities by other sectors. In the absence of such barriers the economic basis of a weaker sector can be eroded and we would analyze instead more fluid economic and political states of affairs *(economic advantages)*.

Thus only particular subsystems of a given country may be considered sectors in the sense just defined, although some kinds of sectors (as in the case of agricultural or urban sectors) may divide into subsectors geographically or otherwise. Our analysis examines politico-economic equilibria in which various market imperfections (which may themselves derive from the political system) define productive sectors within which economic competition remains and which, for social, political or practical reasons form coherent political units on the national scene.

Our model abandons the concept of a benevolent government acting for the general good, instead depicting it as pursuing the interests of certain sectors according to the balance of power. However, we eschew the sources of political coherence within sectors, on the one hand, and of government coherence with sectorial objectives resulting from some sectorial balance of power on the other. Note, however, that some of this coherence (meaning equal access to the benefits of public investment within sectors) simply follows from the accessibility of public goods (which may be local not only geographically but in the sectorial sense) or of private goods supplied by local or sector-specific government investment (on human capital, energy, and so on).

Our assumptions may be more relevant in developing countries than in democratic, developed countries in which political and economic rigidities may be less dramatic. Nevertheless, we have shown that it is a minimal set in contexts in which the concept of stable politico-economic sectors is relevant. The model may be considered as one of *fragmented perfect competition*.

2B Outline of the model

Having clarified the assumptions behind the sectorial structure, we now outline a general model of which only a particular version will be stated and solved mathematically.

The Economic Sphere

The economy is described by a game in which the government is a Stackelberg leader and the remaining agents are representative families each belonging to a sectors and owning the capital inputs of the production function corresponding to its sector. We consider the following stylized facts, based on the existence of the sectorial structure defined above.

1. Market economy. Each sector produces its own good for the market, in perfect competition with members of its own sector. Families and firms

are price takers. The government can buy and sell goods produced by both sectors in the market. If the economy is open the relative price between both goods is exogenous while if it is closed it is endogenous.

2. Productive sectors. Production is divided in two (or more) sectors. Each produces a specific good which families of all sectors consume and which can also be used as capital. Each sector has advantages in the production of its own good with respect to members of other sectors. The production functions may involve capital goods of each type as inputs, either in the form of private or public capital, or considered as externalities of any type of capital of any sector. In the case of an open economy we suppose that both goods are tradeable.

3. Government objectives. The government's objective is to maximize a function having as arguments the utilities of representative families of each sector (also called felicity functions). The objective function is a characteristic of the current political system. It could be identical to the welfare of only one of the sectors, or some combination of them.

4. Taxes. The government raises taxes from families in both sectors. The limit to the amount of taxes it can raise are another characteristic of the current political system.

5. Public investment and its specificity. The resources obtained by the government are invested in public capital (which only the government provides) and which are sufficiently varied to be provided in a sector-specific manner, at least within a certain set of possibilities.

6. Minimal sectorial welfare. When it exercises the public budget and decides the tax rate, the government redistributes resources amongst the sectors. If it favors one, the remainder loose welfare. The minimum bound to the welfare of each sector is a further characteristic of the current political system.

The Political Sphere

We consider three sets of political "data" which correspond to three aspects of political power. These represent qualitatively increasingly complex levels of collective action and organization. The first is the power of passive resistance. It requires simple action which need not even take the form of collective action proper, because it can be based on individual tax evasion, complicity and corruption. The second is the power of organized resistance. It requires collective action whose effect can be based, for instance, on the imposition of costs (an example could be trade unionism) or on political maneuvering, the resort to public opinion, protests, legal action, and so on. Such resistance need not concert the actions of the sector in a fully unified way. The third is socially organized power. It reflects a degree of organization capable of channeling efficiently large amounts of public resources to specific economic projects in a socially articulated and unified way. In sum, we consider the following attributes of the political power of each sector:

1. The power of passive resistance. The capacity of a sector to impose bounds on the tax rate paid to the government.

2. The power of organized resistance. The capacity of a sector to impose as a restriction on the decisions of the government a minimum level of welfare for its sector.

3. Socially organized power. The capacity of a sector to assign to its interests considerable portions of the public budget.

For the purposes of this article the political structure will be considered exogenous. To endogenize it would involve a description of political dynamics which are beyond the scope of this paper. For the same reason, we limit ourselves mainly to studying the steady states of our model, which do not push the exogenous political structure and dynamics and the infinite horizon of the endogenous growth model too far.

3 The model

In this section we consider a simple sectorial economy, with the economy described by an endogenous growth model. Endogenous growth models with more than a few variables tend to be mathematically complicated. Thus we prove some of the consequences resulting from our theoretical framework on the basis of the simplest interesting case of a sectorial structure, and then comment on some simple variations.

We consider a small economy with two productive sectors and a government. The sectors are numbered 1 and 2 and have populations N_1, N_2 with equal growth rate n. These sectors are specialized in the production of goods a and b respectively. Except for the production functions available to them the families are identical and maximize the utility functionals

$$U_i = \int_0^\infty u(a_i,b_i)e^{-rt}dt. \qquad 3.1$$

(i = 1, 2) where

$$u(a,b) = \frac{a^\alpha b^\beta}{1-\sigma} \quad \text{with} \quad \alpha + \beta = 1 - \sigma, \qquad 3.2$$

and a_i, b_i is the per-capita consumption in sector i of goods a and b.

The government maximizes

$$U_G = u_G(U_1,U_2) \qquad 3.3$$

subject to the restrictions

$$Z_G^i = z_G^i(U_1,U_2) \geq 0, \quad i = 1, 2. \qquad 3.4$$

The function u_G is increasing in both variables and concave. It reflects the organized social power of the sectors. The functions z_G^i express a restriction on the minimal welfare in sector i. They are increasing in U_i and decreasing in the welfare of the other sector (as for example in a comparative restriction such as $Z_G^2 = U_2^c/U_1^d - \text{const} \geq 0$).

We take good a as numeraire and let p be the price of good b.

Since our objective is to highlight the possibility of intersectorial transfers to dependent sectors, we make the following simplifying assumptions. Production in the first sector does not require capital inputs other than private capital of good a, while in the second sector capital requirements are private capital of type b and public capital of type a. Families in the second sector are not taxed, so that public capital for production in the second sector is financed by the first. Thus the first sector does not depend on the second for capital inputs and only needs it for consumption, while the second sector also depends on the investment of public capital of type a. This scheme could model a process in which sector 1 pursues policies modernizing sector 2[2].

The aggregate equations of production are the following.

$$\begin{gathered} K_1' = \phi^1(K_1) - C_1 - T_1 \\ K_2' = \phi^2(K_2,K_P) - \frac{1}{p}C_2 \\ K_P' = e_P T_1 \\ T_1 \le \omega K_{10} e^{\gamma t} \end{gathered} \tag{3.5}$$

where $\phi^1(K_1) = A_1K_1$, $\phi^2(K_2,K_P) = A_2K_2^{\theta}K_P^{1-\theta}$, we use the abbreviations

$$C_i = (a_i + pb_i)N_i, \tag{3.6}$$

and the variables are the following:

K_1 is private capital of sector 1, consisting of good a.

K_2 is private capital of sector 2, consisting of good b.

C_i is the total consumption of sector i measured in units of good a.

a_i is the per capita consumption of good a by sector i.

b_i is the per capita consumption of good b by sector i.

T_1 is a lump-sum tax levied on sector 1 and invested in public capital for sector 2, in units of good a.

K_P is the public capital of sector 2, which consists of good a.

ε_P is the efficiency of public investment in K_P.

ω measures the maximum lump-sum tax rate which a family in sector 1 will tolerate, compared to a base line $K_{10}e^{\gamma t}$, where K_{10} is its initial

---

[2]Equations for the price p get more complicated when we allow more complex capital inputs or tax schedules. Note, though, that if we were to include public capital inputs of type a to sector 1 and of type b to sector 2 each financed by its own sector, and the government were interested in increasing the welfare of each sector, either to maximize the objective function or to meet the welfare constraints, the optimization problem could be reduced to a problem of the type proposed, where K_1 and K_2 would now represent both private and public capital inputs of types a and b (in sectors 1 and 2 respectively). In a sense, the AK model, which is often conceived to take positive externalities into account, can be interpreted as considering social blocks or sectors as wholes.

level of private capital and γ is the balanced growth rate of the system, to be found below.

We follow Barro (1990) and Futagami, Morita, and Shibata (1993) in the manner of including public capital in the production function ϕ^2. It exhibits constant returns to scale with diminishing returns to each factor, and the benefits of public capital are provided free of charge. However, we differ in that we consider that the representative production function is $k_2\phi^2(1,K_P/K_2)$ (where k_2 is per-capita capital in sector 2). Thus the private production function is homogeneous of degree 1, while the effect of public capital on production depends on its ratio to the global amount of private capital in sector 2, with decreasing returns.

The choice of production functions makes sector 1 economically independent of sector 2, while sector 2 is economically dependent on sector 1, needing capital inputs form this sector. Since it is the government that provides them, it is also politically dependent.

We need not state the production functions available to each sector for producing other sectors' goods, since these involve disadvantages and will therefore not be used.

The coefficient ε_P may include such considerations as government inefficiency, consumption and corruption. It could also be considered to include the pursuit of interests specific to the government, including the wastage involved in government favor not encompassed by public investment.

We have excluded public services because from a sectorial point of view in which preferences are uniform their main effect is to redistribute resources, and because they involve multiple equilibria (high public expense with low growth, or viceversa, Jison Lee, 1992) which would complicate the exposition.

We have supposed that public capital can be provided by the government completely selectively (the possibility set is $K_P \geq 0$). That is, the development of sector 1 has no externalities which could take the place of the public capital input, and the public capital provided to sector 2 does not benefit production in sector 1. This is realistic when the productive sectors are sufficiently different for it to be possible for public policy to be discriminatory, as when their needs or location are different[3].

In models of endogenous growth with a single equation of state there is no a priori limit to the amount of investment which can be made in a limited time. For symmetry and simplicity, we make the same supposition in the case of public investment. This has the consequence that optimization could be enhanced by instantaneous transfers of capital of the same type, for instance from private to public, which would all occur at time $t = 0$[4]. We have chosen not to include the possibility of these transfers, although they are not altogether irrealistic when a change of political regime occurs. In any case, as explained above, we are mainly interested in the steady states of the model.

We consider two cases for the determination of the relative price p between goods a and b. In the first, the economy is open and p is the international price, which we shall assume is constant. In the second, the economy is closed and p is formed in the internal market. In this simple model the government does not affect the price, since it buys the goods it invests from the sector which it taxes. The market clearing equation is

$$pb_1N_1 = a_2N_2. \qquad \textbf{3.7}$$

This equality also represents the budget restriction for families in each sector.

The model consists of a Stackelberg game in which the government leads and the families of each sectors follow. Each type of player solves the following maximization problems.

---

[3]Including externalities for each of the four types of capital preserves the dependency of sector 2 so long as for constant returns to scale in sector 2's aggregate production function public investment is necessary.

[4]Because the Hamiltonian is linear in τ_1 and convex in the state variables (see Kamien & Schwartz, 1991, §18).

The problem for families in sector 1:

$$\max_{a_1, b_1} U_1 = \int_0^\infty u(a_1,b_1)e^{-rt}dt. \tag{3.8}$$

$$\text{s. t.} \quad k_1' = \phi^1(k_1) - nk - (a_1 + pb_1) - \tau_1$$

where $k_1 = K_1/N_1$ is capital stock per capita and $\tau_1 = T_1/N_1$, $p(t)$ are given.

The problem for families in sector 2:

$$\max_{a_2, b_2} U_2 = \int_0^\infty u(a_2,b_2)e^{-rt}dt \tag{3.9}$$

$$\text{s. t.} \quad k_2' = \phi^2(k_2,K_P/K_2) - nk_2 - \frac{1}{p}(a_2 + pb_2)$$

$$k_P' = \varepsilon_P\tau_1N_{12} - nk_P$$

where $k_2 = K_2/N_2$, $k_P = K_P/N_2$, are capital stock per capita, τ_1, $p(t)$ are given, and we write $N_{12} = N_1/N_2$. The equation for k_P is included in the problem for families in this sector for convenience, so that, although it does not affect their decisions, their optimal utility U_2^* is a function of τ_1 rather than k_P, as in sector 1.

The problem of the government. We suppose that the government announces a lump-sum tax rate independent of the families' decisions so that there is no feed-back in the game. This is realistic in that governments do not change tax rates continuously and greatly simplifies the mathematical problem since the problem ceases to be one of control with feed-back. Let

$$U_1^* = U_1^*(\tau_1,p), \quad U_2^* = U_2^*(\tau_1,p) \tag{3.10}$$

be the maximum utilities (per capita) obtained by the families of each sector given a government policy τ_1 and a price trajectory $p(t)$, formed in an open or closed economy. The governments problem is

$$\max_{\tau_1} u_G(U_1^*,U_2^*) \tag{3.11}$$

subject to $\quad Z_G' = z_G(U_1^*,U_2^*) \geq 0, \ \tau_1 \leq \omega k_{10}e^{\gamma t},$

and to

$$\begin{cases} p = \text{const} & \text{if the economy is open,} \\ 3.10 & \text{if the economy is closed.} \end{cases}$$

We consider three functions u_G:

<u>I. Sector 1 governs:</u> $u_G = U_1$

<u>II. Sector 2 governs:</u> $u_G = U_2$ **3.12**

<u>III. Shared government:</u> $u_G = u_G(U_1, U_2)$ with $u_{GU_i} > 0$, $i = 1, 2$.

The initial conditions we consider are that each capital has a fixed initial value and the usual transversality conditions hold.

4 The closed sectorial economy

The mathematical solution of the model, upon which the following conclusions and discussion are based, are presented in the Appendix.

In the case of a closed economy the government's problem (recall sector 2 is not taxed) is identical in cases I, II and III. This is because to achieve a balance in the consumption of both types of goods, in which the costs of production and therefore the relative price are optimal, any government will have the same incentives to invest in the public goods for sector 2. Unless the tax resistance of families in sector 1 is too high to allow it, solutions will converge to a unique balanced growth trajectory with growth rate

$$\gamma = (A_1 - n - r)/\sigma. \qquad \textbf{4.1}$$

The relative price p tends to a constant price

$$\bar{p} = \frac{1}{(1-\theta)\varepsilon_P}(A_1/A_2)^{1/(1-\theta)}. \qquad \textbf{4.2}$$

The marginal efficiency conditions

$$\bar{\psi}^2 = \bar{\phi}^1_{K_1} = \bar{p}\varepsilon_P\bar{\phi}^2_{K_P}, \qquad \textbf{4.3}$$

where $\psi^2 = \phi^2(1, K_P/K_2)$, hold along the balanced growth trajectory. They compare private capital investment in both types of capital and private versus public investment for capital of type a.

In a closed sectorial economy in steady state, there will be no incentive for capitalists belonging to one sector to invest in the other, independently of the sectorial advantages assumed. The efficiency conditions and prices are the same as in perfect competition.

The distribution of aggregate consumption between sectors depends only on the relative taste (or usefulness) of each sector's product[5] and holds on any trajectory:

$$C_1/C_2 = \alpha/\beta. \qquad 4.4$$

If families in sector 2 are taxed (see section 11), these conclusions remain unaltered, except that

$$\beta C_1 = \alpha C_2 + T_2(\alpha + \beta), \qquad 4.5$$

where T_2 is the aggregate tax on sector 2.

In a closed sectorial economy, distribution will depend on the economic potential of each sector as determined by the aggregate demand for its goods, as well as on the initial distribution of wealth. Within each sector income will be distributed proportionally to the initial allocation of human and non-human wealth, while the aggregate wealth of each sector will depend on the aggregate demand for its good. The productive advantages of each sector will inhibit capital flows from the other sectors, thus allowing each sector to capitalize on the basis of its own income.

When sector 2 is not taxed, the balanced growth path implies a tax rate for sector 1

$$T_{10}/K_{10} = \left(\frac{1}{A_1-n-\gamma} + \frac{\alpha}{\beta(1-\theta)(\gamma+n)}N_{12}\right)^{-1}. \qquad 4.6$$

If this tax rate is greater than ω and is therefore rendered infeasible by the tax resistance of families in sector 1, even at the maximum taxation rate ω the productivity of private capital in sector 2 will remain less than in sector 1, the price of good b will tend to increase to infinity, and the sectorial structure will become unstable when sector 2's

---

When the production functions are more general this result includes intersectorial capital demands and net government demands for goods of each type. Then "usefulness" includes consumption and investment uses.

productive advantages disappear.

Let us examine the role played by the power attributes of each sector. So long as the market for goods clears, an optimal tax rate (if there are taxes) and a ratio of consumption are given, independently of whether convergence to the balanced growth path has been achieved. *A certain income distribution is guaranteed independently of any kind of political power.* Thus the incentives for political organization are weak. Income distribution can be modified by tax resistance or by organized resistance demanding a minimum level of utility, but such demands can only be met by some form of transfer or subsidy between sectors. Demands for more utility which depends on organized resistance will have to counter the tax resistance of the other sectors, which depends only on passive resistance.

Finally let us outline the mechanisms leading to public investment and its efficiency. *In a closed sectorial economy economic incentives tend to lead sectors towards a consensus as to the efficient levels of public investment which are judged by aggregate economic performance.*

5 The open sectorial economy

When the economy opens, the economic dependence of sector 2 on sector 1 is removed, since its inputs and consumption may now be imported. Thus the sector may itself become an engine of growth if we include taxes for sector 2. Its natural growth rate (see section 12) is

$$\gamma_2 = \left\{A_2\left((1-\theta)p\epsilon_p\right)^{1-\theta} - n - r\right\}/\sigma. \qquad \textbf{5.1}$$

Using 4.2,

$$\gamma_2 \leq \gamma \;\Leftrightarrow\; p \leq \bar{p} \qquad \textbf{5.2}$$

Thus if the international price is $p > \bar{p}$, the engine of growth will be sector 1 when the economy is closed and sector 2 when it is open. Our analysis divides into two cases. In the first $p \leq \bar{p}$ and sector 2's natural growth rate at international prices does not exceed sector 1's natural growth rate, while in the remaining case the reverse holds, $\gamma_2 > \gamma$. If the international economy has the same production functions, equality holds.

5A $\gamma_2 \leq \gamma$. *Sector 2's natural growth rate does not exceed sector 1's.*

First we describe the models results with zero taxation on sector 2. In the case of an open economy, both goods are available in the international market, so there are no incentives for one sector to direct its resources towards public invest in the production of the other. A public transfer benefits one sector to the detriment of the other. The model's solutions converge to a family of trajectories parameterized by the total present value of the intersectorial transfer, $T \in [0, T_{max}]$, whose maximum value is determined by the maximum tax rate:

$$T_{max} = \omega(A_1 - n - \gamma)^{-1} K_{10} \qquad \textbf{5.3}$$

The feasible set of sector utilities, if it exists, forms a subinterval along which the utility of one sector increases as the utility of the other decreases.

Case I. Sector 1 governs. The minimum level of taxation compatible with sector 2's minimum utility constraint $Z_G^2 \geq 0$ will be chosen. This level must be compatible with sector 1's tax resistance for a feasible set to exist. If the initial level of public capital K_P is not too high, the solutions converge to a balanced growth trajectory. If the level of organized power of sector 2 is so low that the zero public investment trajectory based on the initial stock of public capital meets the restriction $Z_G^2 \geq 0$, this will be the trajectory chosen by the government and there will not be balanced growth.

If sector 2 were taxed then its minimum growth rate would be γ_2 instead of zero (unless its tax resistance were to high), with the remaining results unchanged except that an intersectorial transfer could go towards sector 1 if public investment in sector 1's production function, or government services and subsidies for families in sector 1 are allowed. Then every case in which the transfer is from sector 1 to sector 2 leads to $Z_G^2 = 0$, while in the reverse case tax resistance may limit the transfer and Z_G^2 could be greater than zero. In this last case the logic is that sector 1 makes sector 2 grow so that it can obtain more taxes from it. However, it must be observed that this logic is weak, because the growth of sector 2 may have consequences in the balance of power which sector 1 may want to avoid.

Case II. Sector 2 governs. The maximum level of taxation compatible with sector 1's minimum utility constraint $Z_G^1 \geq 0$ and with $\tau_1 \leq \omega k_{10} e^{\gamma t}$ (possibly supplemented by taxes levied on sector 2) will be chosen, leading to balanced growth at rate γ. The tax rate rises to ω only if at this level $Z_G^1 \geq 0$. Sector 2 will not use its own resources to finance the public investment, because growth is being force-driven by taxing the higher growth sector 1.

Case III. Shared government. Unless the objective function u_G reflects an equal enough sharing in government, one or the other sector's objectives will be dominant in the feasible region, with the sign of

$$du_G/dT = u_{GU_1} U_{1T} + u_{GU_2} U_{2T} \qquad \textbf{5.4}$$

remaining constant (positive if sector 2 is dominant and the government pushes for the largest possible transfer, negative if sector 1 is dominant), and the solution reducing to Cases I or II. The condition for an interior maximum is for this derivative to be zero in the interior of the feasible region of discounted transfers, and then the solution converges to a balanced growth trajectory.

Along the balanced growth trajectories the same efficiency conditions 4.3 as in the closed sectorial economy hold. *The market for private capital is in equilibrium independently of each sector's advantages.*

Except in the case when a politically weak sector 2 is initially well endowed with public capital (as in transitions caused by openning trade), we reach the following conclusions:

In an open sectorial economy in steady state there will be no incentive for capitalists belonging to one sector to invest in the others, independently of the sectorial advantages assumed. The efficiency conditions and prices are the same as in perfect competition.

A dependent sector not in government will be reduced to the welfare level it can obtain by organized resistance, its economic size being determined accordingly, while an independent sector will obtain the *maximum of the levels implied by its passive and its organized resistance. Only in shared government will the welfare of all sectors be lifted above the levels implied by their powers of resistance. Thus in an open sectorial economy distribution is a result of the relative economic independence and political power of each sector.*

If sector 2 is initially well endowed with public capital, is politically too weak to demand any more, and has a high tax resistance, it will follow a negative growth trajectory at rate $-n$. If it is somewhat less weak, this period will eventually end and it will rejoin balanced growth at a reduced level of size. If sector 2 has tax resistance low enough that the proceeds can be used to finance its public capital needs, it will grow at rate γ_2, transferring income to sector 1 to the limit of its tax resistance but with a level of utility possibly higher than its organized resistance would guarantee.

Finally let us outline the mechanisms leading to public investment and its efficiency. *In an open sectorial economy public investment results from organized political pressure. In trying to minimize the costs of meeting welfare demands, the government will tends towards the usual efficiency conditions.*

5B Sector 2's natural growth rate exceeds sector 1's.

As a result of optimization sector 2 will grow faster than sector 1. Thus a steady state cannot be achieved. Sector 1's production function becomes relatively useless. Some change must happen, either in the sectorial structure, or in the production functions. The model can be thought to predict qualitative historical change in the political system or in the economy. If initially sector 1 is in government, it is likely that its hold on power will weaken while sector 2 will grow stronger. Some examples shall be given below.

6 Discussion of the model and some of its consequences

6A The government as sector

Consider the government, which can often be conceived of as a separate sector, as the first sector (it produces social organization, collective action, normative cohesion, power brokerage, law and order, conflict resolution, contractibility, national identity, etc.) and the productive sector (or any subsector) as the second sector. Then the income of the productive sector depends on the allocation of goods from the second sector that it receives. This models the basic dependence of any productive sector on the government.

6B Trade liberalization of sectorial economies

We first consider the case $\gamma_2 \le \gamma$ in which sector 2's natural growth rate does not exceed sector 1's.

We have found that income distribution, the incentives for political organization, and the mechanisms and efficiency of public investment differ substantially in closed and open sectorial economies. Thus we ask what happens when a closed sectorial economy in a steady state decides to open. Besides the direct economic effects of trade, which depend on the economy's relative advantages, what are the effects of trade liberalization?

We shall answer this question supposing that first the economy opens, then the government modifies its intersectorial public policy according to the new structure of incentives, and finally the political structure changes. We first suppose that the international price equals $\bar{p}$.

Case I. Sector 1 governs. Let us first suppose that income in sector 2 has been based on market earnings and either no political power or on tax resistance limiting transfers to other sectors, and that therefore the incentives for organized resistance have been small. When the economy opens, the incentives for the government to invest in sector 2 disappear. Sector 2 will not have the organization to demand from the government the amount of public investment it used to receive when the economy was closed. Until it is able to organize politically, public investment in its sector will be replaced by consumption in the other sector. Sector 2's utility will fall, and it will cease to invest, even consuming some of its capital. It may devote resources to becoming politically organized, since its economic size will depend on its political power. It may be that sectors which were viable (and efficient) in a closed economy are unviable in an open one because the cost of exercising political power is too high.

In all of the remaining cases no change occurs because income is already allocated according to political power.

If the international price is different from $\bar{p}$ both sectors will continue to produce, but the income and power of each sector will change, so there will be a period of political adjustment. Public investment and therefore the steady state level of income will adjust correspondingly.

Kenzo Abe, 1990, shows that in the presence of public inputs, ceteris paribus, the level of public input will strengthen the comparative advantage of the good enjoying the largest spillover from it. Hence we can conclude that the comparative advantage of sectors requiring public inputs will be a function of their political power.

Summarizing, trade liberalization can represent a formidable blow to sectors depending on public inputs but not counting with the political organization to obtain them. For these sectors liberalization will change the political status quo. The income which could be previously based on market earnings and at most a strategy of passive resistance to avoid intersectorial transfers can only be attained now by a strategy of active political participation. If most public investment used to be allocated to such dependent, under-organized sectors, the resulting political change will be deep. What before could be decided by the leading sector on the basis of cost-benefit analyses now becomes the subject matter of intense power struggle based on political organization. Last but not least, if such a trade liberalization policy is accompanied by a laissez faire policy seeking to leave adjustments to the markets and to diminish government participation in the economy (providing an excellent alibi for the selective cutting of public investment), the effects on politics and trade will be even stronger.

Let us now consider the case $\gamma_2 \geq \gamma$ when sector 2's natural growth rate exceeds sector 1's.

In this case trade liberalization will lead to a higher growth rate in sector 2 than in sector 1, and this should lead eventually to an increase in the power of that sector.

We believe the Case I scenario to be of relevance for many viable (as well as unviable) sectors which are not necessarily the driving growth in the economy in less developed countries changing from an import substitution to an open economy model of development, as in the case of Mexico. Sectors whose growth has been inhibited, and which could drive growth, however, may benefit from free trade and eventually even become engines of growth. The effects on the first sectors, however, can provoke an unstable political juncture which may have to be dealt with first. If the government is considered as a sector (as outlined above) it may survive by changing its system of alliances and priorities until it is more responsive to the needs of the emerging sectors, or it may be that the political organizational requirements of the emerging sectors involve deeper changes in the nature of the government.

6C An increase in protectionism in sectorial economies

When sector 2's natural growth rate does not exceed sector 1's, an increase in protectionism will tend to reduce organized resistance.

Protectionism may be used to change the engine of growth from one sector to another. The conflict between sectors involved in such changes may go as far as civil war. Such an analysis may through light on the American Civil War. The following quotations and account are from Olson, 1992, pages 106 and 32.

"Although historians in general have long seen the Civil War as the pivotal event in U.S. political history, economic historians in particular see the Civil War as a key event in the evolution of the American political economy. In those terms, the federal government assumed a much broader role in American economic life than ever before. When Southern Democrats walked out of Congress in 1860 and 1861, the Republicans were finally able to enact fully Henry Clay's "American System". They passed the Morrill Tariff of 1861, and its revisions in 1862 and 1864 substantially raised tariff levels." Western settlement was also promoted, currency and financial markets centralized, and railroads authorized. The American System "advocated a comprehensive program of federal legislation designed to unite the various sections of the country. (...) a high tariff on foreign goods in order to stimulate American industry (...) vigorous federal development of roads, canals, and river system in order to be able to deliver the goods all over the country. Food would head from west to east and manufactured goods from east to west."

By closing the economy the Northern industrial sector (which otherwise had disadvantages with Europe) became a growth engine, changing the balance of power between North and South and involving the West with the North in an economic dependency relationship. The South had previously been growing in a system involving trade with a European engine of growth, from which it was cut off, transfering its dependence to the North.

6D A comment on the EC

"Many researchers have asked 'has the EC increased world protectionism?'" (Winters, 1994). Our results imply the following point: since the countries participating in the EC are open to each other, the incentives for political organization in each country for sectors requiring public inputs are high. Once political organization is achieved, though, these sectors lobby for trade tariffs with respect to countries outside the EC.

6E Effects of technical change on the political system

Historians often analyze transitions of political systems or changes in hegemony in terms of economic causes driven by technical change. One of the motivations behind the sectorial model is to be able to describe the economic logic behind such analysis. We have seen that the specification of the production functions implies relations of economic and political dependence, as well as defining the leading sectors in terms of growth. Transitions in which a dominated sector undergoes technical change and eventually obtains hegemony are described by our model by specifying the sectors and production functions before and after the technical transition. Some new or old sector which was not dominant may have a higher growth rate, maybe combined with a lower rate of dependence which is able to resist transfers of wealth, which will ensure the growth of its capital and - by means unexplained by our model - its eventual access to power.

6F Fragmented perfect competition

The theoretical results of the fragmented perfect competition model are interesting in themselves. Fragmented perfect competition means that the economy is divided into fragments each of which specializes in the production of some good, for which it has advantages with respect to the other fragments, but the fragments are large enough that there is perfect competition within each of them. The results show that in this market scheme a different Pareto optimum is achieved than in perfect competition. Distribution does not occur according to the initial allocation of total wealth but according to the economic potential of the fragments in question. Within each fragment distribution of capital income occurs according to the initial allocation of capital, but the aggregate sectorial capital income depends on the fragment's economic potential. Wages could reflect a similar structure, if there are barriers to the mobility of labor, or there could be a uniform wage. The closed and open cases of sectorial[6] economies give two examples of such a model, in which this economic potential is defined differently. In the closed case the relative demand for each fragment's product determines its aggregate wealth, while in the open case political power and economic independence determine aggregate wealth. Income is distributed in this way because the productive advantages of any fragment inhibit capital flows from the

[6]"Sectorial" includes the political dimension while "fragment" does not.

others, allowing it to capitalize on the basis of its own income. The advantages do not determine the resulting steady state, which is stable within a corridor of fluctuations whose width depends on their size.

Considering that power often alters market structure, only the weaker effects of power on income distribution are modeled by fragmented perfect competition – we still have efficiency. Nevertheless this approach provides a way to represent these with the tools of perfect competition.

An important result following from the hypotheses of fragmented competition (which apply to the sectorial structure) is that the productive advantages which form a logical component of the concept do not affect any of the equilibrium quantities. The sectorial structure is stable before competition because there is no incentive to brake it. It will change only when fluctuations become too large. Here it is worth mentioning that the process of change may be very complex. A sector may invade the domain of another sector in amoeba like fashion, covering the entry costs in certain regions only.

7 Final remarks

The introduction of a sectorial structure in a model of endogenous growth has provided a rich structure full of intuitively appealing results relating the political properties of sectorial systems to their economic performance in income distribution and growth. The elements of economic optimization, namely, objectives and restrictions, relate naturally to aspects of political power which derive form collective action of different levels of complexity. We have called these the powers of passive and organized resistance, and socially organized power. This classification provides a point of entry for endogenizing the political system. That these levels of power are related to the costs of collective action, also throws light on how limits are set to power.

The model of fragmented perfect competition has provided a means to treat market imperfections with the tools of perfect competition. The model yields a Pareto equilibrium different to the one resulting from perfect competition but with the same efficiency conditions and prices.

Distribution depends on the economic potential of each fragment which can itself be modified by policies resulting from the exercise of political power.

The importance of whether an economy is open or closed is striking, *structurally determining* the mechanisms and incentives for the allocation of public goods, the economic potential yielding the income distribution between sectors, and the incentives for political organization.

For the present, our study has viewed the political system as exogenous to the economic system. However, the aim is to build a framework into which more structure can be introduced, such as games between sectors and the government in the political arena, which may affect growth, costs for collective action leading to political power and determining its exercise, and so on. Political transitions, income distribution and growth may then be modeled in terms of the incentives resulting from different power structures and the costs of achieving them for different sectors.

Appendix. Solution of the model

8 The families' problem

We apply Pontriagyn's Maximum Principle. The Hamiltonian of the problem faced by the families in sector 1 is

$$H^1 = u(a_1,b_1)e^{-rt} + \lambda_1\left(\phi^1(k_1) - nk_1 - a_1 - pb_1 - \tau_1\right). \qquad \textbf{8.1}$$

Here p and τ_1 are parameter functions external to the problem. The first order conditions are:

$$u_a(a_1,b_1)e^{-rt} = \lambda_1, \quad u_b(a_1,b_1)e^{-rt} = p\lambda_1. \qquad \textbf{8.2}$$

$$\lambda_1' = - H^1_{k_1} = (n - \phi^1_{k_1})\lambda_1. \qquad \textbf{8.3}$$

Substituting the definition of u (see 3.2), 8.2 implies

$$a_1 = c_a\left(p^{\beta}\lambda_1 e^{rt}\right)^{-1/\sigma}, \quad b_1 = c_b\left(p^{1-\alpha}\lambda_1 e^{rt}\right)^{-1/\sigma} \qquad \textbf{8.4}$$

where

$$c_a = \left(\frac{\alpha^{1-\beta}\beta^{\beta}}{1-\sigma}\right)^{1/\sigma}, \quad c_b = \left(\frac{\alpha^{\alpha}\beta^{1-\alpha}}{1-\sigma}\right)^{1/\sigma}. \tag{8.5}$$

From these equations we obtain

$$a_1/b_1 = (\alpha/\beta)p. \tag{8.6}$$

Therefore

$$c_1 = C_1/N_1 = (1 + \beta/\alpha)a_1 \tag{8.7}$$

and the behavior of families in sector 1 is represented by

$$k_1' = \phi^1(k_1) - nk_1 - c_1 - \tau_1, \tag{8.8}$$

$$c_1'/c_1 = (\phi^1_{k_1} - n - r - \beta p'/p)/\sigma. \tag{8.9}$$

The Hamiltonian of the problem faced by the families in sector 2 is

$$H^2 = u(a_2,b_2)e^{-rt} + \lambda_2\left(\phi^2 - nk_2 - \frac{1}{p}(a_2 + pb_2)\right) + \lambda_p\left(\varepsilon_p\tau_1 N_{12} - nk_p\right) \tag{8.10}$$

The first order conditions are:

$$u_a(a_2,b_2)e^{-rt} = \lambda_2/p, \quad u_b(a_2,b_2)e^{-rt} = \lambda_2 \tag{8.11}$$

$$\lambda_2' = (n - \psi^2)\lambda_2, \quad \lambda_p' = n\lambda_p - \phi^2_{k_p}\lambda_2 \tag{8.12}$$

where $\psi^2 = \phi^2(1,k_p/k_2)$. From the first two equations we obtain

$$a_2 = c_a\left(p^{\beta-1}\lambda_2 e^{rt}\right)^{-1/\sigma}, \quad b_2 = c_b\left(p^{-\alpha}\lambda_2 e^{rt}\right)^{-1/\sigma}, \tag{8.13}$$

$$a_2/b_2 = (\alpha/\beta)\ p. \tag{8.14}$$

Therefore

$$c_2 = C_2/N_2 = (1 + \beta/\alpha)a_2. \tag{8.15}$$

$$c_2'/c_2 = \left((1-\beta)p'/p + \psi^2 - n - r\right)/\sigma. \tag{8.16}$$

In the case of an open economy p is constant.

9 The government's problem in the case of a closed sectorial economy

Let us first examine the price in the case of a closed economy. Writing $N_{12} = N_1/N_2$, from equation 3.7

$$p = a_2/b_1N_{12}. \tag{9.1}$$

Equations 8.6, 8.7, 8.14, 8.15 and 9.1 imply

$$a_1/a_2 = b_1/b_2 = c_1/c_2 = \alpha/(N_{12}\beta), \tag{9.2}$$

so the distribution of total consumption by sector is proportional to the marginal utility of its product. These identities yield

$$p\lambda_1/\lambda_2 = u_a(a_1,b_1)/u_a(a_2,b_2) = (a_1/a_2)^{\alpha-1}(b_1/b_2)^{\beta} = (\alpha/N_{12}\beta)^{-\sigma}. \tag{9.3}$$

Now write down the total physical products of each sector,

$$a \equiv a_1 + a_2N_{21}, \quad b \equiv b_1N_{12} + b_2 \tag{9.4}$$

($N_{21} = N_2/N_1$). In terms of these p can be written

$$p = a_2/(b_1N_{12}) = \frac{\beta}{\alpha+\beta}N_{12}a/(\frac{\alpha}{\alpha+\beta}b) = \frac{\beta a}{\alpha b}N_{12}. \tag{9.5}$$

The ratio of total physical consumption corrected by the marginal utilities, determines the price p, while

$$C_1/C_2 = c_1N_1/(c_2N_2) = aN_{12}/(pb) = \alpha/\beta. \tag{9.6}$$

Each family's utility can be written:

$$\begin{aligned} u(a_1,b_1) &= \frac{1}{1-\sigma}(\frac{\alpha}{\alpha+\beta})^{1-\sigma}a^{\alpha}b^{\beta}N_{12}^{-\beta}, \\ u(a_2,b_2) &= \frac{1}{1-\sigma}(\frac{\beta}{\alpha+\beta})^{1-\sigma}a^{\alpha}b^{\beta}N_{12}^{\alpha}. \end{aligned} \tag{9.7}$$

Deriving 9.1 logarithmically and substituting a_2'/a_2, b_1'/b_1,

$$p'/p = \phi^1_{k_1} - \psi^2. \tag{9.8}$$

Substituting in 8.9 and 8.16

$$\begin{aligned} a'/a &= c_1'/c_1 = c_2'/c_2 = \Big((1-\beta)\phi^1_{k_1} + \beta\psi^2 - n - r\Big)/\sigma \\ b'/b &= \Big((1-\alpha)\psi^2 + \alpha\phi^1_{k_1} - n - r\Big)/\sigma \end{aligned} \tag{9.9}$$

We turn now to the government's maximization problem. Equations 9.7 imply that maximizing U_1 is equivalent to maximizing U_2. Both, as well as any function U_G are maximized by maximizing

$$V_G = \int_0^\infty \frac{1}{1-\sigma} a^\alpha b^\beta e^{-rt} dt. \qquad 9.10$$

Therefore the government's problem is identical in cases I, II and III (see 3.12). Thus we can write the government's problem as

$$\max_{\tau_1} V_G \quad \text{subject to} \quad pb_1N_1 = a_2N_2. \qquad 9.11$$

The precise identity holding between U_1^* and U_2^* is

$$\kappa U_1^*(\tau_1,p) = U_2^*(\tau_1,p), \quad \text{where } \kappa = (N_{12}\beta/\alpha)^{1-\sigma}. \qquad 9.12$$

This suggests solving problem 9.11 by considering the associated problem

$$\max_{\tau_1,p} \; U_1^*(\tau_1,p) \text{ subject to } U_2^*(\tau_1,p) = \kappa U_1^*(\tau_1,p). \qquad 9.13$$

That is, instead of considering the market clearing condition we suppose the price to be exogenous and ask only that the ratio of optimal utilities hold. All tax and price trajectories considered in the original are also considered in the associated problem. We shall show that the price trajectory optimizing the associated problem is the market clearing price, thus the optimal tax trajectory for the associated problem also is optimal for the original problem. Writing the Lagrangean (in functionals) for the closed economy (we use the index "c" for closed)

$$\begin{aligned}\mathcal{L}_c(\tau_1,p,\eta) &= U_1^*(\tau_1,p) + \eta_c\left(\kappa U_1^*(\tau_1,p) - U_2^*(\tau_1,p)\right) \\ &\quad + \int_0^\infty \mu_c^0\tau_1 + \mu_c^1(\omega k_{10}e^{\gamma t} - \tau_1)dt. \qquad 9.14\end{aligned}$$

Here η_c, $\mu_c^0(t)$, $\mu_c^1(t)$, are Lagrange multipliers with the usual conditions

$$\begin{aligned}&\eta_c\left(\kappa U_1^* - U_2^*\right) = 0 \\ &\mu_c^0\tau_1 = \mu_c^1(\omega k_{10}e^{\gamma t} - \tau_1) = 0; \quad \mu_c^0,\ \mu_c^1,\ \tau_1,\ \omega k_{10}e^{\gamma t} - \tau_1 \geq 0.\end{aligned} \qquad 9.15$$

For independent variations $\tau_1(s_1)$ or $p(s_2)$,

$$0 = \mathcal{L}_{cs_1} = \int_0^\infty \left\{\eta_c\varepsilon_P N_{12}\lambda_P - (1+\kappa\eta_c)\lambda_1 + \mu_c^0 - \mu_c^1\right\}\tau_{1s_1}dt \qquad 9.16$$

$$0 = \mathcal{L}_{cS_2} = \int_0^\infty \left\{\eta_c \lambda_2 p^{-2} a_2 - (1+\kappa\eta_c)\lambda_1 b_1\right\} p_{S_2}\, dt \qquad 9.17$$

Therefore, writing $\eta_c^0 = \eta_c/(1+\kappa\eta_c)$

$$\begin{aligned} 0 < \tau_1 < \omega k_{10} e^{\gamma t} &\Leftrightarrow \lambda_1 = \eta_c^0 \varepsilon_P N_{12} \lambda_P, \\ \tau_1 = 0 &\Leftrightarrow \lambda_1 > \eta_c^0 \varepsilon_P N_{12} \lambda_P, \\ \tau_1 = \omega k_{10} e^{\gamma t} &\Leftrightarrow \lambda_1 < \eta_c^0 \varepsilon_P N_{12} \lambda_P, \\ \lambda_1 b_1 = \eta_c^0 \lambda_2 p^{-2} a_2, \text{ i.e. } p b_1 N_{12}/a_2 &= \eta_c^0 (\alpha/\beta)^\sigma N_{12}^{1-\sigma} \end{aligned} \qquad 9.18$$

(using 9.3). Applying the same argument that led to 9.7 we must have

$$\eta_c^0 (\alpha/\beta)^\sigma N_{12}^{1-\sigma} = 1 \qquad 9.19$$

to satisfy the utility constraint 9.12. Thus the market clearing condition is one of the first order conditions for the associated problem, which as we saw therefore solves the original.

The case $0 < \tau_1 < \omega k_{10} e^{\gamma t}$.

The remaining first order condition in 9.18 is the efficiency condition for the investment of capital goods of type a, which states that the shadow price of its private investment in sector 1 should equal its shadow price as public investment in sector 2. It implies

$$0 = \lambda_1'/\lambda_1 - \lambda_P'/\lambda_P = \phi_{k_P}^2 \lambda_2/\lambda_P - A_1. \qquad 9.20$$

By equations 9.3, 9.18, 9.19,

$$\lambda_2/\lambda_P = p\varepsilon_P \qquad 9.21$$

Thus equation 9.20 implies

$$k_P/k_2 = \left((1-\theta)p\varepsilon_P(A_2/A_1)\right)^{1/\theta}. \qquad 9.22$$

Substituting in equation 9.8,

$$p' = A_1 p - \left((1-\theta)\varepsilon_P/A_1\right)^{(1-\theta)/\theta}\left(A_2 p\right)^{1/\theta}. \qquad 9.23$$

Thus p converges to an equilibrium value

$$\bar{p} = \frac{1}{(1-\theta)\varepsilon_P}(A_1/A_2)^{1/(1-\theta)}. \qquad 9.24$$

At this value 9.20, and 9.21 or 9.8 imply the following two efficiency conditions as equilibrium relations

$$\bar{\psi}^2 = \bar{p}\varepsilon_P\bar{\phi}^2_{k_P} = A_1 \qquad 9.25$$

Convergence to equilibrium is also convergence to balanced growth because 9.25 and 9.9 imply that c_1 and c_2 grow at rate γ. Along the balanced path

$$\bar{k}_2/\bar{k}_P = (A_2/A_1)^{1/(1-\theta)}. \qquad 9.26$$

We can now complete the solution of the balanced growth path. To do so we use the equations of physical (rather than monetary) flows:

$$\begin{aligned} k_1' &= A_1k_1 - nk_1 - a - \tau_1 \\ k_2' &= \phi^2(k_2,k_P) - nk_2 - b \\ k_P' &= \varepsilon_P\tau_1N_{12} - nk_P \\ a'/a &= \left((1-\beta)\phi^1_{k_1} + \beta\psi^2 - n - r\right)/\sigma \\ b'/b &= \left((1-\alpha)\psi^2 + \alpha\phi^1_{k_1} - n - r\right)/\sigma \end{aligned} \qquad 9.27$$

Write the solutions of the balanced growth path for the closed economy in the form

$$k_1^c = k_{10}^c e^{\gamma t},\ k_2^c = k_{20}^c e^{\gamma t},\ k_P^c = k_{P0}^c e^{\gamma t},\ a^c = a_0^c e^{\gamma t},\ b^c = b_0^c e^{\gamma t}. \qquad 9.28$$

The following equations must be satisfied, besides 9.26:

$$\begin{aligned} (A_1 - n - \gamma)k_{10}^c &= a_0^c + \tau_{10}^c \\ (A_1 - n - \gamma)k_{20}^c &= b_0^c \\ (\gamma + n)k_{P0}^c &= \varepsilon_P\tau_{10}^cN_{12} \\ (\beta/\alpha)(a_0^c/b_0^c) &= \bar{p} \end{aligned} \qquad 9.29$$

These give a one parameter family of proportional solutions which can be parameterized by τ_{10}^c as follows:

$$k_{10}^c = \left(\frac{1}{A_1-n-\gamma} + \frac{\alpha}{\beta(1-\theta)(\gamma+n)}N_{12}\right)\tau_{10}^c$$

$$\bar{k}_{20}^c = (A_2/A_1)^{1/(1-\theta)}\varepsilon_P\tau_{10}^cN_{12}/(\gamma + n)$$

$$k^c_{P0} = \varepsilon_P \tau^c_{10} N_{12}/(\gamma + n) \qquad \mathbf{9.30}$$

$$a^c_0 = \frac{\alpha(A_1-n-\gamma)N_{12}}{\beta(1-\theta)(\gamma+n)}\tau^c_{10}$$

$$b^c_0 = (A_1 - n - \gamma)(A_2/A_1)^{1/(1-\theta)}\varepsilon_P\tau^c_{10}N_{12}/(\gamma + n)$$

The cases $\tau_1 = 0$, $\tau_1 = \omega k_{10}e^{\gamma t}$.

To consider these cases let

$$\zeta = \varepsilon_P N_{12}\lambda_P/\lambda_1, \quad \xi = \lambda_2/\lambda_P. \qquad \mathbf{9.31}$$

The first order conditions 9.18 then read

$$\begin{aligned} 0 < \tau_1 < \omega k_{10}e^{\gamma t} &\Leftrightarrow \zeta = 1, \\ \tau_1 = 0 \qquad &\Leftrightarrow \zeta < 1, \\ \tau_1 = \omega k_{10}e^{\gamma t} &\Leftrightarrow \zeta > 1. \end{aligned} \qquad \mathbf{9.32}$$

We write $\tau_1 = \chi k_{10}e^{\gamma t}$ where χ is 0 or ω. Then k_P can be solved in 9.27;

$$k_P = (k_{P0} - \tfrac{1}{\gamma+n}\varepsilon_P N_{12}\chi k_{10})e^{-nt} + \tfrac{1}{\gamma+n}\varepsilon_P N_{12}\chi k_{10}e^{\gamma t}. \qquad \mathbf{9.33}$$

In the case $\chi = 0$ we shall prove that if A_1 is large enough the condition $\zeta < 1$ cannot be maintained over an infinite interval, while in the case $\chi = \omega$ we shall show that if $\zeta = 1$ is not reached in finite time, the trajectory converges in any case to a balanced growth path.

In the case $\chi = 0$ define $\bar{k}_2 = k_2e^{-nt}$, $\bar{k}_P = k_Pe^{-nt}$, $\bar{b} = be^{-nt}$. Then

$$\begin{aligned} \bar{b}'/\bar{b} &= \left((1-\alpha)\psi^2 + \alpha A_1 - n - r\right)/\sigma - n, \\ \bar{k}'_2 &= \phi^2(\bar{k}_2,k_{P0}) - \bar{b}. \end{aligned} \qquad \mathbf{9.34}$$

By the kind of analysis usually applied to the Ramsey model, there is a unique path converging to a steady state at which the right hand sides of equation 9.34 must be zero. This implies $\psi^2 < A_1$ if $A_1 > n(1+\sigma)+r$, in other words, if $\gamma > n$, because at equality the right hand side of 9.34 is positive. Now consider the differential equations for ζ and ξ (obtained from 8.3, 8.12):

$$\xi'/\xi = \phi^2_{k_p}\xi - \psi^2,$$
$$\zeta' = A_1\zeta(1 - \xi\phi^2_{k_p}/A_1). \qquad 9.35$$

We seek to show that $\zeta < 1$ increases to 1. As $\bar{k}_2/k_{p0}$ converges, it is clear that $\xi \to \infty$ or $\phi^2_{k_p}\xi \to \psi^2 < A_1$. In both cases ζ tends to zero. Thus any interval with $\tau_1 = 0$ must be finite and ends with $\zeta = 1$.

In the case $\chi = \omega$ define $\tilde{k}_2 = k_2e^{-\gamma t}$, $\tilde{k}_p = k_pe^{-\gamma t}$, $\tilde{b} = be^{-\gamma t}$. Then

$$\tilde{b}'/\tilde{b} = (1-\alpha)(\psi^2 - A_1)/\sigma,$$
$$\tilde{k}'_2 = \phi^2(\tilde{k}_2,\tilde{k}_p) - \tilde{b}. \qquad 9.36$$

Again there is a unique path converging to a steady state at infinity at which the right hand sides of 9.36 are zero so $\psi^2 = A_1$. From here we can show that, if $\zeta = 1$ is not reached in finite time, $\psi^2 - A_1$ must be integrable over the infinite interval. Hence the equation for $\tilde{a} = ae^{-\gamma t}$,

$$\tilde{a}'/\tilde{a} = (1-\beta)(A_1 - \psi^2)/\sigma \qquad 9.37$$

is also integrable, and so is the equation for $\tilde{k}_1 = k_1e^{-\gamma t}$,

$$\tilde{k}'_1 = (A_1 - n - \gamma)\tilde{k}_1 - \tilde{a} - \omega k_{10}. \qquad 9.38$$

Since $\tilde{a}$ converges, it is clear that there is a unique trajectory $\tilde{k}_1$ satisfying the transversality conditions and tending to

$$\lim_{t\to\infty} \tilde{k}_1 = \frac{1}{A_1-n-\gamma}(\lim_{t\to\infty} \tilde{a} - \omega k_{10}). \qquad 9.39$$

Finally, we sketch a proof that the case $\zeta \neq 1$ can only occur on an interval with initial point $t = 0$. This we do by comparing with the problem in which instantaneous transfers of capital between K_1 and K_p are possible (although we conserve the restrictions on τ_1). This problem is characterized by the initial condition $\zeta = 1$, which is equivalent to the initial condition $V_{Gk_1} = \varepsilon_p N_{12} V_{Gk_p}$ on the value function. Given these initial conditions there is a unique solution with $\zeta \equiv 1$ which involves no initial jump and also no further jump, by a modification of the proof in Kamien & Schwartz, 1991, §18, since the Hamiltonian is convex in the state variables. Wherever ζ reaches 1 the solution without jumps takes over.

Thus solutions may begin with $\tau_1 = 0$ but after a finite interval they continue with one of the other solutions, which we have seen converge to balanced growth.

10 The government's problem in the case of an open sectorial economy

In the case of an open economy the families behave according to

$$\begin{cases} k_1' = (A_1 - n)k_1 - c_1 - \tau_1 \\ c_1'/c_1 = (A_1 - n - r)/\sigma \end{cases} \qquad 10.1$$

$$\begin{cases} k_2' = \phi^2(k_2,k_P) - nk_2 - \frac{1}{p}c_2 \\ k_P' = \varepsilon_P\tau_1 N_{12} - nk_P \\ c_2'/c_2 = (\psi^2(k_P/k_2) - n - r)/\sigma \end{cases} \qquad 10.2$$

This system decomposes into two independent systems each determined by the function τ_1. When taxes increase, the first sector's utility decreases while the second sector's increases. For a variation $\tau_1(s)$,

$$U^*_{1S} = -\int_0^\infty \lambda_1\tau_{1S}dt, \quad U^*_{2S} = \int_0^\infty \varepsilon_P N_{12}\lambda_P\tau_{1S}dt. \qquad 10.3$$

Therefore

$$Z^1_{GS} = \underset{(+)}{z^1_{GU_1}}\underset{(-)}{U^*_{1S}} + \underset{(-)}{z^1_{GU_2}}\underset{(+)}{U^*_{2S}} < 0, \qquad 10.4$$

$$Z^2_{GS} = \underset{(-)}{z^2_{GU_1}}\underset{(-)}{U^*_{1S}} + \underset{(+)}{z^2_{GU_2}}\underset{(+)}{U^*_{2S}} > 0. \qquad 10.5$$

Given a function u_G (corresponding to one of the cases of government) we can define a Lagrangean for the open economy (we use index "o" for open)

$$\mathcal{L}_o(\tau_1,\eta_1,\eta_2) = u_G(U^*_1,U^*_2) + \eta^1_o Z^1_G + \eta^2_o Z^2_G$$
$$+ \int_0^\infty \mu^0_o\tau_1 + \mu^1_o(\omega k_{10}e^{\gamma t} - \tau_1)dt \qquad 10.6$$

Given a variation $\tau_1(s)$, for $0 < \tau_1 < \omega k_{10}e^{\gamma t}$ the first order condition is

$$0 = \mathscr{L}_{oS}(\tau_1,\eta_1,\eta_2) = -\,(u_{\underset{(+)}{GU_1}} + \eta_o^1 z^1_{\underset{(+)}{GU_1}} + \eta_o^2 z^2_{\underset{(-)}{GU_1}})\big|_{(U_1^*,U_2^*)}\int_0^\infty \lambda_1\tau_{1S}dt$$

$$+\,(u_{\underset{(+)}{GU_2}} + \eta_o^1 z^1_{\underset{(-)}{GU_2}} + \eta_o^2 z^2_{\underset{(+)}{GU_2}})\big|_{(U_1^*,U_2^*)}\int_0^\infty \varepsilon_P N_{12}\lambda_P\tau_{1S}dt \qquad 10.7$$

Because λ_1 and λ_P are positive, in every case we must obtain the existence of some constant $\eta_o^0 > 0$ for which

$$\lambda_1 = \eta_o^0\varepsilon_P N_{12}\lambda_P \qquad 10.8$$

Differentiating we obtain 9.20. Writing $\xi = \lambda_2/\lambda_P$ (in the case of the closed economy we could use p)

$$k_P/k_2 = \Big((1-\theta)\xi(A_2/A_1)\Big)^{1/\theta} \qquad 10.9$$

ξ has the differential equation

$$\xi'/\xi = \phi^2_{k_P}\xi - \psi^2 = A_1 - \tfrac{1}{1-\theta}A_1k_P/(\xi k_2)$$

$$\xi' = A_1\xi - (A_2\xi)^{1/\theta}\Big((1-\theta)/A_1\Big)^{(1-\theta)/\theta} \qquad 10.10$$

The solution converges to

$$\bar\xi = \bar\psi^2/\bar\phi^2_{k_P} = \Big((1-\theta)^{1-\theta}A_2/A_1\Big)^{-1/\theta} \qquad 10.11$$

At this equilibrium value

$$\bar\psi^2 = \bar\phi^2_{k_P}\,\bar\xi = A_1. \qquad 10.12$$

Thus at equilibrium both sectors have consumption growing at rate γ, so the equilibrium corresponds to balanced growth. Private capital satisfies the same efficiency condition as in the closed case. Public capital also satisfies this condition if the exogenous price satisfies $p = \bar\xi/\varepsilon_P$.

The balanced growth path satisfies equations

$$\begin{aligned}(A_1 - n - \gamma)k^o_{10} &= c^o_{10} + \tau^o_{10}\\ (A_1 - n - \gamma)k^o_{20} &= \tfrac{1}{p}c^o_{20}\\ (\gamma + n)k^o_{P0} &= \varepsilon_P\tau^o_{10}N_{12}\\ k^o_{20}/k^o_{P0} &= (A_2/A_1)^{1/(1-\theta)}\end{aligned} \qquad 10.13$$

Parameterizing with τ^{o}_{10}, the solutions are

$$k^{o}_{P0} = \varepsilon_P \tau^{o}_{10} N_{12}/(\gamma + n)$$

$$k^{o}_{20} = (A_2/A_1)^{1/(1-\theta)} \varepsilon_P \tau^{o}_{10} N_{12}/(\gamma + n) \qquad 10.14$$

$$c^{o}_{20} = p(A_1 - n - \gamma)(A_2/A_1)^{1/(1-\theta)} \varepsilon_P \tau^{o}_{10} N_{12}/(\gamma + n)$$

$$c^{o}_{10} = (A_1 - n - \gamma)k^{o}_{10} - \tau^{o}_{10}$$

τ^{o}_{10} is set to satisfy the minimum utility constraints of one or the other government, unless in the case of a shared government the government's objectives are maximized in the interior of the set of feasible utilities.

Now let us suppose $\tau_1 = 0$. System 10.1, 10.2 has a solution in which sector 1 grows at rate γ and sector 2 converges to a trajectory growing at rate $-n$. Even so sector 2 has a certain utility which may satisfy the political constraints. Similarly $\tau_1 = \omega k_{10} e^{\gamma t}$ gives a solution in which sector 1 grows at rate γ and sector 2 converges to a trajectory growing at rate γ. These two possibilities define the extremes of the distribution of wealth between the sectors. In between we will get solutions which may have $\tau_1 = 0$ in an initial finite interval, as in the closed case, and which then converge to balanced growth.

We sketch a proof that the set of optimum values forms a one-parameter family which can be parameterized by the total discounted transfer

$$T = \int_0^{\infty} T_1 e^{-(A_1 t)} dt = N_{10} \int_0^{\infty} \tau_1 e^{-(A_1 - n)t} dt. \qquad 10.21$$

Given a variation $\tau_1(s)$

$$T_s = N_{10} \int_0^{\infty} \tau_{1s} e^{-(A_1 - n)t} dt = \frac{N_{10}}{\lambda_{10}} \int_0^{\infty} \tau_{1s} \lambda dt = -\frac{N_{10}}{\lambda_{10}} U^{*}_{1s}. \qquad 10.22$$

This implies that U^{*}_1 can be parameterized by $T \in [0, T_{max}]$, where

$$T_{max} = \omega(A_1 - n - \gamma)^{-1} K_{10} \qquad 10.22$$

is the discounted transfer corresponding to the maximum tax-rate. On the other hand it is clear from the maximization procedure that one value of U^{*}_2 corresponds to each value of U^{*}_1.

11 Sector 2 taxed in the closed case

Suppose sector 2 is taxed in the closed case. The modified equations for k_1 and k_2 are:

$$k_1' = \phi^1(k_1) - nk - (a_1 + pb_1) - \tau_1 + \tau_2$$
$$k_2' = \phi^2(k_2, K_P/K_2) - nk_2 - \frac{1}{p}(a_2 + pb_2) - \frac{1}{p}\tau_2 N_{12} \qquad 11.1$$

Modifiying the Hamiltonian of each representative family accordingly, when we solve problem 9.13 (now maximizing in τ_1, τ_2) we get in the unrestricted case $0 < \tau_1 < \omega k_{10} e^{\gamma t}$, $0 < \frac{1}{p}\tau_2 < \omega_2 k_{20} e^{\gamma t}$,

$$\lambda_1 = \eta_c^1 \varepsilon_P N_{12} \lambda_P, \quad \lambda_1 = \eta_c^1 N_{12} \lambda_2 / p, \qquad 11.2$$

$$\lambda_1 b_1 = \eta_c^1 \lambda_2 p^{-2}(a_2 + \tau_2 N_{12}). \qquad 11.3$$

In this case the market clearing condition is

$$pb_1 N_{12} = a_2 + \tau_2 N_{12}, \qquad 11.4$$

which is obtained together with 9.19 as before from 11.3 using 9.3. Now 11.2 implies 9.20, 9.21, and 9.22. We now get 10.10, 10.11, 10.12. and therefore convergence to a balanced trajectory with the same equilibrium price $\bar{p}$. Now we shall have from 8.6, 8.7, 8.14, 8.15 and 11.4,

$$\beta C_1 = \alpha C_2 + T_2(\alpha + \beta). \qquad 11.5$$

12 Sector 2's natural growth rate in the open case

Suppose sector 2 is taxed in the open case. Then the problem a government faces when maximizing its utility based on sector 2 financing the public capital is

$$\max_{\tau_2, a_2, b_2} U_2 = \int_0^\infty u(a_2, b_2) e^{-rt} dt \qquad 12.1$$

$$\text{s. t. } k_2' = \phi^2(k_2, K_P/K_2) - nk_2 - \frac{1}{p}(a_2 + pb_2) - \frac{1}{p}(\tau_2^1 + \tau_2^2)$$
$$k_P' = \varepsilon_P \tau_2^1 - nk_P$$

where $\tau_2^1 \geq 0$ are per-capita taxes used to finance its public capital and τ_2^2 is a per-capita intersectorial transfer, which may be of either sign. Using the appropriate modification of Hamiltonian 8.10, equations 8.11, 8.12 and 8.16 are found to hold, together with the condition

$$\frac{1}{p}\lambda_2 = \lambda_p \varepsilon_p. \qquad \textbf{12.2}$$

Differentiating equation 12.2, and using equations 8.12, we obtain the efficiency condition for public investment,

$$\psi^2 = p\varepsilon_p \phi^2_{k_p}. \qquad \textbf{12.3}$$

Therefore

$$k_p/k_2 = (1-\theta)p\varepsilon_p \qquad \textbf{12.4}$$

and, substituting in 8.16, the natural growth rate of sector 2 is

$$\gamma_2 = \left\{A_2\left((1-\theta)p\varepsilon_p\right)^{1-\theta} - n - r\right\}/\sigma. \qquad \textbf{12.5}$$

References

Abe, K.: A public input as a determinant of trade. *Canadian Journal of Economics, Vol 23, No 2,* 400-407, May 1990.

Alesina, A. and Perotti, R.: The Political Economy of Growth: A Critical Survey of Recent Literature. *The world Bank economic Review, Vol 8, No 3,* 351-371, Sept 1994.

Arrow, K. J. and Kurz, M.: *Public Investment, the Rate of return, and Optimal Fiscal Policy*. Johns Hopkins University Press, Baltimore, 1970.

Aschauer, D. A.: Is public expenditure productive? *Journal of Monetary Economics 23* , 177-200, 1989.

Atkinson, A. B. and Stiglitz, J. E.: *Lectures on Public Economics.* Mc-Graw-Hill, New York, 1980.

Barro, R. J.: Government spending in a simple model of economic growth. *Journal of Political Economy 98,* 103-25, 1990.

Barro, R. J.: Democracy and Growth, *Working Paper No 4909,* National Bureau of Economic Research, Inc., 1994.

Barro, R. J. and Sala-i-Martin, X.: Public Finance in models of economic growth. *Review of Economic Studies 59,* 645-61, 1992.

Barniard, S.L. and Verdier, T.: Lobbying and adjustment in declining industries. *European Economic Review, Vol 38, Nos 3/4,* 586-595, April, 1994.

Congleton, R.D. and Bennet, R.W.: On the political economy of state highway expenditures: Some evidence of the relative performance of alternative public choice models. *Public Choice, Vol 84, Nos 1-2,* 1-24, July 1995.

Evans, P.: *Embedded Autonomy*. Princeton University Press, 1995.

Futagami, K., Morita, Y., and Shibata, A.: Dynamic analysis of an endogenous growth model with public capital. *Scandinavian Journal of Economics 95* (4), 607-625, 1993.

Futagami, K. and Mino, K.: Infrastructure and long-run growth with threshold externalities. Mimeo, Ritsumeikan and Tohoku Universities, 1992.

Gorter, H. de and Zilberman, D.: On the Political Economy of Public Good Inputs in agriculture. *American Journal of Agricultural Economics, Vol 72, No 1,* 131-137, February 1990.

Hinich, M.J. and Munger, M.C.: *Ideology and the Theory of Political Choice*. The University of Michigan Press, 1994).

Iwamoto, Y.: An evaluation of public investment policy in postwar Japan (in Japanese). *Economic Review 41,* 250-61, 1990.

Jones, L. E. and Manuelli, R.: A convex model of equilibrium growth: Theory and policy implications. *Journal of Political Economy 98,* 1008-38, 1990.

Kamien M. and Schwartz, N.: *Dynamic Optimization,* Advanced Textbooks in Economics, volume 31, North Holland, 1991.

King, R. and Rebelo, S.: Public policy and economic growth: Developing neoclassical implications. *Journal of Political Economy 98,* 126-50, 1990.

Lee, J.: Optimal magnitude and composition of government spending. *Journal of the Japanese and International Economies 6,* 423-39, 1992.

Lucas, R. E.: On the mechanics of economic development. *Journal of*

Monetary Economics 22, 3-42, 1988.

Mino, K.: Analysis of a two-sector model of endogenous growth with capital income taxation, Faculty of Economics DP, Tohoku University, 1990a.

Mino, K.: Accumulation of public capital and long-run growth. Mimeo, Tohoku University 1990b.

Olson, J.S. with Wladaver-Morgan, S.: *Dictionary of United States Economic History*, Greenwood Press, USA, 1992.

Olson, M.: *The Logic of Collective Action*, Harvard Economic Studies volume CXXIV, Harvard University Press, second edition, 1971.

Olson, M.: *The Rise and Decline of Nations*, Yale University Press, 1982.

Pipitone, U.: *La salida del atraso: un estudio histórico comparativo*, Fondo de Cultura Económica, México, 1994.

Rebelo, S.: Long run policy analysis and long run growth. *Journal of Political Economy 99*, 500-21, 1991.

Riaz, K., Shogren, J.F. and Johnson, S.R.: A general model of rent-seeking for public goods. *Public Choice, Vol 82, Nos 3-4,* 243-259, March 1995.

Romer, P.: Increasing returns and long-run growth. *Journal of Political Economy 94*, 1002-37, 1986.

Saint-Paul, G. and T. Verdier, Education, Democracy and Growth. *Journal of development Economics 42*, 399-407, 1993.

Schmitter, P. and Lehmbruch, G.: *Neocorporativismo I. Más allá del estado y del mercado.* Alianza Editorial, México, 1992.

Sturzenegger, F. and Tommasi, M.: The distribution of political power, the costs of rent-seeking, and economic growth. *Economic Inquiry, Vol 32, No 2,* 236-248, April, 1994.

Uzawa. H.: Sur la théorie économique du capital collectif social. Cahiers du seminaire d'économetrie, 103-22, 1974. Reprinted as Chapter 19 in H. Uzawa, *Preference, Production and Capital*, Cambridge University Press, New York, 1988.

Verdier, T.: Models of Political Economy of Growth. *European Economic Review, Vol 38, Nos 3/4,* April, 757-763, 1994.

Winters, L.A.: The EC and protection: The political economy. *European Economic Review, Vol 38, Nos 3/4,* 596-603, April, 1994.

Zhou, H.: Rent-seeking and market competition. *Public Choice, Vol 82, Nos 3-4,* 225-241 March 1995.