Government decisions on income redistribution and public production
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Citation for published version (APA):

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6 The behavior of firms, technology and public goods

6.1 Introduction

The impact of public capital on private sector productivity has long been neglected. Although this impact was already put forward in Arrow and Kurz (1970) and Ratner (1983), it only received full attention at the end of the eighties in the debate on the slowdown of the U.S. economy. In a seminal study Aschauer (1989) reported that (nonmilitary) public capital has a positive effect on productivity. This conclusion was supported by several other empirical studies with different set-ups. In addition, the investigation of the impact of different types of public capital, that was already taken at hand by Aschauer, was further elaborated in Nadiri and Mamuneas (1994) and Pinnoi (1994). The study of Pinnoi also allows for differences in regional and industrial effects of government capital, while Nadiri and Mamuneas concentrate on industrial effects. Although the outcomes of these studies are more ambiguous, they support, in general, Aschauer’s view that some core elements of infrastructure have a positive effect on productivity, albeit that the effect is significantly smaller than Aschauer suggests. A fairly different set-up was also chosen in Lynde and Richmond (1993), where the impact of public capital on value-added output is analyzed. Their outcomes seem to support the view discussed in Chapter 4 above, that public capital has a positive influence on the private-capital rate of return (shadowprice of capital). Morrison and Schwartz (1996) use a cost function approach to study the impact of infrastructure on productivity growth. They conclude that shortfalls in investments in infrastructure may have hindered productivity growth. Whether the net benefits of investments in infrastructure are positive depends not only on the effect on productivity growth, but also on the social costs of investments. Their empirical findings suggest that the benefits of additional infrastructure for manufacturing firms may be smaller than the costs of the investments in additional infrastructure. Finally, the impact of public capital on economic performance was studied in an equilibrium framework in Shah (1992). The results in Shah’s study for the Mexican economy suggest that the current Mexican public and private capital stocks are below their (static) equilibrium values and that an upgrading of the public capital stock may reduce efficiency costs and increase private output.

The findings of Aschauer (1989) were, however, not without criticism. A key element in the critique is the question whether the production function variables are stationary [see, e.g., Tatom (1991)]. If the variables are not stationary, estimating
Chapter 6

A production function makes not much sense. Instead, changes in variables must be used for estimation. The problem then moves from investigating the effect of the public capital stock on productivity to the effect of public investments (changes in public capital) on economic growth (changes in production). TATOM (1991) and EVANS AND KARRAS (1994) find no significant effect of public investments on economic growth. The conclusion from these studies, that public investments have no effect on economic growth, is supported by BARRO (1991), who uses a fairly different set-up to estimate the relation between these variables. In contrast, MUNNELL (1992) points at the implausible coefficients for labor, private capital and public capital in the estimated production functions in TATOM (1991) and EVANS AND KARRAS (1994).

A second line of critique refers to the enormous range of estimates for the impact of public capital on productivity. For the studies that are reported in MUNNELL (1992) and PINNOI (1994) values for the output elasticity of public capital are found that differ between 0.026 and 0.39. MUNNELL (1992) tries to clear up the air a bit in classifying these studies by the size of the geographic area. Studies that use nation-wide data find an output elasticity of public capital between 0.34 and 0.39, while this elasticity lies between 0.15 and 0.20 for studies that focus on regions and is smaller than 0.08 in studies that examine metropolitan areas. According to Munnell, the higher impact of public capital for more extensive geographic areas is due to benefit spillovers: extra public capital in one state or metropolitan area leads to extra benefits in other states or metropolitan areas, which, in turn, have a positive effect on the development in the first area. Although the positive relation between public capital and productivity is not evidenced by all studies and the above remarks do not fully cover the critical questions that are put forward [see GRAMLICH (1994) for a review of the critique], MUNNELL (1992) notes that assuming away the influence of public capital on private production is one step too far. This view is adopted here. Therefore, the production functions in the model of Chapter 4 contain public capital as one of the production factors that are necessary for production. For the value of the output elasticity of public capital a value of 0.1 is chosen (cf. Table 4.1), which is rather modest.

In contrast with the sizable literature that focuses on economic aspects of public capital, the attention for its political aspects is surprisingly small. A study focusing on decisionmaking with respect to public capital formation is PETERSON (1991). It is analyzed whether the size of infrastructure is in accordance with voters' preferences. Results of referenda on infrastructure bond proposals are used to
determine voters' preferences. About 20 percent of the works concerning infrastructure passes through the referendum process. It follows from the median voter theory that, if the public officials have a right perception of the voters’ tastes, infrastructure proposals submitted by public officials will be accepted half of the time, while about 50 percent of the population will vote for the proposal. Peterson analyzes the local election results of referenda on infrastructure for the period 1948-1990. Over the entire period more than 70 percent of the proposals were accepted, which indicates that voters find the size of infrastructure too low. Only between 1968 and 1978 less than 50 percent of the proposals passes the referendum process with a positive result. For the period 1984 to 1989 about 80 percent of the infrastructure proposals were accepted, with an average of 66 percent of yes-votes. This result suggests that voters are willing to pay more for infrastructure, which supports the view that public investments are too low.

The results in Peterson (1991) suggest that government decisions with respect to public capital formation are not in accordance with the preferences of voters, but it is not explained why the government does not implement the policy that is in accordance with the voters’ preferences. One reason is that the median voter model fails if decisionmaking has more dimensions. The size of infrastructure that follows from the choice of the voter with median preferences on infrastructure may conflict with other government plans. The median voter model is not an appropriate tool to analyze multidimensional decisionmaking. Probabilistic voting models would be more appropriate [see Coughlin (1992)]. Another reason might be that some voters, who are not supporting the infrastructure projects, are better able to promote their interests than other voters. The greater influence of these voters may be due to the fact that these voters belong to an interest group that has a strong group coherence [cf. Coughlin et al. (1990b)] or exerts political pressure [cf. Potter (1992)]. Another issue that is important in this respect, and which is not taken into account by the median voter model, is the behavior of bureaucrats. According to the theory of bureaucracy, bureaucrats have an interest in expanding budgets, suggesting that government spendings are higher than voters prefer, which contradicts the findings in Peterson (1991). In their studies of referenda voting on other subjects, Romer and Rosenthal (1979, 1982) and Shapiro and Sonstelie (1982) find indeed that bureaucrats try to enlarge their

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1 Thus, the median voter theory is in Peterson’s study not a positive theory that forms the basis for an explanation how government actually behaves, but, instead, a normative tool that gives a reference point to analyze how government should behave if it wishes to fulfill the preferences of the median voter.
budgets to a level that is higher than voters (that is, the median voter) prefer. The above extensions of a (probabilistic) voting model are captured by the interest function approach which underlies the model presented in Chapter 4. This model will be used throughout this chapter. In this model, productivity in the private sectors does not depend on public capital or public investments, but on a public production good that may be regarded as infrastructure. Thus, infrastructure is seen as a commodity that needs capital and labor as inputs. Labor is not only required for the production of the stock of physical infrastructure, but also for related services as, e.g., traffic police, or for maintenance. The need of maintenance is also captured by the depreciation of the capital stock. Infrastructure is, thus, not interpreted as a public capital stock, but as services users receive from this capital [compare NADIRI AND MAMUNEAS (1994)]. In Section 6.2 it is analyzed how changes in the political influence structure affect the size of infrastructure and private and public production levels.

As already noticed, the value of the output elasticity of public capital varies in the studies that empirically investigate the relation between public capital and productivity. In Section 6.3 the impact of changes in the output elasticities of infrastructure, private capital and labor, is studied. An increase in the output elasticity of infrastructure negatively affects the productivity of infrastructure, under conditions that are given in Section 6.3. In BAUMOL (1967) it is argued that growth between two sectors is unbalanced when labor productivity grows in one sector and is stagnant in the other sector. The growth rate of the stagnant sector falls behind the growth rate of the sector with growing labor productivity. In this chapter it will be analyzed whether a corresponding unbalanced development occurs if an asymmetry in infrastructure productivity growth is observed. Section 6.3 discusses the steady state effects of such a shock, while Section 6.4 also pays attention to transition effects. Related to the above observation of Baumol is the so-called Baumol's disease, stating that more of labor (or other input factors) must be transferred to the stagnant sector if the ratio of output between the sectors is held constant [see also BAUMOL ET AL. (1985)]. Since the output levels are endogenous in our model, we will not further investigate Baumol's disease.

In the model that was presented in Chapter 4, investments, required to adapt the capital stock, imply adjustment costs. The presence of these costs restricts capital mobility. Capital formation in the two public sectors is also accompanied by adjustment costs. The extra costs that are necessary to adjust a department-specific capital stock are an obstacle for cross-departmental flexibility in production. This is
especially true if capital has a broad meaning and also contains learning-by-doing aspects. Section 6.5 studies the consequences of changes in the adjustment costs.

6.2 Political influence, infrastructure and private economic performance

6.2.1 Introduction

In this section it is analyzed how changes in the political influence structure affect the level of infrastructure and the private production levels. With respect to infrastructure it is not analyzed whether the expenditures on infrastructure are too high or to low compared with the preferred expenditures of the median voter, as in Peterson (1991). Instead, it is investigated how the level of infrastructure changes if the political influence weights deviate from the numerical strengths of the social groups. In Section 5.2 the impact of changes in the political influence structure on redistribution and private and public consumption were discussed. This section builds on the results that were presented there. First the effects of changes in political influence on infrastructure and economic performance are studied if individuals have identical, homothetic preferences. Then, the same analysis is undertaken when consumers have different preferences.

6.2.2 Identical homothetic preferences

The effects of changes in the political influence structure are summarized in Tables 5.1 - 5.5 of Section 5.2.2. In that section the results of a change in the political influence structure for the situation that individuals have identical, homothetic preferences were discussed. It turned out that in such situation the distribution effects are the most prominent effects of a change in the political influence structure. With respect to efficiency, it was noticed in that section that a distribution of political influence over the social groups that differs more from the numerical strengths of the social groups (in the remainder, such situation will be called a more unequal distribution of political influence), led to a lower level of the public consumption good and to a higher value of the political interest function ($P$).

A similar argument as put forward for the public consumption good can explain these findings. Note, in this respect, that the marginal value of the political interest
function with respect to infrastructure (the public production good) depends on the marginal individual benefits of capital owners via the impact of infrastructure on dividend income and on the public consumption good, while the dependence on the marginal individual benefits of workers runs only via the impact of infrastructure on the public consumption good [compare eq. (5.1)].

Intuitively, it might be expected that a stronger political influence of capital owners would lead to an increase in the level of the public production good, because a higher level of this good raises private production, while its production is co-financed by workers. The income from dividends then increases and offsets the loss in disposable income that is due to higher taxes. In this way, the public production good could serve as an instrument for the redistribution of income from workers, who have now a limited political influence, to capital owners. This will not occur here, however, because the government can use a more efficient instrument to redistribute income: the lump-sum transfer system. The public production good is, therefore, not used as a redistribution mechanism but only as a production good. In Chapter 7 it will be examined how these results are affected if the government cannot use a lump-sum transfer system for the redistribution of income.

The above conclusions are still relevant if a change in political influence implies an increase in the political influence of capital owners in sector 2 at the cost of the political influence of capital owners in sector 1, as can be read from the last lines in Tables 5.1 - 5.5. Note that the dependence of production on infrastructure is similar for these sectors. In Section 6.4.3 a similar change in the political influence structure is discussed, except that in that case production in private sector 1 will be more dependent on infrastructure than production in private sector 2. It then follows that an increase in the political influence of capital owners in sector 1 accompanied by a decrease in the political influence of capital owners in sector 2 leads to an extension of infrastructure, although this extension is rather small.

6.2.3 Different homothetic preferences

As discussed in Section 5.2.3, the impact of the political influence structure on production levels is more substantial if preferences differ between the individuals of different social groups. Compared to workers, capital owners were assumed to have a higher preference for private commodities, which implied that an increase in the political influence of capital owners caused private production to increase.
The level of the public consumption good then declines, but this decline is not substantial. As a result of these changes in production, there will be a higher demand for infrastructure (the public production good). Therefore, an extension of infrastructure can be observed if the political influence of capital owners increases. Again, it is not for distributional reasons that infrastructure expands, for the transfer system can redistribute income more efficiently. Instead, the increase in private production and the fact that private production depends more on infrastructure than the production of the public consumption good, cause the level of infrastructure to increase. Note, finally, that a transfer of political influence from capital owners in sector 1 to capital owners in sector 2 gives only small effects on production levels. This is not surprising because the capital owners in both sectors have identical preferences.

6.3 Technological change, productivity and economic performance

The unbalanced development of sectors facing different increases in labor productivity was analyzed in Baumol (1967) by looking at the impact of changes in labor productivity on the growth rates. The growth rate of the sector with a relatively stagnant labor productivity is then smaller. This section studies the effects of changes in productivity of the input factors. The productivity of infrastructure is, in particular, analyzed. In the general equilibrium model used in this chapter neither exogenous nor endogenous growth is included. To analyze the effects of changes in the productivity of infrastructure it is first investigated how private production levels change in the new steady state, compared to their levels in the initial steady state. Furthermore, the analysis differs from Baumol’s analysis in the type of technological change that is studied. Instead of the neutral technological change in Baumol (1967) a nonneutral technological shock is implemented.2 The productivity change is induced by a change in the production function parameters. To describe the procedure, consider an increase in the production elasticity of infrastructure in a private sector \((\delta_{G} \text{ increases})\). In order to maintain constant returns to scale, assume that the production elasticity of capital decreases equally \((\delta_{K} \text{ decreases})\). It can now easily be checked that for a decrease in the productivity of infrastructure \((X_{j}/G_{p})\) it is sufficient that the private capital stock is larger than the level of infrastructure \((K_{j} > G_{p})\) and the parameter change

\[ \delta_{G} \text{ increases, } \delta_{K} \text{ decreases} \]

\[ \text{if } X_{j}/G_{p} < 1 \]

\[ \text{if } X_{j}/G_{p} > 1 \]

\[ \text{if } K_{j} > G_{p} \]

\[ \text{if } K_{j} < G_{p} \]

\[ \text{if } X_{j}/G_{p} = 1 \]

2 A neutral technological change leaves the marginal rate of substitution unaltered, whereas this rate alters if the technological change is nonneutral.
does not lead to an increase in the capital-infrastructure and labor-infrastructure ratios. This is the case in the initial steady state. Not only the productivity of infrastructure is affected by this parameter change, but also the productivity of private capital and labor are affected. These productivity changes are less straightforward and will be discussed in the next paragraph. Apart from the productivity change just discussed, this section will also pay attention to changes in labor productivity that go with changes in capital productivity. The comparative statics effects are presented in the Tables 6.1 - 6.4. In Section 6.4 the transition effects of a change in the productivity of infrastructure will be discussed.

A change in technology such that $\delta_{Gi}$ increases and $\delta_{Ki}$ decreases, leads, ceteris paribus, to a decrease in the productivity of both infrastructure and capital (cf. footnote 2). However, it turns out that, if general equilibrium effects are taken into account, the productivity of infrastructure decreases, while the productivity of capital increases. In order to understand the consequences of this technological change, let us assume for the moment that private production does not change and prices are fixed. In that case, the technological change causes private capital to decrease and infrastructure to increase. A smaller private capital stock implies a decrease in private investments. Although this leads to higher average adjustment costs (as will be explained in Section 6.5), investment costs per unit of production decrease, which gives firms the opportunity to pay a higher dividend. Contrary to the lower investments in the private sector is the increase in public investments that follows from the higher production of the public production good. The higher public investments do, however, not compensate the fall in private investments.

3 The productivity of the public production good equals

$$\frac{X_j}{G_p} = \left( \frac{K_j}{G_p} \right)^{b_k} \left( \frac{L_j}{G_p} \right)^{b_l}, \quad j = 1, 2, s$$

The partial derivative with respect to $\delta_{Gi}$ equals

$$\frac{\partial (X_j/G_p)}{\partial \delta_{Gi}} = - \frac{\partial (X_j/G_p)}{\partial \delta_{Ki}} = - (\frac{K_j}{G_p})^{b_k} (\frac{L_j}{G_p})^{b_l} \ln (\frac{K_j}{G_p})$$

which is negative if $K_j > G_p$. To obtain a negative total derivative, it is sufficient that the capital-infrastructure and the labor-infrastructure ratios do not increase if $\delta_{Gi}$ increases. Analogously, the partial derivative of the productivity of capital with respect to $\delta_{Gi}$ can be derived

$$\frac{\partial (X_j/K_j)}{\partial \delta_{Gi}} = (\frac{G_p}{K_j})^{b_w} (\frac{L_j}{K_j})^{b_l} \ln (\frac{G_p}{K_j})$$
Table 6.1 Effects on capital and shadowprice of capital

<table>
<thead>
<tr>
<th>Change in technological parameters</th>
<th>$\delta_{G1}$, $\delta_{G2}$, $\delta_{Gs}$</th>
<th>$K_1$</th>
<th>$K_2$</th>
<th>$K_3$</th>
<th>$K_p$</th>
<th>$q_1=q_2$</th>
<th>$q_p=q_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10, 0.10, 0.10</td>
<td>511.69</td>
<td>369.57</td>
<td>89.075</td>
<td>169.84</td>
<td>.36961</td>
<td>.002186</td>
<td></td>
</tr>
<tr>
<td>0.15, 0.15, 0.10</td>
<td>338.78</td>
<td>219.77</td>
<td>79.904</td>
<td>204.44</td>
<td>.37816</td>
<td>.002335</td>
<td></td>
</tr>
<tr>
<td>0.00, 0.00, 0.10</td>
<td>1363.4</td>
<td>1010.3</td>
<td>140.97</td>
<td>49.333</td>
<td>.31621</td>
<td>.001657</td>
<td></td>
</tr>
<tr>
<td>0.10, 0.10, 0.00</td>
<td>509.44</td>
<td>358.33</td>
<td>175.57</td>
<td>133.10</td>
<td>.37491</td>
<td>.002281</td>
<td></td>
</tr>
</tbody>
</table>

Note: a change in $\delta_{Gj}$ goes with an opposite change in $\delta_{Kj}$, $j = I, 2, s$.

Table 6.2 Effects on labor demand, leisure and the wage rate

<table>
<thead>
<tr>
<th>Change in technological parameters</th>
<th>$\delta_{G1}$, $\delta_{G2}$, $\delta_{Gs}$</th>
<th>$L_1$</th>
<th>$L_2$</th>
<th>$L_3$</th>
<th>$L_p$</th>
<th>$\ell_1$</th>
<th>$p_L$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10, 0.10, 0.10</td>
<td>236.10</td>
<td>327.93</td>
<td>121.04</td>
<td>52.629</td>
<td>.26230</td>
<td>.64091</td>
<td></td>
</tr>
<tr>
<td>0.15, 0.15, 0.10</td>
<td>215.81</td>
<td>323.08</td>
<td>119.93</td>
<td>71.229</td>
<td>.26995</td>
<td>.61374</td>
<td></td>
</tr>
<tr>
<td>0.00, 0.00, 0.10</td>
<td>285.50</td>
<td>341.72</td>
<td>121.71</td>
<td>9.8891</td>
<td>.24118</td>
<td>.79633</td>
<td></td>
</tr>
<tr>
<td>0.10, 0.10, 0.00</td>
<td>242.46</td>
<td>327.96</td>
<td>123.04</td>
<td>43.308</td>
<td>.26323</td>
<td>.63098</td>
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</tr>
</tbody>
</table>

Note: $\ell_1$ refers to leisure of social group $i$, $i = c_1, c_2, w$

Table 6.3 Effects on production and commodity prices

<table>
<thead>
<tr>
<th>Change in technological parameters</th>
<th>$\delta_{G1}$, $\delta_{G2}$, $\delta_{Gs}$</th>
<th>$X_1$</th>
<th>$X_2$</th>
<th>$G_1$</th>
<th>$G_p$</th>
<th>$p_1$</th>
<th>$p_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10, 0.10, 0.10</td>
<td>286.55</td>
<td>323.16</td>
<td>125.53</td>
<td>87.102</td>
<td>.81242</td>
<td>.86714</td>
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<tr>
<td>0.15, 0.15, 0.10</td>
<td>237.15</td>
<td>293.81</td>
<td>126.61</td>
<td>113.85</td>
<td>.85927</td>
<td>.89985</td>
<td></td>
</tr>
<tr>
<td>0.00, 0.00, 0.10</td>
<td>545.37</td>
<td>495.21</td>
<td>113.47</td>
<td>19.181</td>
<td>.64134</td>
<td>.73268</td>
<td></td>
</tr>
<tr>
<td>0.10, 0.10, 0.00</td>
<td>285.28</td>
<td>315.14</td>
<td>146.00</td>
<td>70.902</td>
<td>.82500</td>
<td>.87553</td>
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</table>

Table 6.4 Effects on dividend, utility, the value of the political interest function, the income tax rate and special provisions

<table>
<thead>
<tr>
<th>Change in technological parameters</th>
<th>$\delta_{G1}$, $\delta_{G2}$, $\delta_{Gs}$</th>
<th>$d_1$</th>
<th>$d_2$</th>
<th>$U_1=P$</th>
<th>$\tau_b$</th>
<th>$\sigma_{c_1}$</th>
<th>$\sigma_{c_2}$</th>
<th>$\sigma_w$</th>
</tr>
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<tbody>
<tr>
<td>0.10, 0.10, 0.10</td>
<td>.3825</td>
<td>.3883</td>
<td>2.1948</td>
<td>.2418</td>
<td>-.3054</td>
<td>-.3112</td>
<td>.0771</td>
<td></td>
</tr>
<tr>
<td>0.15, 0.15, 0.10</td>
<td>.4105</td>
<td>.4646</td>
<td>2.0912</td>
<td>.2665</td>
<td>-.3230</td>
<td>-.3771</td>
<td>.0875</td>
<td></td>
</tr>
<tr>
<td>0.00, 0.00, 0.10</td>
<td>.3148</td>
<td>.2333</td>
<td>2.7175</td>
<td>.1783</td>
<td>-.2600</td>
<td>-.1785</td>
<td>.0548</td>
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</tr>
<tr>
<td>0.10, 0.10, 0.00</td>
<td>.3867</td>
<td>.3823</td>
<td>2.2270</td>
<td>.2426</td>
<td>-.3098</td>
<td>-.3054</td>
<td>.0769</td>
<td></td>
</tr>
</tbody>
</table>

Note: $U_i$ refers to utility of social group $i$, $i = c_1, c_2, w$
Investment goods are produced in sector 1. The diminished demand for investment goods leads therefore to a decrease in production in sector 1. Furthermore, the increased dependence of private production on infrastructure leads to an increase in the production of the public production good (an expansion of infrastructure). The decrease in production in sector 1 leads to a further decrease in private capital and investments, and to a decrease in the demand for labor. The extra labor input in the public sector, that results from the expansion of infrastructure, cannot undo the fall in labor input in the private sector. It can be checked from the tables that these changes in input levels lead to an increase in capital productivity \( (X_j/K_j) \), while labor productivity diminishes \( (X_j/L_j) \) in both private sectors. Total labor demand decreases, therefore, which leads to a decrease in the wage rate. Total earned income and, as a consequence, the tax base, decreases because the lower wage rate and the concomitant decrease in labor supply offset the increase in dividend payments. The lower tax base and the higher public costs that follow from the extra infrastructure push up the income tax rate, which leads to a further decrease in labor supply. The decrease in earned income and the higher income tax rate reduce disposable income. The demand for both domestic and foreign private goods then decreases. The decline in the demand for foreign goods leads to a decrease in import. In order to equate the balance of trade, the export level must also decline. This is realized by an increase in the foreign price of the domestic commodities \( (p_j/p_e, j = 1, 2) \). Because the exchange rate is the numéraire \( (p_e = 1) \), these foreign prices can only be adjusted by adapting the domestic prices \( (p_1 \) and \( p_2) \). The increase in these prices leads to a further decrease in the demand for the domestic private goods. The extension of the infrastructure makes an increase in the production of the public consumption good possible, without striking changes in the input of labor and capital.

Summarizing the effects on production, it follows that a decrease in the productivity of infrastructure in the private sector leads to an extension of infrastructure, but it negatively affects production, capital input, labor input and investments in the private sectors. In the public consumption sector only capital strongly decreases, while production and labor input hardly change. Furthermore, labor supply decreases, dividend payments increase, the tax rate increases, commodity prices increase and the wage rate decreases. The higher dividend payments and the lower wage rate make the pre-tax income distribution more unequal. In order to equalize disposable incomes, which is the policy that follows from the political influence structure, the redistribution of income via special provisions is enlarged. Although the level of the public consumption good and
leisure consumption increase, utility levels diminish, because the decrease in disposable income and the increase in domestic commodity prices have a substantial negative effect on the consumption of private commodities. The effects of a technological change that makes private production less dependent on infrastructure and more dependent on capital ($\delta_{qi}$ decreases and $\delta_{Ki}$ increases), which leads to an increase in the productivity of infrastructure, are now straightforward.

From the Tables 6.1 - 6.4, we can also obtain the effects of a technological change in the production of the public consumption good. Suppose that the production of the public consumption good depends more on its public capital stock and less on the public production good ($\delta_{pi}$ decreases while $\delta_{Ki}$ increases). This technological change leads in the public consumption sector to a decrease in the productivity of the public capital stock $K_p$ and an increase in the productivity of infrastructure. The capital stock used for the production of the public consumption good increases, while the level of infrastructure and the demand for labor in the public consumption sector decrease. The increase in the capital stock raises the demand for investment goods, which has a positive effect on the production level in private sector 1. The decrease in the level of the public production good has, on the other hand, a direct negative effect on the production in both private sectors, because production in these sectors depends on the level of the public production good. Production in sector 1 encounters an extra, indirect negative effect because the lower production level of this public good leads to a lower demand for investment goods. The decrease in labor input in the public production sector causes the wage rate to decrease. The lower wage rate makes it more attractive for producers to use labor in their production process. The labor input in the private production sectors will therefore change only slightly, notwithstanding the decrease in private production levels. Another effect of the decrease in the wage rate is that earned income falls. This leads to a decrease in the consumption of private goods, including those that are imported. The balance-of-trade condition requires an increase in the domestic commodity prices, which has an additional negative effect on the demand for domestic private commodities. The increased prices for the commodities and the decreased average production costs have a positive effect on profits, leading to higher dividend payments. Although these higher dividends increase earned incomes, they cannot offset the negative effect of the decreased wage income. Finally, the net effect of the increase of the level of the public consumption good, the decrease of the level of the public production good and the reduced tax base is a small increase in the tax rate. The negative impact of the
higher tax burden on utilities is, however, outweighed by the positive effects of the higher level of the public consumption good and leisure.

Another technological change that we analyzed is a change in the productivity of labor that affects the productivity of capital. The results of such a technological change are rather straightforward and are, therefore, not presented here. The main results can be summarized as follows. As expected, an increase in labor productivity ($\delta_{Lj}$ decreases and $\delta_{Kj}$ increases for $j = 1, 2, s$) has a positive effect on all capital stocks and all production levels. The increase in production in the private sector and in the public consumption sector leads to an expansion of infrastructure. It turns out that the increase in production in private sector 1 and in the public production sector is so strong that the demand for labor increases in these sectors, notwithstanding the higher labor productivity. The strong increase in the dividend payments and the increase in the wage rate have a positive effect on the purchasing power of the consumers. These positive effects off-set the negative effects on the purchasing power that are due to the higher tax rate and the lower labor supply. The consequent increase in the consumption of private commodities leads, with the increase in leisure and the public consumption good to a higher utility level and, thus, to a higher value of the political interest function.

The unbalanced economic development that was obtained from an unbalanced development in labor productivity in Baumol (1967) and Baumol et al. (1985) is also found in our analysis. However, the effects of an unbalanced development in labor productivity may be mitigated by the presence of infrastructure. The increase in production in the sector with a higher labor productivity has a positive effect on the level of infrastructure. The expansion of infrastructure is also beneficial for the sector with a stagnant labor productivity, which mitigates the unbalanced development between the sectors. Furthermore, it turned out that the difference in the change of labor productivity is important: an increase in labor productivity may have a negative effect on the level of production if the other sectors observe a stronger increase in labor productivity. The increase in labor productivity reduces employment, but has a positive effect on the utility of all social groups. With respect to the unbalanced development in the productivity of infrastructure, it follows from our analysis that a higher productivity of infrastructure in one sector has a negative effect on the level of infrastructure.\(^4\)

\(^4\) Compare the second line in Table 6.3 with the first line. The change from the second line to the first line is induced by a decrease in $\delta_{C1}$ and $\delta_{C2}$, which leads to an increase in
The stagnant sector faces, in that case, a strong decrease in infrastructure, which negatively affects the production in that sector.

6.4 Transition effects of a technological change

6.4.1 Introduction

The comparative statics analysis in Section 6.3 examined mainly the effects that result from technological changes occurring simultaneously in both private sectors. In this section the (dynamic) consequences of a technological change that happens only in sector 1 are investigated. It is analyzed in Section 6.4.2 how a technological change that makes production in sector 1 more dependent on infrastructure influences production, not only in private sector 1, but also in private sector 2 and in the public production sectors. The analysis gives an indication of the short-run and long-run implications of the dependence of production on infrastructure. To study this impact, we will not only examine the comparative statics effects, but also the transitory effects. One may expect that the greater dependence of private production on infrastructure will lead to an expansion of infrastructure. In Section 6.4.3 we analyze whether the government will speed up the expansion of infrastructure if the technological change goes with an increase in the political influence of capital owners in sector 1. The parameter configuration that is used for the analysis in this section is similar to that in Section 5.4 (see Tables 5.A.3 and 5.A.4 of Appendix 5.A). We also use the same expectations rule as in Section 5.4, which implies that expectations are assumed to be static. The technological change is modeled by a change in the parameters of the production in sector 1, where a higher production elasticity of infrastructure is assumed, while the production elasticities of capital and labor are assumed to be lower.\(^5\) The values of the new steady states are reported in Tables 5.A.6 - 5.A.10. The transition paths of the technological change in private sector 1 are presented in Figures 6.1 - 6.8.

\(^5\) The production elasticity of labor, \(\delta_L\), decreases from 0.45 to 0.30, the production elasticity of capital, \(\delta_K\), from 0.35 to 0.30 while the production elasticity of infrastructure, \(\delta_G\), increases from 0.20 to 0.40.
Figure 6.1 Transition effects on capital stocks if production elasticity of infrastructure in sector 1 increases

Figure 6.2 Transition effects on labor demand if production elasticity of infrastructure in sector 1 increases
Figure 6.3 Transition effects on production if production elasticity of infrastructure in sector 1 increases.

Figure 6.4 Transition effects on the shadow price of capital if production elasticity of infrastructure in sector 1 increases.
Figure 6.5 Transition effects on the investment-capital ratio if production elasticity of infrastructure in sector 1 increases

Figure 6.6 Transition effects on the labor-capital ratio if production elasticity of infrastructure in sector 1 increases
Figure 6.7 Transition effects on labor productivity if production elasticity of infrastructure in sector 1 increases

Figure 6.8 Transition effects on utility levels and value of political interest function (P) if production elasticity of infrastructure in sector 1 increases
6.4.2 Infrastructure and technological change

The technological change that is discussed in this section entails that production in sector 1 becomes more dependent on infrastructure. The government has in that case an incentive to extend infrastructure because the social benefits of extra infrastructure increase (cf. Figure 6.3). The shadowprice of capital that is used in the public production sector \((q_p)\) increases strongly (cf. Figure 6.4), which leads to an increase in investment in the capital stock of this sector. Whereas the adjustment of capital in the public production sector is spread over some periods, the adjustment in labor demand occurs immediately in the first period after the technological change (cf. Figures 6.1 and 6.2). However, if the capital stock increases, less labor is required for infrastructure, which leads to a downward adjustment of labor demand. As noticed in the introduction of this section, it is assumed that the technological change in sector 1 makes production in that sector less dependent on the own capital stock. This implies that the expansion of infrastructure goes with a decrease in the capital stock of sector 1. The shadowprice of capital \((q_p)\) decreases and investment in this sector slows down. Capital owners in sector 2 and managers in the public consumption sector observe that production in their sector profits from extra government spendings on infrastructure. Investments diminish in these sectors because the extra infrastructure makes a smaller capital stock sufficient for the same production level. The production level of the public consumption good decreases a bit in the first periods, because the government needs tax revenues for extra investments in infrastructure, but this production level recovers after the first few periods. The capital stocks of the two private sectors, as well as the capital stock of the public consumption sector, gradually move to the new steady state. This is not the case for the capital stock that is used for infrastructure, where the overinvestment pushes the capital stock up to a level that is higher than the new-steady-state level (cf. Figures 6.1 and 6.5). The static expectations rule is important for this result (cf. Section 4.8). It goes with a production level in this sector that also overshoots the level in the new steady state. The overinvestment in infrastructure is due to the shadowprice of this sector's capital. However, if the capital stock becomes too large, its shadowprice decreases and even reaches a level that is below the value in the new steady state. As a consequence of this low shadowprice, the investment-capital ratio declines and reaches a value that is lower than the depreciation rate (cf. Figure 6.5), which explains the decrease in the capital stock of this sector that arises after the first periods. The size of infrastructure follows a similar path as its capital stock. The increase in public investments requires higher tax revenues. In order to
collect more tax revenues, the government must increase the income tax rate. If the government discovers that it overinvests in infrastructure and, therefore, decreases these investments, the tax rate can decrease, but it remains at a substantial higher level than before the technological change.

The adjustment in labor input is concentrated in the first periods. The lower production level in sector 1 and the smaller dependence of production on labor leads to a decrease in the sector's labor demand (cf. Figure 6.2; see also Figures 6.6 and 6.7). The main effect takes place in the first few periods. After the initial decrease, labor demand slowly decreases over about 25 periods and remains stable after 30 periods. The strong decrease in the first periods is due to the fact that the absence of labor market restrictions allows firms to change their labor input without delay. An opposite effect occurs in the public production sector, where the increased demand for infrastructure leads to a higher labor demand. The technological change has a small negative effect on labor demand of private sector 2 and the public consumption sector. Although these sectors profit from the expansion in infrastructure, they do this in particular by decreasing the input of capital, while labor input and production are hardly influenced by the expansion of infrastructure. It follows that the decrease in labor demand in sector 1 is dominant, which leads to a lower total labor demand. The equilibrium condition then causes the wage rate and labor supply to decrease. For the new steady state, the latter can be read from the higher leisure consumption by the representative individuals of all social groups in Table 5.A.7.

The strong decrease in both labor demand and adjustment costs for private sector 1 has a strong positive effect on the profits for this sector. The impact on dividend payments is even stronger, because the lower demand for investment goods, and the concomitant lower costs for the purchase of these goods, gives an additional positive effect on dividend payments. The higher dividend payments over the entire transition path and in the new steady state indicates that the value of the firm is positively influenced by the technological change. If the choice between the old production technology and the new, more infrastructure intensive, technology were up to the managers in sector 1, they would opt for the new technology, because the use of this technology leads to a higher value of the firm.

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6 Compare the transition paths for a change in political influence and in preferences, as discussed in Chapter 5, where we also found a strong change in labor demand in the first periods and a more gradual change in the capital stocks.
The representative individuals of the three social groups face lower private consumption (in particular of the domestic commodity of type 1) and public consumption. Furthermore, the decrease in labor supply means that leisure increases. It turns out that, notwithstanding the increase in leisure, utility decreases for all social groups (cf. Figure 6.8). The decrease in utility is most prominent for capital owners, which is due to their higher preference for private commodities. The decrease in utility in the first periods follows from the fact that the higher investments in infrastructure crowd out the consumption of the commodity that is produced in sector 1. When these investments diminish after a few periods, the consumption of this commodity increases a bit, which leads to a small rise in utility. This recovery is only temporary, however. Note that the technological change leads to the result that the utility level of the capital owners in sector 1 decreases, while the value of the firm and, as a consequence, the dividend payments in sector 1 increase. It is, therefore, interesting to analyze the impact of a change in the political influence of the capital owners in sector 1 on the adaptation of infrastructure. This analysis is the subject of the next section.

6.4.3 Political influence, technological change and infrastructure

The technological change discussed in the previous section gave the paradoxical result of a negative effect on the utility of capital owners in sector 1, but a positive effect on the value of the firm in this sector. As managers of the firm, the capital owners of sector 1 would, therefore, be interested in persuading the government to extend the infrastructure. However, the interests of managers are not taken into account in the governmental decisionmaking process. Only the interests of the capital owners of sector 1 as consumers play a role. These interests are represented by their utility function. The strength with which these interests are promoted depends on the political influence structure. The higher dividend payments that capital owners of sector 1 receive after the technological change, are redistributed through lump sum transfers over the different social groups, because the political influence of these capital owners is not strong enough to keep the extra dividend.

In this subsection it is, therefore, investigated whether a simultaneous change in the technology of sector 1 and the political influence of capital owners in that sector changes the conclusions reached in the previous subsection. To highlight the effects on redistribution, a change in the political influence structure must be chosen that has no (or a small) effect on production levels. As discussed in Sections 5.2
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and 6.2, such a situation occurs if the political influence changes between social groups that have identical, homothetic preferences. Therefore, it is assumed in this subsection that the greater political influence of capital owners in sector 1 goes at the cost of the capital owners in sector 2. From Table 5.A.8 it then follows that, compared to the situation that only technology changes, the level of the public production good \( G_p \) is higher in the new steady state, but this increase is negligible. Compared with the initial steady state, the difference in the level of the public production good follows in particular from the change in technology whereas the effect of the change in political influence is very small. It can, furthermore, be read from Table 5.A.8, that production in other sectors also hardly changes if a change in the political influence structure is added to a change in technology. This is also the case for the value of firm. What changes, however, is the distribution of income over the different groups (see Table 5.A.9). The greater political influence of capital owners in sector 1 leads to a strong decrease in the transfer that capital owners in sector 1 have to pay, which has a positive effect on the disposable income and utility of these capital owners. Note that this higher disposable income of capital owners in sector 1 goes with a decrease in the disposable income of capital owners in sector 2, who are confronted with a smaller political influence. The disposable income and utility of workers is hardly affected if a change in the political influence structure is added to a technological change. Thus, the addition of an increase in the political influence of capital owners in sector 1 has a strong effect on the redistribution of income between the capital owners of the two private sectors, while it hardly affects the production levels and the utility of workers.

The transition effects of a simultaneous change in political influence and technology are more or less similar to the transition effects of a technology change. Therefore we will only give the transition paths of capital and utility in Figures 6.9 and 6.10, respectively. It can be seen from the development of capital that the greater influence of capital owners in sector 1 leads to a faster adjustment of infrastructure and its capital stock in the first periods (compare 6.1 with 6.9).

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7 The political influence weight of capital owners in sector 1 \( (\mu_{cl}) \) goes from 0.10 to 0.16, while the political influence weight of capital owners in sector 2 \( (\mu_{c2}) \) decreases from 0.10 to 0.04.
Figure 6.9 Transition effects on capital stocks if production elasticity of infrastructure in sector 1 increases and political influence of capital owners in sector 1 increases

Figure 6.10 Transition effects on utility levels and value of political interest function (P) if production elasticity of infrastructure in sector 1 increases and political influence of capital owners in sector 1 increases
6.5 The role of adjustment costs

Adjustment costs depend on the investment-capital ratio \( (I_j / K_j) \) and are represented by a quadratic function [see eq. (4.33)]. For the analysis of the role of adjustment costs it is instructive to consider first the influence of investments on these costs. To that purpose, the first derivative of the adjustment costs to investments \( [\partial (\varphi_j I_j)] / \partial I_j \) must be determined. The sign of this derivative is positive (negative) if the investment-capital ratio is higher (lower) than the adjustment cost parameter \( \varphi_j \), indicating that an increase in investments leads to an increase (decrease) in adjustment costs. In the steady state, the capital stock remains stationary. Investment are then only necessary for the replacement of capital. Therefore, the investment-capital ratio equals the depreciation rate in the steady state. As a consequence, the comparative statics effects of the adjustment cost parameters depend largely on the sign of the difference between the depreciation rate and the adjustment cost parameter \( \varphi_j \): (dep - \( \varphi_j \)).

An exogenous shock in the adjustment costs, which is expressed by a higher scale parameter \( \varphi_j \), implies higher adjustment costs at a given investment level. It then depends on the sign of depj - \( \varphi_j \) whether producers in the private and public sectors will increase or decrease investments as a reaction to the shock. Here it is assumed that depj < \( \varphi_j \). The exogenous shock and the concomitant increase in the adjustment costs lower the shadowprice of capital (lower \( q_j \)), which encourages capital owners to increase the capital stock and, consequently, investments, in order to spread the adjustment costs over a larger stock. This leads to lower average adjustment costs increase (decrease) if investments increase. The comparative statics effects for changes in the adjustment costs are given in Tables 6.5 - 6.8.

---

8 Recall that depj = 0.10, j = 1, 2, p, s.

9 The choice of this relation between the depreciation rate and the parameter \( \varphi_j \) was inspired by GOULDER AND SUMMERS (1989), where a same relation can be obtained from the parameter values they give in Table 3. Later, that is, after we finished our calculations, we found out that the Tables 2 and 3 in the Goulder and Summers paper are not without errors. Although the assumption depj < \( \varphi_j \) leads to a decreasing adjustment cost function in \( I_j \), the function is still convex \( (\partial \Phi_j / \partial I_j < 0 \text{ and } \partial^2 \Phi_j / \partial I_j^2 > 0) \). Note, furthermore, that the adjustment costs \( (p_j \Phi_j (...)I_j) \) are decreasing and convex in \( I_j \) and the investment costs \( [p_j (I + \Phi_j (...)I_j)] \) are increasing and convex in \( I_j \).
### Table 6.5  Effects on capital and shadow prices of capital

*Changes in adjustment costs*

<table>
<thead>
<tr>
<th>Φ&lt;sub&gt;1j&lt;/sub&gt;, Φ&lt;sub&gt;2j&lt;/sub&gt;</th>
<th>K&lt;sub&gt;i&lt;/sub&gt;</th>
<th>K&lt;sub&gt;s&lt;/sub&gt;</th>
<th>K&lt;sub&gt;p&lt;/sub&gt;</th>
<th>q&lt;sub&gt;i&lt;/sub&gt;</th>
<th>q&lt;sub&gt;2&lt;/sub&gt;</th>
<th>q&lt;sub&gt;3&lt;/sub&gt; = q&lt;sub&gt;p&lt;/sub&gt;</th>
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<tr>
<td>10, 0.12</td>
<td>511.69</td>
<td>369.57</td>
<td>89.075</td>
<td>166.84</td>
<td>.36961</td>
<td>.36961</td>
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<td>15, 0.12</td>
<td>585.77</td>
<td>402.13</td>
<td>95.736</td>
<td>182.92</td>
<td>.24366</td>
<td>.24366</td>
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<tr>
<td>10, 0.12 Φ&lt;sub&gt;12&lt;/sub&gt; = 15</td>
<td>516.17</td>
<td>396.70</td>
<td>88.558</td>
<td>166.97</td>
<td>.37172</td>
<td>.24781</td>
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<tr>
<td>10, 0.14 Φ&lt;sub&gt;22&lt;/sub&gt; = .14</td>
<td>621.13</td>
<td>401.31</td>
<td>93.982</td>
<td>184.17</td>
<td>.12218</td>
<td>.12218</td>
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<tr>
<td>10, 0.12</td>
<td>522.64</td>
<td>400.31</td>
<td>87.919</td>
<td>167.07</td>
<td>.37312</td>
<td>.12437</td>
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### Table 6.6  Effects on labor demand, leisure, the wage rate, utility and value of political interest function

*Changes in adjustment costs*

<table>
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<tr>
<th>Φ&lt;sub&gt;1j&lt;/sub&gt;, Φ&lt;sub&gt;2j&lt;/sub&gt;</th>
<th>L&lt;sub&gt;i&lt;/sub&gt;</th>
<th>L&lt;sub&gt;s&lt;/sub&gt;</th>
<th>L&lt;sub&gt;p&lt;/sub&gt;</th>
<th>L&lt;sub&gt;p&lt;/sub&gt;</th>
<th>U&lt;sub&gt;i&lt;/sub&gt; = P</th>
<th>P&lt;sub&gt;L&lt;/sub&gt;</th>
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<tr>
<td>10, 0.12</td>
<td>236.10</td>
<td>327.93</td>
<td>121.04</td>
<td>52.629</td>
<td>.26230</td>
<td>2.1948</td>
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<tr>
<td>15, 0.12</td>
<td>244.86</td>
<td>323.27</td>
<td>119.35</td>
<td>52.936</td>
<td>.25958</td>
<td>2.1992</td>
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<tr>
<td>10, 0.12 Φ&lt;sub&gt;12&lt;/sub&gt; = 15</td>
<td>238.43</td>
<td>327.22</td>
<td>120.47</td>
<td>52.731</td>
<td>.26114</td>
<td>2.1955</td>
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<td>10, 0.14 Φ&lt;sub&gt;22&lt;/sub&gt; = .14</td>
<td>255.56</td>
<td>317.53</td>
<td>117.12</td>
<td>53.281</td>
<td>.25650</td>
<td>2.1699</td>
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<td>10, 0.12</td>
<td>241.82</td>
<td>325.66</td>
<td>119.80</td>
<td>52.849</td>
<td>.25987</td>
<td>2.1867</td>
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*Note:* L<sub>i</sub>, L<sub>s</sub>, and U<sub>i</sub> refer to leisure and utility of social group i, i = c<sub>p</sub>, c<sub>2</sub>, w.<sup> </sup>

### Table 6.7  Effects on production and commodity prices

*Changes in adjustment costs*

<table>
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<tr>
<th>Φ&lt;sub&gt;1j&lt;/sub&gt;, Φ&lt;sub&gt;2j&lt;/sub&gt;</th>
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<th>p&lt;sub&gt;s&lt;/sub&gt;</th>
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</thead>
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<td>10, 0.12</td>
<td>286.55</td>
<td>323.16</td>
<td>125.53</td>
<td>87.102</td>
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<td>15, 0.12</td>
<td>304.60</td>
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<td>125.48</td>
<td>90.293</td>
<td>.80738</td>
<td>.86591</td>
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<td>10, 0.12 Φ&lt;sub&gt;12&lt;/sub&gt; = 15</td>
<td>289.06</td>
<td>326.14</td>
<td>125.01</td>
<td>87.237</td>
<td>.81739</td>
<td>.86168</td>
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<td>10, 0.14 Φ&lt;sub&gt;22&lt;/sub&gt; = .14</td>
<td>318.02</td>
<td>320.74</td>
<td>123.45</td>
<td>90.893</td>
<td>.81483</td>
<td>.87000</td>
</tr>
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<td>10, 0.12</td>
<td>292.68</td>
<td>325.47</td>
<td>124.38</td>
<td>87.381</td>
<td>.82101</td>
<td>.86171</td>
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Table 6.8 Effects on dividends, special provisions and taxes

Changes in adjustment costs

<table>
<thead>
<tr>
<th>$\varphi_{ij}$, $\varphi_{2j}$</th>
<th>$d_1$</th>
<th>$d_2$</th>
<th>$\sigma_{i1}$</th>
<th>$\sigma_{i2}$</th>
<th>$\sigma_{ii}$</th>
<th>$\tau_n$</th>
<th>$T$</th>
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<tr>
<td>10, 0.12</td>
<td>0.38245</td>
<td>0.38832</td>
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<td>-0.31124</td>
<td>0.07708</td>
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<td>132.930</td>
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<td>15, 0.12</td>
<td>0.35943</td>
<td>0.35930</td>
<td>-0.28756</td>
<td>-0.28743</td>
<td>0.07187</td>
<td>0.24552</td>
<td>136.318</td>
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<td>10, 0.12</td>
<td>0.38816</td>
<td>0.35885</td>
<td>-0.31346</td>
<td>-0.28415</td>
<td>0.07470</td>
<td>0.24207</td>
<td>133.285</td>
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<tr>
<td>$\varphi_{12} = 15$</td>
<td>10, 0.14</td>
<td>0.31987</td>
<td>0.31828</td>
<td>-0.25605</td>
<td>-0.25446</td>
<td>0.06381</td>
<td>0.25025</td>
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<td>10, 0.12</td>
<td>0.39477</td>
<td>0.31990</td>
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<td>0.07146</td>
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</table>

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the sectors that have a high production elasticity of capital (high $\delta_{Kj}$), to wit: private sector 1 and the public production sector. There is, in addition, an extra positive effect on the production of sector 1, because this sector produces investment goods and, thus, profits from the capital expansion. The higher production leads to a higher demand for labor. The higher labor demand induces an increase in the wage rate, which makes a higher labor input only attractive for those sectors that can afford these higher labor costs. It appears that only private sector 1 and the public production sector demand more labor. The labor input in the other two sectors decreases. This decrease is so strong in the public consumption sector that the positive effect on production that followed from the higher capital stock, disappears. The production in this sector decreases a little. The increase in the production of the public production good and the slightly changing production of the public consumption good lead to increasing production costs. Since the tax base increases, due to the fact that the increase in labor income exceeds the decrease in dividend payments, a small increase in the income tax rate suffices. All in all, disposable income hardly changes. The lower prices allow individuals to consume more of the private goods, although the increase is small. The effect on utility of the shock in the adjustment costs is rather small and is the result of the small positive effect on private consumption, the negative effect on leisure and the negligible (negative) effect on the level of the public consumption good. The positive effect on private consumption is dominant. All in all, the higher adjustment costs have a (small) positive effect on utility. This result is due to the assumption that $dep_j - \varphi_{2j}$.

Tables 6.5 - 6.8 also give the results of an exogenous shock in the adjustment costs of only private sector 2. In this case, the adjustment costs differ between the two private sectors after the shock. The difference in adjustment costs leads to non-
identical shadow prices of capital (Tobin's $q$) of the two private sectors. The higher adjustment costs in private sector 2 lead to an increase in investments as well as in the capital stock of this sector. Furthermore, the higher adjustment costs have a negative effect on the shadow price of capital in private sector 2 ($q_2$). The small increase in $q_1$ follows from the increase in the investment price, which equals the price of commodity 1 [see eq. (4.34)]. The remaining effects are straightforward.

An increase in the parameter $\varphi_{ji}$ has similar comparative static effects as an increase in $\varphi_{ji}$. As for the increase in $\varphi_{ji}$, a higher value of $\varphi_{ji}$ leads to higher adjustment costs, and, therefore, to a decrease in the shadow price of capital [$q_j$; see eq. (4.34)], higher investments and a higher capital stock. The direction of the further effects of the two types of shocks is similar.

One might perhaps expect that in this comparative statics analysis variables attain their maximum if adjustment costs vanish in the steady state, which holds if $\varphi_{ji} = dep_j$. Although it turns out that this is not the case for capital stocks and production levels, it indeed holds for dividend payments, utility levels and the value of the political interest function.

6.6 Concluding remarks

Aschauer (1989) found that public capital has a positive impact on productivity. This result led him to the conclusion that a drop in public investments can explain the productivity decline in the U.S. economy. Munnell (1992) goes a step further and concludes that extra investments in infrastructure may be desirable, because these investments have a significant positive effect on output and growth. From a positive point of view, it is of interest to analyze when a government will invest more in public capital. The relevance of this approach more particularly follows from the fact that the expansion of infrastructure may have different origins, that have different effects on the productivity of the input factors and on the production in the private sector and the public consumption sector. To illustrate this we discuss four cases that lead to an expansion of infrastructure.

First, if workers have a higher preference for public consumption than capital owners, infrastructure may expand if the political influence of capital owners increases at the cost of the political influence of workers (see Section 6.2.3). In that case, the expansion of infrastructure goes with an increase in private
production, while the productivity of capital, labor and infrastructure hardly change. The expansion of infrastructure has a positive effect on the utility of capital owners and a negative effect on the utility of workers. The value of the political interest function only increases if there is a strong increase in the political influence of capital owners. In Chapter 7 it will be shown that this result also holds if individuals have identical preferences and there are no special provisions. An exception is the effect on the utility of workers, which is positive in the latter case.

Second, as discussed in Section 6.3, the government may decide to enlarge infrastructure if a technological change occurs that makes private production more dependent on infrastructure and less dependent on private capital. In that case, more infrastructure goes with less private production, an increase in capital productivity and a drop in the productivity of labor and infrastructure in the private sectors. If the technological change is concentrated in private sector 1, these effects occur only in this sector, while production in sector 2 is positively influenced by the expansion of infrastructure (see Section 6.4). The expansion of infrastructure leads to a decrease in utility and in the value of the political interest function.

Third, as follows from the discussion in Section 6.3, a technological change that leads to a higher dependence on private capital and a lower dependence on labor input, gives an increase in both infrastructure and private production. Capital productivity now declines and the productivity of labor and infrastructure increases. Utility of all social groups is positively affected by the expansion of infrastructure.

Fourth, the government may extend infrastructure because changes in preferences may induce extra investments in infrastructure. For example, if the preference of all individuals for public consumption increases, while their preferences for leisure decreases, government will decide to extend not only the level of the public consumption good, but also the level of infrastructure (see Section 5.3.2). In that case production in private sector 1 increases, while production in sector 2 decreases. Labor productivity is positively affected in both private sectors, whereas the productivity of infrastructure is negatively affected. Capital productivity is hardly influenced in that case. The preference change leads to an increase in the utility of all social groups. However, if the expansion of infrastructure follows from an increase in the preference for private commodities at the cost of the preference for the public good, utility will decrease, notwithstanding the expansion of infrastructure.
Apart from the relationship between changes in the level of infrastructure and the private production levels, we studied in this chapter the impact of changes in productivity of the different input factors on private production and utility. The observation of Baumol (1967) that a different development of labor productivity between sectors leads to an unbalanced growth, was supported by our analysis. The effect may, however, be mitigated by infrastructure, because the increase of production in the sector with a strong increase in labor productivity leads to an expansion of infrastructure, which is also beneficial for the stagnant sector. Due to the productivity growth, all social groups end up with a higher utility level. With respect to the increase in productivity of infrastructure it was further found that production in a sector that remains more dependent on infrastructure will fall short of the production in sectors with a stronger increase in productivity. Because the latter sectors are less dependent on infrastructure, the government will be inclined to reduce the level of infrastructure, which has an additional negative effect on the production in the stagnant sector.

In this chapter we investigated the hypothesis of Baumol in a model without steady state growth. Although we conjecture that these results will still be valid if the model allows for (endogenous) growth, it would be interesting to investigate this hypothesis with such a model. In a model with growth, the growth rates of two sectors with a different dependence on infrastructure (or on labor) can be compared with each other, as in the model of Baumol. Moreover, the relation between the level of infrastructure and the aggregate growth rate could be investigated. In the concluding chapter we will return to these issues.

A final issue that was discussed in this chapter, concerns the impact of adjustment costs. Adjustment costs reduce the mobility of capital between production sectors. Public capital formation is also confronted with adjustment costs. Because the assumption of sector-specific public capital seems plausible, these costs can be regarded as one of the factors obstructing cross-departmental flexibility in production (facilitating the ‘cocooning’ of departments).