Government and growth

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Die zentralen Ergebnisse auf einen Blick

- Empirisch ist kein Zusammenhang zwischen der gesamten Staatstätigkeit und dem pro-Kopf-Wachstum des BIP nachweisbar.
- Nur für wenige Aufgabenbereiche sind bescheidene positive Wachstumswirkungen festzustellen. Diese sind: die Verkehrsinfrastruktur, die Wasserversorgung und die Raumordnung, die Bildung sowie die Forschung und Entwicklung.
- Sowohl indirekte als auch direkte Steuern zeigen keine Wachstumseffekte.

Fazit: Diese Studie legt nahe, dass eine optimale Staatsquote kaum zu ermitteln ist. Die vorliegende empirische Studie dient als ein grober Kompass für die Wachstumswirkungen der Staatstätigkeit. Wichtig bleibt allerdings die Einzelprüfung der staatlichen Massnahmen auf ihre ökonomischen Wirkungen hin.

Zusammenfassung

In den letzten zwei Jahrzehnten hat die Schweiz im Vergleich zum Durchschnitt der OECD-Staaten unter einer Wachstumsschwäche gelitten. Dies zeigte sich insbesondere in den 90er-Jahren als die Schweizer Volkswirtschaft mit real durchschnittlich 1.1% 1.5 Prozentpunkte (PP) weniger wuchs als der OECD-Durchschnitt. Angesichts der lang anhaltenden Wachstumsschwäche stellt sich auch die Frage, ob die Finanzpolitik in der Lage ist, das Wachstum nachhaltig zu beeinflussen. Dies ist der Anknüpfungspunkt für die vorliegende, umfassende empirische Studie des Ökonomenteams der Eidgenössischen Finanzverwaltung gewesen, welche den Zusammenhang zwischen den Staatsaktivitäten, insbesondere der Ausgabenseite, und dem Wirtschaftswachstum pro Kopf analysiert hat.

Die empirische Literatur zur Beziehung zwischen der Staatstätigkeit und dem Wachstum bietet bereits eine Vielzahl von Studien. Allerdings zeigen Sensitivitätsanalysen von Levine und Renelt (1992) und Sala-i-Martin (1997), dass die Ergebnisse dieser Studien nicht als stabil angesehen werden können. Dies ist auf verschiedene Probleme bei empirischen Studien wie die Separierung von Ausreissern, die Datenqualität, die Heterogenität der Stichprobe zurückzuführen (Temple, 1999). Im Gegensatz zu anderen empirischen Analysen ist diesen Problemen in der vorliegenden Studie durch die Verwendung robuster Schätzmethoden begegnet worden.

Auf Basis der neuen ökonomischen Wachstumstheorie sind in dieser Studie drei Kanäle identifiziert worden, über welche die Staatsausgaben das Wirtschaftswachstum beeinflussen können. Diese sind:

1. *Die Arbeitsproduktivität*

Hierunter lassen sich alle Massnahmen fassen, die möglicherweise zur Erhöhung der Arbeitsproduktivität beitragen. Dazu zählen insbesondere die Ausgaben für die Bildung, aber auch die aktive Arbeitsmarktpolitik.

2. *Die Vorleistungen für die Privatwirtschaft*

In diese Kategorie fallen Güter, von denen aufgrund von natürlichen Monopolen oder öffentlichen Gütern ein Marktversagen zu vermuten ist. Daher werden sie von privaten Akteuren nicht oder in zu geringen Mengen bzw. mit zu hohen Preisen bereitgestellt. Bei einer privaten Bereitstellung könnten wichtige Produktionsfaktoren zu einem Engpass für den Wachstumsprozess werden. In diesem Zusammenhang sind insbesondere die Ausgaben für die Bereitstellung von Infrastrukturen im Verkehr, in der Energie- und Wasserversorgung zu nennen. Eine wichtige Vorleistung für private Unternehmen können

auch die Ergebnisse staatlich finanzierter Forschungsprojekte oder Kooperationen zwischen der öffentlichen Hand und privaten Unternehmen sein.

3. Sicherheit und soziale Stabilität

Sowohl soziale Stabilität als auch Sicherheit werden als öffentliche Güter angesehen, was eine staatliche Bereitstellung rechtfertigen kann. Zudem ist die Gewährleistung eines möglichst störungsfreien Ablaufs der Markttransaktionen eine wichtige Voraussetzung für die Funktionsfähigkeit eines Marktes. Nehmen in einer Gesellschaft z.B. Eigentumsdelikte überhand, kann dies negative Auswirkungen auf die Investitionsbereitschaft und die Konsumneigung haben. Auch soziale Instabilitäten wie Streiks, Proteste oder Unruhen führen zu Störungen der Marktprozesse mit entsprechenden negativen Wachstumsfolgen. Entscheidend für soziale Instabilitäten dürfte u.a. sein, ob die Umverteilung durch den Staat überwiegend als genügend gerecht empfunden wird.

Allerdings ist für alle drei Kanäle anzumerken, dass das Ausmass der staatlichen Aktivität entscheidend für dessen Wachstumswirkung ist. Dabei ist zu vermuten, dass nicht allein ein einziges optimales Niveau der Ausgaben, z.B. für die Verkehrsinfrastruktur, besteht, sondern eine optimale Bandbreite existiert. Werden die Ausgaben unter eine bestimmte, empirisch jedoch kaum quantifizierbare, Grenze gesenkt oder über eine bestimmte Grenze erhöht, sinkt das BIP unter sein maximales Niveau. Die Bereitstellung staatlicher Güter sollte im Idealfall komplementär und nicht substitutiv zu den Marktleistungen erfolgen. Zugleich kann eine zu starke Umverteilung sich negativ auf die Anreize zu investieren und zu arbeiten auswirken. Mit dem Ausmass der Umverteilung ist zugleich die staatliche Einnahmenseite angesprochen.

Gemäss ökonomischer Theorie verzerren Steuern mit Ausnahme von pro-Kopf-Steuern die Entscheidungen der Menschen zu Lasten der Kapital-, Humankapitalakkumulation und führen zur Einschränkung des Arbeitsangebots und können somit wachstumshemmend wirken.

Die Ergebnisse dieser Studie zeigen, dass der gemessene Zusammenhang der Staatstätigkeit zum Wirtschaftswachstum in den betrachteten 21 OECD Ländern im Zeitraum von 1971 bis 2001 eher schwach war. So ist auch kein Wachstumseffekt der Gesamtausgaben festzustellen gewesen. Von den staatlichen Aufgaben konnten für die Verkehrsinfrastruktur, die Wasserversorgung und die Raumordnung, die Bildung sowie auch für die Forschung und die Entwicklung positiv signifikante Korrelationen geschätzt werden. Dabei erweist sich insbesondere der Zusammenhang zwischen der Verkehrsinfrastruktur und dem Wirtschaftswachstum als relativ robust. Jedoch sind die

Wirkungen der Staatsausgaben mit maximal geschätzten 0.06 PP Steigerung der realen, in Kaufkraftparitäten ausgedrückten, pro-Kopf-BIP-Wachstumsrate für die Verkehrsinfrastruktur bescheiden. Für die Ergebnisse bzgl. der Bildung ist zu bedenken, dass der Konnex zum Wirtschaftswachstum sehr komplex ist. So sind die in der Schule erworbenen Fertigkeit nicht direkt auf dem Arbeitsmarkt umsetzbar, sondern es bedarf noch ergänzender berufsbildnerischer Massnahmen. Dieser komplexe Zusammenhang kann jedoch in einer empirischen Regressionsanalyse nicht erfasst werden.

Zudem ist gemäss der vorliegenden Ergebnisse weder für die Gesamteinnahmen, noch für die direkten und indirekten Einnahmen ein negativer Zusammenhang zum Wirtschaftswachstum nachweisbar. Somit können die Aussagen bzgl. der Entscheidungsverzerrungen der ökonomischen Theorie nicht bestätigt werden.

Insgesamt zeigen die Ergebnisse, dass die in der öffentlichen Diskussion erörterte Frage nach einer optimalen Staatsquote aus wissenschaftlicher Sicht kaum zu beantworten ist. Die Ergebnisse weisen zudem darauf hin, dass empirische Studien makroökonomische Orientierung geben, jedoch die umfassende Bewertung einzelner staatlicher Massnahmen hinsichtlich ihrer wirtschaftlichen Wirkungen nicht ersetzen können. Schliesslich ist anzumerken, dass mögliche nicht-lineare Wachstumseffekte der Staatsaktivität nicht geprüft wurden.

Summary

In contrast to most empirical growth studies, this study applies a robust estimator, which accounts for outliers, non-Gaussian distributions and a lack of quality in datasets like those for growth empirics. According to the empirical analysis, the relationship between government activities and economic growth is generally weak. Positive correlations with economic growth have been verified, however, for water and sewer systems and transport and communication infrastructures, as well as public research and development expenditures. The growth effects of transport and communication infrastructures in particular appear to be stable. Positive correlations have been identified for public educational expenses only at central government level. However, it must be stated that the relation between education and economic performance is complex. In contrast, no significant growth effects were found with respect to government revenues. As a consequence, the predictions of endogenous growth theory cannot be confirmed for the revenue side. Furthermore, no significant relation between government size and economic growth was confirmed. This suggests that the question of optimal government size is empirically not solvable. Thus, empirical analyses should be focused on the growth effects of single government activities.

JEL Classifications: E62, H50, C23.

Key words: new growth empirics, government expenditures, modified maximum likelihood estimator.

Structure

1 Introduction*

During the last two decades Switzerland has suffered from weak growth performance in comparison to the OECD average. The Swiss economy experienced a prolonged period of stagnation from 1991 to 1996. The recession was sparked off by the weakness of the European economy in the early nineties. In addition to a lack of confidence on the part of Swiss consumers, as well as structural and regional factors, monetary and fiscal policy have been made responsible for prolonging the stagnation in the nineties (Bruchez, 2002). Fiscal policies extended the stagnation through restrictive measures such as the introduction of value added tax, the increase in the rate of unemployment insurance contributions and the consolidation of public finances. Thus, indisputably, fiscal policy plays its role, and if well-designed, a positive one, in business cycles. However, have governmental policies also contributed to the persistent weakness of Swiss growth performance? This question is the starting point of my analysis.

Since it is the purpose of my analysis to address the role of government in economic activity in general, an empirical study of 21 OECD countries, including Switzerland, has been carried out. There are already a considerable number of studies, which have dealt with the question of public finances and growth. Unfortunately, the main conclusion is that a stable or robust relationship cannot be empirically identified. An early sensitivity analysis of Levine and Renelt (1992) suggests that in linear regressions, no robust relationship between fiscal indicators and growth could be determined. Sala-i-Martin (1997), who concentrates on government spending, comes to the same conclusion in his sensitivity analysis. This vagueness can be exemplified by a study of Fölster and Henrekson (2001). Whereas Fölster and Henrekson's (2001) analysis shows a significant negative relationship between government size and total taxes and economic growth, Agell et al. (2003), using the same data set, come to the conclusion that the correlations are highly unstable and insignificant. The difficulty in grasping the connection between public finances and growth is explained by several reasons such as measurement errors, influential outliers, heterogeneity of the samples, endogeneity problems, model uncertainty, etc. (e.g. Temple, 1999).

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However, in view of the fact that economic data cannot be regarded as high quality data and thus may contain outliers, the least-squares based regression applied widely in growth empirics are not suitable (Zaman et. al., 2001). If outliers are present and data is non-Gaussian, the least-squares-estimator becomes inefficient and probably biased. To cope with this problem, robust estimators should be used. For example, Temple (1998) and Zaman et al. (2001) show that using a robust estimator instead of a least squares estimator to test the augmented Solow-model lead to considerably different conclusions. Therefore the present study uses a robust estimator, i.e. a modified maximum likelihood estimator, which is, to the best of the author's knowledge, the first time it was applied to growth empirics. The modified maximum likelihood estimator has a higher efficiency than the robust estimator (least trimmed squares) utilised by Temple (1998) and Zaman et al. (2001). Besides, the studies of Temple (1998) and Zaman et al. (2001) do not test the relationship between government activity and growth.

This study is organised as follows. First of all, I would like to refer to the theoretical basis of government and growth in economics. Section 2 briefly introduces economic growth theory, whereas section 3 studies the role of government activities in economic theory. Based on the growth effects of the public sector predicted by endogenous growth theory, a classification of public spending and taxation is provided in section 3. This classification is used as a yardstick for the choice of fiscal variables in the empirical analysis, which is described in section 4. In section 5 some conclusions are drawn.

2 Economic growth theory – a short explanation

According to recent growth theory (new or endogenous growth theory), taxes and public expenditure can influence the long-term growth rate of per capita gross domestic product (GDP) (see Barro/ Sala-I-Martin, 1995, 152).[1] In order to explain the effects of governmental policies on growth, the basic concept of standard economic growth theory will be briefly outlined.

[1] According to new growth theory, flexible prices lead to dynamic market equilibria, i.e. supply and demand are equalised. Disequilibria such as unemployment are viewed as short or medium term phenomena. In the long run all disequilibria vanish if there is sufficient price flexibility. The latter is presumed in the new growth theory so that ‘only’ the long term is considered (see also footnote 2).

The new or endogenous growth theory is based on the neoclassical growth theory. In a neoclassical growth model (Solow, 1956), perfect competition[2] is assumed for the goods and factor, i.e. capital and labour, markets. The assumed production technology of the economy exhibits diminishing returns to the accumulation of capital. A constant growth rate of the labour force under the assumption of perfect competition, along with diminishing returns to capital accumulation leads to stable equilibria in time with constant GDP growth rates, i.e. steady state growth. However, as returns to capital are diminishing the output per capita is constant through time. Note that due to the perfect functioning of the capital market enough saving takes place to sustain sufficient capital accumulation to stabilise a constant growth rate of output. The only way to endow this model with a positive per capita growth rate is to assume exogenous technical progress.[3] The latter causes output per capita to grow at the rate of technical progress.

The endogenous growth theory (e.g. Romer 1986, Lucas 1988) takes as a starting point the assumption of diminishing returns to capital accumulation and goes on to explain why non-diminishing returns to capital can prevail in time. In contrast to neoclassical growth theory, a positive growth rate of output per capita is determined by endogenous variables included in these models. One intuitive way to integrate these growth-causing processes is to assume that the investment in new capital enhances the productivity of the labourers. Another approach considers that workers improve their skills in time by learning by doing and can therefore increase labour productivity. Moreover, the stock of human capital is taken into account.[4] The acquisition of knowledge and thus the accumulation of human capital causes a rise in the productivity of the labour force. In addition spill-overs of human capital accumulation to the other producers are assumed. Some authors model the research and development (R&D) section of businesses explicitly (see Barro/ Sala-I-Martin, 1995, ch. 6 and 7). Since, in contrast to other goods, the results of R&D activities can be used by more than one person at a time, entrepreneurs will only invest in research if they expect a positive return. For this, an innovator should be able to exclude other entrepreneurs from the market for a certain period of time. The latter is possible in an environment of

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[2] In a market ruled by perfect competition, a single homogenous good or factor exists. The assumption of fully flexible prices, which convey all essential information to the market participants, leads to market equilibrium. This means full employment in the case of factor markets.

[3] For other shortfalls of this model (see Podrecca, 1993, 412-414).

[4] The stock of human capital can be set equal to the product of workers and the average education level (see Frenkel/ Hemmer, 1999, 177).

monopolistic competition[5] as assumed by some authors (Romer, 1990). The innovations are embodied in new capital goods, which enhance the productivity of a given amount of capital goods. Thus the incentive to engage in R&D activities is also important for long-term growth.

3 The influence of governmental activities on output growth

On the basis of new growth theory this section discusses possible growth effects of public spending (section 3.1) and taxation (3.2).

3.1 Government expenditures

The involvement in R&D activities and the accumulation of human capital create spill-over, which can cause market failure. Usually the existence of market failures lead to non-optimal outcomes of competition so that governmental policies can improve private factor productivity. There are also other reasons for governmental activities such as social transfers to avoid social unrest, which can be harmful for economic growth.

In the following, government expenditures, which are assumed to be productive, will be roughly structured according to the way in which different policies may influence economic growth. These expenditures will be subdivided into those which enhance labour productivity, those which can be directly used as inputs to private firms and thus also raise capital productivity, and those which foster growth more indirectly through the creation of social stability and security.

Consequently we will only focus on possible allocational improvements of governmental interventions. Musgrave's stabilisational and distributional divisions are merely touched upon insofar as they also have allocational consequences. In other words: only economically sustainable public expenditure will be taken into consideration.[6] Due to the aim of this study to identify the growth effects of governmental expenditures and due to the weaknesses of previous empirical studies, the following structure is, in contrast to other analyses, not based on the degree of efficiency effects of governmental activities (see European Commission, 2002, 102-103).

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[5] In contrast to perfect competition a product of one firm is slightly different or is viewed by consumers as slightly different to a good of another firm in monopolistic competition. This 'monopolistic' competition between firms can take place if consumers regard these goods as sufficient substitutes.

[6] For the classification into economically, socially and ecologically sustainable expenditures, see Thöne (2003).

3.1.1 Policies concerning labour productivity

Spill-over, i.e. positive externalities, and negative externalities cause market failures because they are by-products of consumption or investment, which are not captured by market prices. Consequently, competition does not lead to a social optimum, and thus may justify governmental intervention (see Podrecca, 1993, 415). The existence of spill-over indicates that private returns to the hiring of skilled labour for example, are lower than social returns. This may lead to insufficient private investment in human capital. Besides, education is viewed as a public good, which also causes a market failure. Since more than one person can use a public good simultaneously, unit costs decrease with the number of students in a single school. Additionally, the more well-educated people work for example in a single firm, the more positive externalities such as a general improvement in industrial organisation and, in all likelihood, more innovations generated within this firm which can spill over to other firms. Thus, government expenditure for education can be growth-enhancing by increasing labour productivity. Not only education but also those labour market measures, which improve the professional abilities of unemployed people in order to facilitate taking up of employment, can raise labour efficiency. Moreover family policy can increase the participation rate of women, especially mothers, in the labour market and enhance labour productivity and the capacity of labour by applying human capital, which was previously "unused".

Financial assistance enabling access to the education system is especially important for the poor. If there is no governmental financing of education for poor people they have difficulties obtaining access to education. This is because of the presence of imperfect credit markets (see Gerson, 1998, 9). The imperfections are due to the fact that creditors cannot acquire sufficient information about the future of labour markets, about future abilities to pay off their debtors etc. At the same time, poor people cannot provide collateral. For these reasons their chances of obtaining access to the credit markets are low.

Not only expenditures for education are thought to increase labour productivity but also expenditures for healthcare. A good healthcare system can reduce absenteeism and illness. This increases the capacity of the labour force for education and for learning new skills (see Gerson, 1998, 10). Government should provide part of public healthcare because some externalities exist. For example in the case of an infectious disease, there is a positive effect of immunised people on other non-immunised people. As this effect is not contained in market prices a provision by the market causes an insufficient immunisation rate of the population. At the same time governmental funding can increase access to health services.

Without governmental intervention a lot of people e.g. the poor, disabled or elderly, would probably be excluded from healthcare.

3.1.2 Directly applicable inputs for private firms

Other governmentally provided goods can be used directly by private firms and can enhance private factor productivity. Infrastructure services and the outcomes of governmentally financed R&D activities belong to these goods. As in the case of human capital, R&D activities are thought to be public goods and create positive externalities. Thus social returns are higher than private returns which cause inadequate private investment in R&D activities. Therefore R&D policies may improve growth performance either by patent law, own research or by subsidisation.

In economic theory, no well-defined delimitation of infrastructure exists. Due to measurement problems, empirical literature focuses on tangible publicly provided goods,[7] which are called “core infrastructure”. The services of transport networks, energy facilities, water and sewer lines, communication systems and development planning, for example the development of industrial estates, are included in core infrastructure (see Colombier, 2001, 16-17). Most of these systems are characterised by indivisibilities, which can be accompanied by large fixed costs. The latter may lead to economies of scale, or in the case of a multi-product firm to a sub-additive structure of costs, which causes a natural monopoly. In a natural monopoly, private providers of infrastructure tend to offer quantities which are too small at prices which are too high, which is viewed as a market failure. At the same time, the provider often has to bear costs for the exclusion of users of infrastructure services. For example, a provider of highways has to install toll barriers to exclude users from a highway system. Thus, it may be too costly for private investors to engage in infrastructure. However, the possibility of contestable markets in the case of natural monopolies, as well as technological progress, which leads to cost reductions of user exclusion, reduces the role of government (see Colombier, 2001, 18). Moreover, it should be considered that the effect of investment depends on capacity utilisation. If there is sufficient capacity of infrastructure, expenditures for additional homogeneous units of infrastructure will not be productivity-enhancing (see also section 3.1.4).

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[7] Note that publicly provided goods are not identical to public goods. The former contains the latter, but not vice versa (see e.g. Colombier, 2001, 24-28).

3.1.3 Security and social stability

Security as well as social and political stability, which are also public goods, depend partly on social transfers. Social transfers can reduce the risk of social and political unrest by mitigating income differences. It is quite obvious that social stability produces a creative and productive atmosphere. This atmosphere is favourable for the economic activity of each individual and thus for the whole economy.

To put it in more concrete terms, social transfers can lower, for example, the risk of criminal offences by reducing poverty. If, for example, unemployment and poverty expand, the propensity of the affected persons to offend against property will probably increase (see e.g. Roloff, 2001, 98-99). At the same time this development discourages investment because the risk of expropriated returns to capital is heightened and because more resources have to be directed towards less productive expenditures for security (see Gerson, 1998, 20). Apart from social transfers, labour market policies, which lower unemployment, and security measures are certainly also necessary to create a safe and stable environment for economic activity. According to Roloff (2001, 98-99) social and labour market policies are more effective than security measures in order to minimise social costs of offences against property.

Furthermore, too much income inequality may lower the incentive of poor people to educate themselves and can contribute to bad health amongst the poor (see Gerson, 1998, 22). Social insurance in particular significantly reduces the risk of poverty due to illness, old age, unemployment or invalidity. Consequently, the risk that these groups may be socially excluded is lowered.

Summarising the above, to a certain degree social transfers seem to strengthen solidarity within society. This fosters the creation of public goods or spill-overs such as social stability, better security, better average education and health. These public goods can be growth-enhancing. However, one should consider that income taxes which are too high or excessively high social contribution rates for financing social transfers may discourage economic activity (see 3.2).

3.1.4 Additional considerations

Not only the quantity, but also the quality or design of a publicly provided good is important for the evaluation of its effects. For example, consider two governments, which spend the same amount of money on university education. If one system is more efficiently organised and has better teaching facilities than the other, the outcome is better educated

students and thus more productive employees. The country with the better education system will probably have higher future growth rates, although it does not devote a greater amount to resources for education. For this reason it is important in empirical studies to check the quality of governmentally provided goods as far as possible.[8]

Furthermore, the discussion above shows that the degree of governmental expenditure may be decisive. Generally speaking, if some resources absorbed by the government can be used more productively in private firms, then these governmental expenditures may reduce growth rates (see Roloff, 2001, 118). In other words, in a (in economic terms) perfect world, government activities should complement initiatives from the private sector, i.e. to ensure the way the markets work and to counter market failures. Consequently, there is an optimal level or an optimal range of governmental activity (see also section 4.4.1.1). Leaving aside this perfect world, there are additional factors which influence the optimal level of governmental intervention:

(i) Distortionary taxation, which can hamper growth performance (see 3.2).

(ii) Credit financing of governmental expenditures may increase private capital costs and thus can crowd out more productive private investment.

(iii) Due to different reasons such as informational costs, government prestige or the influence of interest groups, there may be an overproduction of governmental services, which leads to idle capacities. For example, when a road is widened in spite of the fact that at no time was there any congestion on it.

Usually these reasons given for limiting government size and those arguments in favour of government involvement are interrelated. For example, if the amount of social transfers is too high, financing of social transfers can discourage economic activity. An example would be a social pension scheme which can affect capital accumulation negatively. But as described in section 3.1.3 an amount of social transfers which is too low may also discourage economic activity. To sum up, this reasoning indicates a non-linear relationship between governmental expenditures and growth (see Levine/ Renelt, 1991, 30-31; Barro/ Sala-I-Martin, 1995, 155; European Commission, 2002, 87).

The portion of economically useful or sustainable expenditures as well as those which are ecologically and socially sustainable, can serve as a yardstick for the quality of total governmental expenditures (see European Commission, 2002, 79; Thöne, 2003, chapter 1).

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[8] Gerson (1998, 19) even sees the results of empirical studies not carrying out checks on the quality of public investment as "inconclusive". At the moment, however, quality control seems to be virtually impossible (see section 4.4.2).

3.2 Taxes on income and consumption

The models of the new growth theory are based on the notion of a rational individual or household, which maximises utility over time with respect to income (see Podrecca, 1993, 412). Usually the models take a representative household, living for two periods, which is an agent of an infinite existing dynasty within an overlapping generation context.[9] This household makes an intratemporal choice between leisure and working hours, as well as an intertemporal choice between consumption in period t and consumption in period t+1. Consumption in t+1, discounted by the interest rate of capital, is identical to the savings in t. If the savings in t are equalised to gross investment in t, equilibrium on the goods market is attained. In order to achieve a positive steady state growth rate of output per capita, the amount of savings must be sufficiently high. The amount of savings depends positively on the interest rate of capital and the preference of the household for consumption in t+1.

3.2.1 Income tax

We will now consider the introduction of an income tax, which is levied on wages and on returns to capital. Firstly, the income tax will distort the decision between consumption and savings (intertemporal choice). As the after-tax returns to capital will be reduced, the household substitutes savings by consumption in period t. Since the total income is also lowered, consumption is decreased in both periods. If capital is mobile and after-tax returns are higher in a foreign country there will be an outflow of capital. Thus domestic savings will be reduced. Consequently the accumulation of capital and thus steady state growth is probably hampered by the taxation of capital. Additionally, the accumulation of human capital is negatively affected if it is produced with physical capital.

At the same time the tax on wages distorts the decision of the household between leisure and working hours (intratemporal choice). This is due to the lowering of the marginal benefit of income. The latter is measured by the after-tax wage rate which a worker gets for the last hour worked. Thus the household has an incentive to reduce working hours in comparison to leisure.[10] If the stock of human capital raises the productivity of labour, the wage rate is partly due to accumulated human capital, i.e. the return to human capital. As the household has to invest part of the working time in order to acquire human capital, the

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[9] Often the representative household is assumed to live infinitely. The latter is equivalent to the household described above as long as the agent of a dynasty is thought to care for his descendants.

[10] The more strongly the household wants to substitute consumption with leisure, the more probable is a reduction of working hours. The latter is always true, if leisure is a “non-normal” good, i.e. leisure does not depend positively on income, or if the tax structure is progressive (see Gerson, 1998, 27-28).

household must renounce part of its wage and its consumption in period t. Thus the taxation of wages reduces the incentive to acquire human capital and also hampers the accumulation of human capital (see Myles, 2000, 153).[11,12] Consequently, according to new growth theory, income tax will have a negative impact on the growth performance of an economy (see Tanzi/ Zee, 1997, 186; Strauss, 2001, 137).

3.2.2 Consumption tax

In contrast, a tax on consumption will only distort the intratemporal decision of households but not the intertemporal decision. After-tax returns to capital do not change because the consumption tax is neutral with respect to the relative price of consumption in t and in t+1. Thus there is a levelling effect of the consumption tax on output per capita rather than a growth effect (see Tanzi/ Zee, 1997, 185). Moreover, there are a lot of consumer goods such as sports equipment, which are complementary to leisure. Thus the distortive effect of a consumption tax should be relatively small. In practice the tax distortion is also weakened by the fact that the freedom to decide between leisure and working hours is limited. Of course this is also true for tax on wages.

3.3 Structuring government activities and theses to be tested

By summarising the sections 3.1 and 3.2 a tool for analysing governmental activities empirically is provided. Since this analysis focuses on the expenditure side, the effect of governmental finance on growth will only be structured roughly. The taxes are differentiated according to their distortions predicted by new growth theory (see table 1).

Table 1: Expected distortions of taxes according to new growth theory

More distortive taxation	**Less distortive taxation**
- taxes on profits, i.e. corporate income and part of personal income taxes - capital income taxes - payroll taxes - social security contributions	- taxes on goods and services - property taxes, i.e. wealth tax, real estate tax, gift tax and death duty

Turning to public spending, different governmental policies are assigned to the structure presented in section 3.1. Alternatively one could differentiate public expenditures

11 If the household has to pay tuition fees for education or if there is a progressive tax structure, these effects are reinforced (see Gerson, 1998, 28).

12 However, if a proportional tax on wages is not levied on the earnings of human capital a wage tax is equivalent to a tax on consumption, which is described below.

according to investment and consumption. In analogy to the private sector, public investments in particular are usually viewed to be able to extend growth potential. Even if this is taken for granted, difficulties exist in defining public investments as governmental statistics do not use investment in an economic sense (see Thöne, 2003, 16-25). Thus, this differentiation would not appear to be apt for an empirical analysis of growth of public expenditures.

In governmental statistics a variety of different measures is put into the same category so that the evaluation of policies cannot be uniform. Moreover, policy measures can affect growth in different ways. For example, unemployment benefits contribute to the creation of social stability. Additionally, persons who are still employed do not worry so much about unemployment as they would should there be no benefits. Consequently unemployment benefits can contribute to better work performance and thus can be thought of as a positive moral hazard effect of a social unemployment insurance.[13] Despite the difficulties of assignment the expenditures are put in those categories for which they contribute to the greatest extent. Expenditures which could not be assigned to any of those categories are classified as "other". The latter are not thought to have a relevant growth effect or can even have a negative impact. The intended structure of governmental spending is shown in table 2.

The organisation of governmental activities according to tables 1 and 2 is restricted by data availability in the empirical analysis. For example, due to limitations in the case of income taxes, for which the split into individual and corporate taxes are only available at the central government level in Government Finance Statistics (GFS), this split has not been used in this analysis. Furthermore, transport and communication data are not available separately in the GFS data set.

As an outcome of the above discussion, the following ***theses*** are analysed empirically:

(i) The structure of government expenditures seems to have a substantial influence on the performance of growth.

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[13] In contrast, the standard argument in economic theory claims that the incentive to work can be reduced by an unemployment insurance. However, except for the positive moral hazard effect mentioned above there are other opposing forces to this moral hazard behaviour: (i) the duration of unemployment benefits is restricted and the amounts are, for most people, much less than their salaries, (ii) people view unemployment as an enormous hardship (see Bewley, 2003, 21), (iii) the social acceptance of unemployment is low and (iv) future career opportunities may be reduced by unemployment phases.

(ii) The tax structure's relative weights of income taxation for example and consumption taxation in total taxes would appear to have an important impact on growth.

The main emphasis of the empirical analysis is related to the first thesis. In connection with this thesis, the effect of government size on economic performance is discussed as well.

Table 2: Public expenditures assigned according to the way they influence growth performance

Enhancing labour productivity	**Directly usable inputs for private firms**	**Security and social stability**	**Other**
- Education - Active labour market policies (ALP) - Healthcare - Family/ children benefits	- R&D activities - Core infrastructure: - transport networks - energy facilities - water and sewer systems - communication networks - development planning	- Unemployment benefits insofar as not ALP - Benefits against relative poverty, e.g. welfare assistance, housing benefit - Compensation for social hardship and transitional subsidies due to a crisis of a branch or natural disasters - Outlays for judiciary and police - Old-age- and invalidity pensions	- Defence - Permanent subsidies due to lobbying of interest groups, e.g. agricultural subsidies

4 Estimating the effects of the public sector

So far the empirical evidence for the thesis that government size and tax structure have a strong influence on economic growth is much weaker than theory would suggest (see

Sala-i-Martin, 1997, 182; Tanzi/ Zee, 1997, 187; Temple, 1999, 145, also section 1). In contrast, there is somewhat more support in the empirical literature for a positive impact of governmentally provided infrastructure on economic growth (see Temple 1999, 145; Colombier, 2001, 15). In a time-series analysis, Singh and Weber (1997) showed a positive significant relationship between government expenditure on education and health on long-term growth of per capita output for Switzerland. Recently, Kneller et al. (1999) and Bleaney et al. (2001) revealed positive effects of productive governmental expenditure like transportation and communications infrastructure on growth. In order to identify the determinants of economic growth usually cross-country studies or panel data studies are applied (see Temple, 1999, 119). As already mentioned, this analysis uses panel data of a sample of 21 OECD countries to test the hypotheses in 3.3. Section 4.4 focuses on the expenditure side, whereas in section 4.5 the revenue side is outlined. The following section 4.6 sheds some light on answering the question of an optimal government size. Firstly, the estimation method (section 4.1), the basic model (section 4.2) and the fiscal variables applied to the regressions (section 4.3) are described.

4.1 Design of the estimation

In order to take into account the long-term notion of models of endogenous growth, five year moving averages of the data are used. In contrast to the usual procedure of taking five year averages (see Levine/ Renelt, 1991, 8), moving averages are chosen to avoid the choice of special periods. However, one should note that five years may be too short since most countries have longer business cycles. On the other hand, it is argued that business cycles may also have important effects on long-term growth. Thus, these five year averages are a compromise, which is also due to data availability in the government sector. In addition, parts of the effect of business cycles on government expenditures, i.e. higher expenses in recessions and vice versa, can be eliminated. The data limitations could be remedied by applying a more sophisticated smoother such as a Hodrick-Prescott filter. An objection against the usage of smoothed data is simply that in practice we do not know, where this long-term path of economic development might lead and it can only be met by chance. However, in order to cope with the worst outliers, smoothing can be a fruitful approach. In turn smoothing incorporates the fact that an important part of data information may not be accounted for in the empirical analysis.

The scope of panel data or cross-country analysis is to detect common patterns of growth in countries. Thus, the basic assumption of empirical analysis is that the predictions

of endogenous growth theory apply to all countries. Although the growing international exchange of goods and knowledge as well as the mobility of production factors foster the convergence of countries, each country is still an unique entity. The latter is totally desirable but unfortunately this fact aggravates the empirical analysis. It follows, that one cannot be sure that the production elasticity of labour for example does not differ significantly across countries. In economic analysis this problem is known as parameter heterogeneity (see e.g. Levine/ Renelt, 1991, 5-11). Parameter heterogeneity can be mitigated by careful detection of outliers since outliers of a panel can be viewed as shaping, which can be either time or country specific. Unfortunately, least squares regressions which are widely used in growth empirics (see appendix, table A1) "tend to produce normal-looking residuals even when the data itself behaves badly [i.e. non-Gaussian]" as Hubert et al. (2004) put it. Thus, even for high quality data, which deviates only slightly from Gaussian distribution, least squares estimators (LSE) show substantial losses (10%-100%) in efficiency (see Hampel, 2001, 1-2). Moreover, a small portion of outliers can produce systematic distortions of LSE (see Zaman et al., 2001, 2). To deal adequately with outliers, robust statistics should be used (see Temple, 1999, 127).[14,15] Although, there are additional causes of outliers in economic data sets such as the quality of the available data and omissions of variables, robust statistics have so far rarely been applied in the analysis of economic growth (see Zaman et al., 2001, 1).[16] The absence in particular of high quality data in most economic data sets as in growth empirics favours the application of a robust estimator (see Zaman et al., 2001, 1-2).

Consequently, in order to account for outliers and non-Gaussian data a robust estimation method, i.e. a modified maximum likelihood regression (MM-regression), is applied to this analysis. Due to the advanced capabilities of the MM-estimator to detect outliers, country and time-specific effects can be better separated than in the case of LSE[17]. As a result, if a maximum of fifty percent of the data constitute special effects shaped as outliers, and the

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14 "Robustness" in this context means that the estimator is robust against deviations of the data from the assumed statistical distribution, usually the normal distribution. For example, this is not true for least-squares estimators. As a result, in contrast to ordinary estimators such as least squares, robust estimators are not distorted by influential outliers.

15 A method to detect specific effects explicitly is to use dummies for the chosen time periods and countries. However, this may be face with computing capacity constraints (see footnote 22).

16 For example, Temple (1998) and Zaman et al. (2001) use a robust regression approach for the analysis of economic growth.

17 This is an advantage of all robust estimators (see Temple, 1998, 372-73).

rest follow the same model, the MM-estimator is able to distinguish the special effects from the correct model.

4.2 Basic model

The basic equation, which is estimated, is as follows :

Growth rate of per capita GDP in purchasing power parities (ppp) =

+ per capita growth rate of private real investments (excl. stockbuilding) in ppp (ginv)
+ per capita growth rate of real exports in ppp (gxp); from section 4.4.1.2: an export ratio, which is corrected by the population of a country (xpr)
+ the growth rate of the share of the population between the age of 15 and 64 in respect to the whole population in a country (lpop)
+ the per capita growth rates of different categories of real government expenditures as presented in table 2, section 3.3, i.e. enhancing labour productivity, direct usable inputs, security and social stability.

The first three independent variables correspond to the economic control variables. In view of possible collinearities, i.e. linear dependencies among the independent variables, which can severely bias the estimations, the number of economic control variables is kept small. For example, the real exchange rate and the real long-term interest rate are excluded due to collinearities (see appendix, table A4). According to the conditional convergence hypothesis of neoclassical theory the real per capita growth rates of GDP in terms of purchasing power parities of countries should draw nearer over time. However, for the applied sample, the per capita growth rates have diverged over a period of time (e.g. the standard deviation for the average growth rate of GDP from 1971 to 1975 amounts to 1.3, whereas the standard deviation for the average GDP growth rate from 1997 to 2001 amounts to 1.5). Moreover, negative significance of the initial GDP regressor, which is viewed as empirical proof of conditional convergence predicted by neoclassical growth theory, cannot be interpreted unambiguously. As Thirlwall (2003, 45) points out, negative significance of the initial GDP, can be due to effects such as a shift of the whole production function or faster structural changes in the poorer countries, which are not explained by the neoclassical growth model. On the other hand, if no conditional convergence is found, this is not necessarily empirical proof against neoclassical growth theory as there may be differences in the technology parameters and their rate of increase across countries (see Pack, 1994, 65). Therefore testing conditional convergence would not appear to be an apt instrument for deciding empirically in favour of or against neoclassical

growth theory. For this reason and the possible presence of collinearities, conditional convergence hypothesis is not accounted for in these estimations. The population ratio (lpop) is a proxy for the labour force potential. The export ratio (xp, xpr) is usually interpreted as an indicator for the degree of openness of a country.

The economic control variables are included in every estimation. In contrast, the selection of expenditure categories differ due to several reasons:

(i) The number of data of different expenditure categories differ notably.

(ii) The data is obtained from different databases, i.e. from the OECD, Government Finance Statistics of the IMF (GFS); some Swiss data comes from the Swiss Federal Finance Administration (FFA) (see table 3, section 4.3).

(iii) Due to the second point double counting exists between the expenditures for research and development of the OECD and the GFS expenditure categories as education expenditures, which already include research and development expenditures in the education sector.

(iv) Although aggregated variables such as infrastructure services may have positive effects on growth, this can be the result of a compensation effect. As a consequence all infrastructure services may be supported to foster growth, although e.g. energy facilities are not growth enhancing. Thus, more and less aggregated expenditure categories are tested.

The points (i), (ii) and (iii) are also applicable for the revenue side. The sample, which is used for the robust growth regressions consists of 21 OECD countries within the time period from 1971 to 2001.[18]

4.3 Predictions of endogenous growth theory

Before the results are presented it should be mentioned, which sign is to be expected according to endogenous growth theory for the fiscal variables.

Small g at the beginning of the abbreviations of the fiscal variables indicates their growth rate. Whereas tax revenues and social contribution as well as the government balances are expressed as ratios to GDP, the expenditure variables are represented as per

[18] The sample includes the following countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Republic of Korea, Netherlands, New Zealand, Portugal, Spain, Switzerland, Sweden, UK and USA. Other industrialised OECD countries, which include Iceland, Luxembourg and Norway have not been chosen due to some peculiarities. Norway is an oil-producing country, whereas Luxembourg and Iceland are much smaller in population than the smallest country of the sample, New Zealand (2003: 4 million inhabitants, Luxembourg: 450,000 and Iceland: 289,000).

capita magnitudes at constant prices and purchasing power parities.[19,20] In order to considerably reduce the risk of collinearities, the growth rates of expenditure categories have been applied to the estimations if more than one public expenditure variable has been tested in a single equation (see Appendix, table A4).

[19] Government expenditures are deflated by a public consumption deflator. Usually, the base year corresponds to 1995. Due to limited data availability other base years have had to be used for the following countries: Australia 2001/02, Canada 1997, Finland and the United Kingdom 2000, New Zealand 1995/96, Switzerland 1990 and the USA 1996.

[20] Per head magnitudes are chosen because GDP is the denominator of the expenditure variables and the nominator of the per capita GDP growth rate. Thus, there is a negative relationship a priori, which might influence the results. In the case of tax revenues the ratio can be viewed as a proxy for the tax rate, which the citizens expect to bear. As the tax ratios are ex post, it is implicitly assumed that the expectations of citizens with respect to the tax rate are met.

Table 3: Predicted relations of per capita GDP growth and fiscal variables[21]

Variable	Expected Sign	Reasons	Database
Ratio taxation and social contributions/gdp: taxt	-	Distortion investment (physical and human capital)/ labour decision	OECD
Ratio taxation and social contributions/gdp: trevi	-	Distortion investment (physical and human capital)/ labour decision	GFS
Ratio indirect taxes to nominal GDP: tindi	small -	Less distortive taxation	GFS
Ratio direct taxes to nominal GDP: tdiri	-	More distortive taxation	GFS
Ratio property taxes to nominal GDP: tpropi	small -	Less distortive taxation	GFS
Ratio social security contributions to nominal GDP: tsoci	-	More distortive taxation	GFS
Ratio deficit/gdp: gdebt	-	Crowding out; expectation of future tax increases	OECD/ CH: FFA
Ratio deficit/gdp: defti	-	Crowding out; expectation of future tax increases	GFS
Education: geduhi	+	Enhancing labour productivity	GFS
healthcare: ghealhi	+	Enhancing labour productivity	GFS
Healthcare: ghea	+	Enhancing labour productivity	OECD
Family benefits: gfam	+	Enhancing labour productivity	OECD
Active labour market policy: galp	+	Enhancing labour productivity	OECD
R&D-activities: hgovrd	+	Direct usable input for firms	OECD
Transport and communication networks: gtranshi	+	Direct usable input for firms	GFS
Energy facilities: generghi	+	Direct usable input for firms	GFS
Water and sewer systems, development planning: ghoushi	+	Direct usable input for firms	GFS
Social welfare minus family benefits, active labour market policies and health: gsores	-/ +	Distortion of labour supply, moral hazard; social stability and security	OECD
Social welfare: gsocialhi	-/ +	Distortion of labour supply, moral hazard; social stability and security	GFS
Safety: gsafehi	+	Security	GFS
Mining and construction: gmconstrhi	No/ -	Distortions by subsidies	GFS
Agriculture: gagrhi	-	Distortions by subsidies	GFS
Culture: gculthi	No/ -	Distortions by subsidies	GFS
General:ggenhi	No		GFS
Mean student performance per country according to PISA study: pisa	+	Enhancing labour productivity	PISA (2003)
Average indicator of product market regulation: pmr	-	Costs of regulation	OECD (2001)

[21] For a more detailed description of public expenditure categories see Classifications of the Functions of Government (COFOG), United Nations Statistics Division.

4.4 Government spending

Section 4.4.1 analyses the growth effect of different public expenditure categories, whereas section 4.4.2 deals with the quality of public expenditure and growth. In addition the correlation between public R&D activities and growth is studied.

4.4.1 Public expenditure categories

Table 4 summarises those at the general level of government estimated equations among the tested ones, which show the highest plausibility in economical and statistical terms, i.e. the highest robust R^2. In contrast, table 4a mainly shows the outcome of estimations on the central government level. In table 4b estimations of governmental data are shown which stem exclusively from the GFS-database of the IMF. Instead of the per capita exports (xp), an export ratio (xpr), which is corrected by the population size, is used in the estimations in table 4b. This is done because the export ratio, which should represent the degree of openness of an economy, is correlated with the population size. Furthermore, the variation of the tax ratio (gtaxt) is accounted for in the estimations in tables 4 and 4a because the MM-estimator has been biased in a considerable amount of equations if the tax ratio (taxt) has been used as an independent variable.[22, 23]

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22 Since MM-regressions need more computational capacities than least squares regressions, country-specific effects could only rarely be taken into account. Incorporating country-fixed effects improves the possibilities of an MM-estimator to separate country-specific effects adequately.

23 Due to the smoothing of data, serious autocorrelation problems emerge. Unfortunately, no autocorrelation resistant covariance is available in the statistical package used (S-Plus 6.0). Therefore, the Cochrane-Orcutt-method has usually been applied to deal with autocorrelations. In some cases bootstraps have been performed to get non-biased standard errors. However, sometimes the bootstrapped standard errors have shown considerable scattering so that estimations with 5 year averages of the data, which are not overlapped, i.e. from 1971 to 1975, from 1976 to 1980 etc., have been implemented.

Table 4: Government expenditure and economic growth – general government level

Variable	Model 1	Model 1a	Model 2	Model 2a
Government level	General	General	General	General
Ginv	0.238* (10.6)	0.278* (4.4)	0.248* (5.9)	0.248* (4.5)
Gxp	0.168* (6.7)	0.158^ (1.7)	0.13* (2.9)	0.097^ (1.7)
Lpop	0.992* (5.6)	0.928 (1.3)	0.972* (2.1)	1.51* (2.3)
Gtaxt	-0.045 (-0.9)	-0.215 (-0.5)	-0.138 (-1.5)	-0.16 (-1.22)
Gdebt	-0.011 (-0.8)	-0.014 (-0.2)	0.007 (0.2)	0.013 (0.4)
gtranshi	0.013 (1.6)	0.013 (0.8)		
generghi	0.0003 (0.19)	0.0006 (0.2)		
ghoushi	**0.01^ (1.7)**	0.01 (0.6)		
ginfrah= grtranshi+ghousi+ generghi	calculated: 0.023	calculated: 0.021	0.02 (0.7)	0.008 (0.2)
Geduhi	0.034 (1.4)	0.016 (0.2)	-0.013 (–0.29)	
ghealhi	-0.004 (-0.4)	0.004 (0.1)		
Gsores				-0.032 (-0.3)
Gfam			0.027 (1.1)	
Galp			-0.002 (–0.1)	
Ghea			0.08 (1.5)	
gelpho = geduhi+ galp+gfam+ghea			calculated: 0.096	0.023 (0.4)
gsafehi				0.016 (0.3)
Country	no	no	no	no
Period		period		
Robust R^2 in %	61	64	61	76
Number of obs.	238	49	131	94
Smoothing method	5 year moving averages with bootstrap	5 year averages from 1971 to 75, 76 to 80, etc.	5 year moving averages with bootstrap	5 year moving averages with bootstrap

: 5%-significance-level; ^ 10%-significance-level; t-values in parentheses; R^2:= the percentage of variation of GDP which can be explained by the estimations; country:= country fixed effects – if possible: yes, if not possible: no, and if significant: yes (5%) or yes^ (10%); period:= period fixed effects in 5 year average models – if significant: period* (5%) or period^ (10%).

4.4.1.1 First estimations and some difficulties

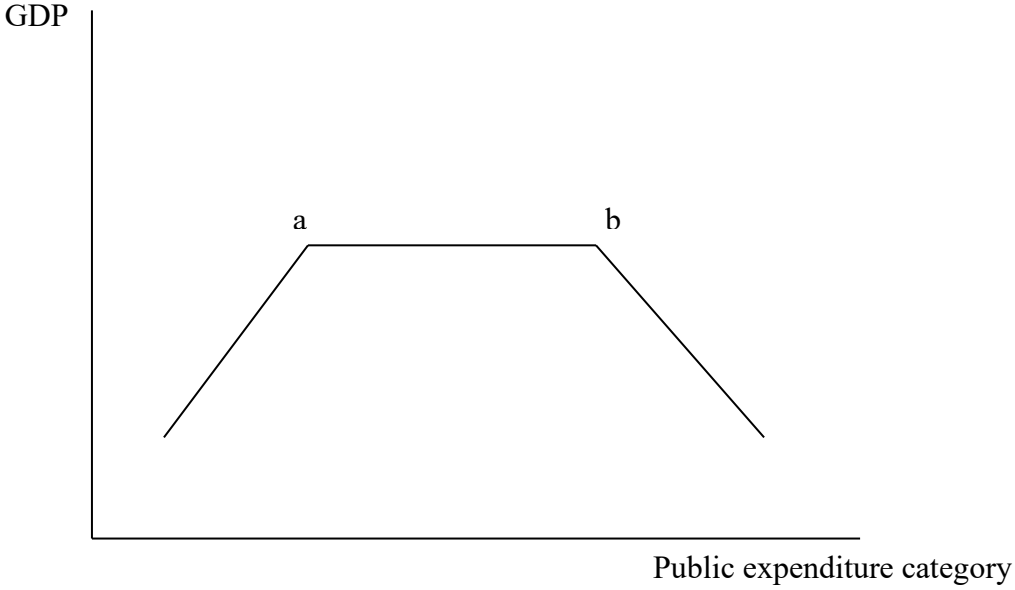
Before I begin to discuss the coefficients of the fiscal variables, I would briefly like to comment on the coefficients of the economic variables. The following reasoning is based

on the estimation outcomes presented in table 4. As one can see, the relationship between the growth rate of output and the growth rate of investment is very stable and significant. The coefficient of the investment growth rate is roughly equal to 0.24. This means that a one percentage point rise in private investments creates 0.24 percentage points of per capita GDP growth. The coefficient of the growth rate of exports varies throughout the estimations only to a small extent and is also significant in all equations. But in model 2a (see table 4), it is only significant at the 10% level. Thus, if an economy increases its degree of openness by a stronger orientation towards exports, it could foster growth performance significantly. In accordance with models 1, 2 and 2a, the same is true if the share of the labour force rises in the population. Only in the case of model 1a is the coefficient insignificant. The different results may be due to a relatively small sample size of model 1a. However, in comparison to the investment and export coefficient, the parameter of the labour force is less stable across the estimated models. It is striking that according to the models in table 4 the parameter of the labour force is close to one. This may be due to the fact that the labour force represents not only a production factor but also those consumers, which on average earn more income than the elderly and the younger ones. Thus, consumption is implicitly integrated into the tested equations. Additionally, the relatively high coefficient of the labour force may implicitly reflect technical progress, which is not included in the estimations. Although, the estimations in tables 4a and 4b show some insignificancies with respect to the export ratio (gxp, xpr) and the labour force variable (lpop), the reasoning above is confirmed largely (see table 4a, models 1a period, 1b; table 4b, models1c, 1d, 6). The latter is applicable, although the estimates in table 4b use the corrected export ratio (xpr) instead of per capita exports (xp).

In contrast to the significant and rather stable relationship between economic variables and growth performance, the correlations between fiscal variables and economic growth, which are reported in table 4, are statistically not significant, apart from one exception – water and sewer systems (see table 4, model 1, ghoushi). But this outcome can be doubted as a switch of the smoothing method causes the parameter of the expenditures for water and sewer systems (ghoushi) to become insignificant (see table 4, models 1, 1a). So, what can be learned from these estimates? To answer this question, a closer look at the economic meaning of the coefficients of public expenditure categories may help. Since the growth rates of public spending have been applied and the chosen expenditure categories are supposed to be productive, the coefficients can be interpreted as output elasticities. As outlined in section 3.1.4 there are economic reasons which hint at a non-linear relationship

between government expenditure and output. Usually this relationship is thought of as an inverted U. Since infinite variations of the data are not possible it is probable that in the real world the relationship between public spending and output is not exactly U-shaped. As depicted in graph 1, one can imagine three lines with two points ("a" and "b" in graph 1) that represent this non-linear relation. Note that the location of the graph below can differ across public expenditure categories. In addition, the slopes and the length of the line between the points "a" and "b" depicted in graph 1 are probably distinct. If the level of a public expenditure category is lower than the one at point "a", a higher output can be reached by increasing the expenditure for this category. If expenditures become higher than the one at point "b" output can be put up by reducing public spending for this certain category. Consequently, the area between "a" and "b" describes the optimal range for government activity.

Graph 1: Non-linear relationship between public expenditure categories and GDP



Due to the zero slope the output elasticity must be zero within this optimal range. Thus, a statistically insignificant coefficient may hint at the fact that government spending falls in the optimal range between points "a" and "b". However, a second interpretation might be that certain categories of government spending are simply neutral to economic performance.

Additionally, statistical testing of fiscal variables carries an inherent problem, which is due to the fact that revenues and expenditures represent two sides of the same coin. Due to the relation deficit/ surplus = expenditures - revenues there is a priori a linear dependence between deficits, expenditures and taxes. If the linear dependence is strong enough

between the realisations of the fiscal variables, i.e. the data, the outcome of statistical inference can become unreliable.[24] This can simply be remedied by leaving aside the revenue and deficit variables. But, since statistics cannot differentiate between fiscal variables, and revenues and expenditures run roughly parallel in the long run in the chosen sample and, expenditures are financed by revenues and deficits, the signs can be entangled.[25] This means that the tax ratio may have a significant positive sign or vice versa. As this outcome would be rather unexpected, it may well be due to the parallelism of the development of revenues and expenditures (see table 4a, model 1d; Bassanini et al., 2001, 29). This difficulty can be mitigated by applying indicators for the deficit and tax variables.

As a consequence, some further estimates with respect to infrastructure and education expenditures have been run (see table 4a). These incorporate, as an indicator for the deficit part of the budget, the ratio of government net interest payment to GDP in nominal terms (int). However, throwing the tax ratio and the deficit ratio out of the regression does not change the results (see table 4a, model 1a period).

4.4.1.2 Estimates on central government level and with IMF fiscal data only

In order to carry out an examination of the above estimates, statistical tests with central government expenditures have been performed as well (see table 4a). As in the case of general government expenditure, no significant relationship with economic growth could be identified in the case of central government expenditures if the tax and deficit ratios are accounted for (see table 4a, model 1b). Leaving the deficit ratio (gdebt) aside, results in a positive significant connection between transport and communication infrastructures (granshic) and economic growth (see table 4a, model 1c). At the same time, the provision of energy facilities by the central government (generghic) seems to hamper growth. Since the chosen periods differ significantly (see table 4a, model 1c), the results can be biased by this choice. Therefore, the same model is tested by applying 5 year moving averages (see table 4a, model 1d). The outcome indicates a positive significant correlation between transport and communication infrastructures as well as education expenses and economic growth. Surprisingly, the variation of the revenue ratio (gtaxt) also fosters economic

[24] Unfortunately, statisticians do not know exactly to what extent linear dependence between the explaining variables can be admitted without harming statistical inference.

[25] This is certainly true for the present sample as the spearman's rank correlation between the aggregated expenditure and tax ratio amounts to 92% (see also section 4.6).

growth. The latter is certainly due to the described parallelism between revenues and expenditures so that this outcome seems to be economically irrelevant. Because of this parallelism and the linear dependence of fiscal variables, other estimations without the tax and deficit ratios, but with the ratio of government net interest payments to GDP are performed. Since the outcome with 5 year averages points to significant differences between the chosen periods (see table 4a, model 1e), a regression with 5 year moving averages is run. The outcome of the model 1f (see table 4a) underpins the results of model 1d, though education expenditures are only significant on a 10% level. Consequently, at the central government level, the positive correlations of transport and communication infrastructures as well as education expenditures and economic growth seem to be rather stable. However, using only IMF government data gives slightly differing conclusions concerning the central government level (see table 4b). Whereas the transportation infrastructures show a positive significance in “nmodel 1c” and “nmodel 1d” (table 4b), a significant correlation of education expenditures is no longer supported (see table 4b). This indicates that the relationship between transportation infrastructure and economic growth is closer than between education and economic growth. Furthermore, the results in table 4b (models 3-6) at the general government level underpin the outcome indicated in table 4.

Moreover, as Wagner’s famous law stipulates, government expenditure increases in accordance with the development of an economy and as five year averages may not suffice to eliminate business cycle effects on public spending, not only higher expenditures may cause economic growth but the contrary might also be true (see section 4.1). In order to tackle this problem of reversed causation between growth and government expenditures, the fiscal variables of models 3 and 4 are instrumented, i.e. in crude terms replaced, and with respect to their values lagged from one to three periods. The outcome of the instrumented equations supports the conclusion that transport infrastructure seems to foster economic growth as well at the general government level (see table 4c, models 3IV, 4IV). In contrast, no significant relationship for education expenditures can be determined (see table 4c, models 3IV, 4IV). However, there may be a much longer run relation between education and growth. Also, the performance of education systems can be very important. Both points are not accounted for in these growth estimations (see also section 4.4.2). As in model 1 (table 4) the expenditures for water and sewer systems show a significant correlation to economic growth (see table 4c, models 3IV, 4IV). Although the relation of transport infrastructures to economic growth is rather tight, a percentage point increase of

this expenditure category is expected to cause, at most, only 0.06 percentage point per capita growth of GDP (see table 4a, model 1c).[26]

There are still different results concerning education expenditures (geduhi) as well as water and sewer systems (ghoushi) at the central and general government level (see tables from 4a to 4c). Therefore, one might ask, why the outcomes for central and general government activity differ. The following could explain the difference:

(i) Central and general government expenditures may differ substantially.

(ii) There might be compensational effects among the same and different government levels.

(iii) The data quality, especially the data comparability between countries, may be reduced with government level.

(iv) Central government may pay considerable grants to lower government levels and these grants are budgeted at the central level.

[26] Note that the upper limit of the confidence interval corresponds to 0.06.

Table 4a: Government expenditure and economic growth - central government level

	Model 1a period	Model 1b	Model 1c	Model 1d	Model 1e	Model 1f
Government level	General	Central	Central	Central	Central	Central
ginv	0.27* (4.2)	0.24* (4.7)	0.2* (6.7)	0.17* (13.6)	0.26* (8.3)	0.2* (14.9)
gxp	0.17^ (1.8)	0.08 (1)	0.12* (2.7)	0.13* (6.5)	0.17* (3.6)	0.12* (6.14)
lpop	1.13 (1.5)	0.45 (0.7)	0.38 (0.6)	0.21 (1.6)	0.7^ (1.8)	0.25^ (1.8)
gtaxt		-0.09 (-0.2)	-0.005 (-0.02)	0.27* (2.7)		
gdebt		0.005 (0.06)				
int	-0.08 (-0.8)				-0.05 (-0.8)	-0.04 (-1.6)
gtranshi	0.01 (0.4)					
generghi	0.001 (0.9)					
ghoushi	0.009 (0.4)					
geduhi	0.03 (0.4)					
ghealhi	0.0003 (0.005)					
gtranshic		0.02 (0.5)	**0.04* (3.8)**	**0.02* (3.5)**	**0.01^ (1.7)**	**0.02* (3.1)**
generghic		-0.0005 (-0.7)	**-0.01* (-2.1)**	-0.0001 (-0.2)	-0.0004 (-0.7)	0 (-0.1)
ghoushic		-0.008 (-0.5)	-0.01 (-1.1)	0.003 (1.1)	0.0007 (0.2)	0.002 (0.6)
geduhic		0.01 (0.5)	0.02 (1)	**0.02* (2.5)**	0.02 (1.2)	**0.02^ (1.95)**
ghealhic		-0.0002 (-0.07)	-0.002 (-0.9)	-0.0021 (-0.4)	-0.0016 (-1)	-0.0017 (-0.3)
Country	no	no	no	no	no	no
Period	period	period	period*		period*	
Robust R^2 in %	61	65	71	62	61	62
Number of obs.	53	61	46	352	68	338
Smoothing method	5 year averages from 1971 to 75, 76 to 80, etc.	5 year averages from 1971 to 75, 76 to 80, etc.	5 year averages from 1971 to 75, 76 to 80, etc.	5 year moving averages with bootstrap	5 year averages from 1971 to 75, 76 to 80, etc.	5 year moving averages with bootstrap

: 5%-significance-level; ^ 10%-significance-level; t-values in parentheses; R^2:= the percentage of variation of GDP which can be explained by the estimations; country:= country fixed effects – if possible: yes, if not possible: no, and if significant: yes (5%) or yes^ (10%); period:= period fixed effects in 5 year average models – if significant: period* (5%) or period^ (10%).

Table 4b: Estimations with IMF government finance data

	nModel 1c	nModel 1d	Model 3	Model 4	Model 5	Model 6
Government level	Central	Central	General	General	General	General
ginv	0.23* (8.4)	0.23* (19.5)	0.2* (10.5)	0.22* (16)	0.2* (15.5)	0.18* (11.7)
xpr	0.05 (0.9)	0.08* (2.3)	0.1* (2.3)	0.12* (2.8)	0.13* (2.9)	0.11* (2.7)
lpop	0.7^ (1.9)	0.4^ (1.8)	0.38 (1)	0.05 (0.2)	-0.09 (-0.3)	0.9* (2.5)
gtrevi-(c)	0.04 (0.7)	-0.008 (-0.4)	0.03 (1)			
gtranshi-(c)	**0.02* (3)**	**0.006^ (1.9)**	0.007 (1.5)	0.005 (1.4)		
generghi-(c)	-0.0007 (-1.5)	-0.0001 (-0.9)	0.0007 (0.6)	0.0006 (0.4)		
ghoushi-(c)	0.0002 (0.06)	0.0006 (0.42)	0.001 (0.3)	0.002 (0.3)		
geduhi-(c)	0.02 (1)	0.01 (1.4)	0.01 (0.5)	0.005 (0.3)		
ghealhi-(c)	-0.0004 (-0.3)	-0.0005 (-0.6)				-0.01 (-0.9)
gsocialhi					-0.02 (-1.5)	
gsafehi						0.03 (1.6)
gdefhi					0.01 (0.9)	
ggenhi					0.001 (0.1)	
gculthi						-0.0008 (-0.07)
gagrhi						-0.0006 (-0.1)
gmconsthri					-0.002 (-1.1)	
Country	no	no	no	no	no	no
Period	period*					
Robust R^2 in %	63	44	40	46	49	50
Number of obs.	70	348	245	285	280	143
Smoothing method	5 year averages from 1971 to 75, 76 to 80, etc.	5 year moving average	5 year moving average	5 year moving average	5 year moving averages	5 year moving average
Chi-square test for bias of LS (p-value)	non-biased (0.8)	biased (0)*	biased (0)*	biased (0)*	biased (0)*	biased (0.02)*

: 5%-significance-level; ^ 10%-significance-level; t-values in parentheses; R^2:= the percentage of variation of GDP which can be explained by the estimations; country:= country fixed effects – if possible: yes, if not possible: no, and if significant: yes (5%) or yes^ (10%); period:= period fixed effects in 5 year average models – if significant: period* (5%) or period^ (10%); the bias of least squares (LS) is tested relative to the MM estimator.

Table 4c: Estimations with IMF government finance data and instrumented fiscal variables (IV)

	Model 3 IV	Model 4 IV	Model 3	Model 4
Government level	General	General	General	General
ginv	0.2* (17.4)	0.22* (17.6)	0.2* (10.5)	0.22* (16)
xpr	0.15* (4.4)	0.17* (4)	0.1* (2.3)	0.12* (2.8)
lpop	-0.36 (-1.1)	0.2 (0.7)	0.38 (1)	0.05 (0.2)
grevi	0.02 (0.8)		0.03 (1)	
gtranshi	**0.02* (3.3)**	**0.009* (2.9)**	0.007 (1.5)	0.005 (1.4)
generghi	-0.0008 (-1)	-0.0006 (-0.8)	0.0007 (0.6)	0.0006 (0.4)
ghoushi	**0.013* (3.3)**	**0.01* (2.7)**	0.001 (0.3)	0.002 (0.3)
geduhi	-0.005 (-0.4)	0.005 (0.8)	0.01 (0.5)	0.005 (0.3)
Country	no	no	no	no
Robust R^2 in %	47	45	40	46
Number of obs.	192	221	245	285
Smoothing method	5 year moving average	5 year moving average	5 year moving average	5 year moving average
Chi-square test for bias of LS (p-value)	biased (0.001)*	biased (0)*	biased (0)*	biased (0)*

: 5%-significance-level; ^ 10%-significance-level; t-values in parentheses; R^2:= the percentage of variation of GDP which can be explained by the estimations; country:= country fixed effects – if possible: yes, if not possible: no, and if significant: yes (5%) or yes^ (10%); period:= period fixed effects in 5 year average models – if significant: period* (5%) or period^ (10%); the bias of least squares (LS) is tested relative to the MM estimator.

4.4.1.3 Estimations with annual data

To take full account of the information, included in the data, regressions with annual data are performed relating to central and general government levels (see table 4d). In contrast to the estimations above, these estimations are restricted to the short-term influences of government activities (exerted within the same year) on the per capita growth rate of GDP. Due to the fact that presently there is no filter for business cycle effects, the change of unemployment rate (unch) is included. The statistical significance and the high coefficient of the unemployment rate hint at the strong dependence of unemployment on short-term economic performance (see table 4d).

There is a positive significant correlation between transport and communication infrastructures as well as education expenditures of the general government on economic growth (see table 4d, model A1). This may be due to the fact that government activities can only foster growth in the short-term. Due to the fact that the education sector is very labour intensive, an increase of expenditures can cause a rise in public consumption and thus a surge in the per capita growth rate of GDP.

Table 4d: Estimations with annual data

	Model A1 (g1)	Model A2 (cg1)
Government level	General	Central
ginv	0.14* (9.8)	0.15* (12.3)
xpr	0.11* (3)	0.1* (3.3)
lpop	0.5^ (1.7)	0.35^ (1.7)
int	-0.11^ (-1.8)	-0.13* (-2.4)
unch	-0.78* (-6.3)	-0.7* (-7.4)
gtranshi	**0.007^ (1.9)**	
generghi	-0.0001 (-0.07)	
ghoushi	0.002 (0.7)	
geduhi	**0.03* (2.1)**	
ghealhi	-0.002 (-1.1)	
gtranshic		**0.006* (2.2)**
generghic		0.0002 (0.9)
ghoushic		0.0001 (0.8)
geduhic		0.006 (1)
ghealhic		0.0005 (1)
Robust R^2 in %	53	51
Number of obs.	349	425
Smoothing method	Annual	Annual
Chi-square test for bias of LS (p-value)	biased (0)*	biased (0.02)*

: 5%-significance-level; ^ 10%-significance-level; t-values in parentheses; R^2:= the percentage of variation of GDP which can be explained by the estimations; country:= country fixed effects – if possible: yes, if not possible: no, and if significant: yes (5%) or yes^ (10%); period:= period fixed effects in 5 year average models – if significant: period* (5%) or period^ (10%); the bias of least squares (LS) is tested relative to the MM estimator.

At the central government level, the coefficient shows no significance (see table 4d, model A2) which does not underpin the explanation of a rise in public consumption. Moreover, apart from the "public consumption hypothesis", there are no convincing reasons for educational expenses having a short-term effect at first glance. According to economic considerations (see 3.1.1), the effect of an educational reform needs a few years to exert its full effect on growth performance. At the central government level, transport and communication expenditures are positive significant (see table 4d, model A2).

Additionally, government net interest payments seem to crowd out private investments (see table 4d). This result should be interpreted cautiously because the ratio is mainly driven by the denominator, which is the nominal GDP (see fn. 20).

4.4.1.4 Initial conclusions

According to the performed estimations, infrastructures such as those for transportation and communication, as well as water and sewer systems, seem to foster growth. The regressions, especially for transportation and communication infrastructure, indicate a rather stable relationship to economic growth. In contrast, since statistically significant and economically relevant growth effects of educational expenses are only found on the central government level, this correlation seems to be much weaker. However, the lags for the effects of education may be quiet long and the quality of education is certainly even more growth-relevant. Estimations with a quality indicator of education are run in the subsequent section. Moreover, the coefficients of the fiscal variables mentioned suggest that these variables may influence economic growth only to a small extent.

Ultimately, two interpretations of the estimations but with different policy conclusions are possible:

(i) If non-significance of a coefficient of government expenditure concurs with the non-linear relationship as depicted in graph 1, the expenditure level (in real per capita terms) should at least be held constant for this category. But both limits, the lower ("a") and the upper ("b"), should be respected (see graph 1). However, since the limits depicted in graph 1 are not known, this is a rather difficult task. In the case of neutrality, the variation of the expenditure category is not relevant for growth.

(ii) If there is a significant positive coefficient as in the cases of transport infrastructure and education, these categories should be expended in any case. But in the case of a non-linear link to output, attention should be paid to the fact that the second point "b" (see graph 1), but which is not known (see above), should not be passed.

4.4.2 Quality indicators and R&D

So far we have estimated the relationship between government spending and growth. However, government spending serves as an input to economically relevant activities like education. Thus, if it was possible to measure the outcome of government activities, more reliable estimations could certainly be performed. Unfortunately, there are not too many

indicators available for the quality of government activities. Therefore, only two proxies of government performance of the OECD have been included in the regressions. Due to the data availability of the quality indicators, annual data has been applied to the estimations. In order to filter business cycle effects to some extent, the change of unemployment rate (unch) enters the regressions. One indicator corresponds to the outcome of the famous PISA study (PISA/ OECD, 2003). The points achieved by the students of every country are included in the estimations. As only data points for the year 2000 are available, the regression is initially restricted to this year. No significant influence could be found (see table 5, model 10a). In addition, assuming that the outcome of PISA had been valid for five or ten years does not change the results (see table 5, models 10b, 10c). One possible explanation for this result is that skills learned at the age of 15 or 16 may not be directly applicable to the job. These skills would appear to serve as a prerequisite for further education at professional schools or universities. Another explanation is simply that the performance of school education has changed over time.

Table 5: Quality indicators and economic growth

	Model 10a	Model 10b	Model 10c	Model 11	Model 12
ginv	-0.11 (-1.3)	0.1 (1.2)	0.3 (0.8)	0.2* (5.3)	0.19* (17.9)
xpr	0.12* (2.5)	0.01 (0.1)	0.02 (0.02)	0.04 (1)	0.1* (6.3)
lpop	-0.21 (-0.6)	1.4 (0.8)	0.3 (0.06)	0.4 (1)	0.9* (4.2)
unch	-0.003 (-0.0083)	0.6 (0.7)	-1.1 (-0.3)	-0.7* (-3.2)	
pisa	0.004 (0.6)				
pisa with lag of 5 years		0.007 (0.4)			
pisa with lag of 10 years			0.005 (0.05)		
pmr				**0.24^ (1.7)**	
hgovrd (general government)					**0.004* (3.2)**
Country	no	no	no	no	yes*
Robust R^2 in %	21	24	72	60	57
Number of observations	21	21	21	100	336
Smoothing method	year 2000; cross country	year 2000; cross country	year 2000; cross country	annual	5 year moving average
Chi-square test for bias of LS (p-value)	non-biased (1)	non-biased (1)	non-biased (1)	non-biased (0.4)	non-biased (0.7)

: 5%-significance-level; ^ 10%-significance-level; t-values in parentheses; R^2:= the percentage of variation of GDP which can be explained by the estimations; country:= country fixed effects – if possible: yes, if not possible: no, and if significant: yes (5%) or yes^ (10%); period:= period fixed effects in 5 year average models – if significant: period* (5%) or period^ (10%); the bias of least squares (LS) is tested relative to the MM estimator.

The second proxy is an indicator of product market regulations in OECD countries (pmr) (OECD, 2001). The indicator encompasses the average regulation of seven industries.[27] The scale of the indicator goes from "0", i.e. least restrictive, to "6", i.e. most restrictive. The indicator is available at five-year intervals (1978, 1982, 1988, 1993, 1998), during the time period between 1978 and 1998. According to the regression, which shows a positive significant relationship between product market regulation and economic growth, more regulation would foster growth (see table 5, model 11). Maybe this outcome expresses the fact that some deregulation, like that of the British railway systems, has not been very well performed. Furthermore, there may be problems in the construction of this indicator.

27 These are: gas, electricity, post, telecommunication, air transport, railways, road freight.

Taking the results of this section into account, it would not appear to be very promising to do further estimations with these two indicators. But the outcome of the educational indicator may be improved if time series data becomes available for PISA. However, the indicators that have been applied up to now primarily in growth empirics for educational attainment and thus the accumulation of human capital, i.e. the Barro/Lee-dataset, are not able to map the performance of educational systems adequately (see Pohlenz, 2000, 154-157).

Apart from the possible influence of quality of public spending on growth, an estimation with government expenditures for research and development has been performed. According to the outcome of model 12 (see table 5), R&D expenditure shows a significant relation to economic growth. Thus, an increase of one percentage point of per capita public R&D expenditure can raise the growth rate by 0.004 percentage points provided that there is no reversed causality.[28]

4.5 The revenue side

Although this analysis focuses on the expenditure side of government, some regressions have also been run with respect to the revenue side of government (see table 6). However, the results can be summarised briefly.

[28] The outcome of the estimation for public R&D expenditure is reported separately because they are already included in the public expenditure categories used in the presented estimations in section 4.4.1.

Table 6: Tax ratios and economic growth[29,30]

	Model 9a	Model 9b	Model 9c
Government level	General	General	General
ginv	0.2* (17.3)	0.2* (20.7)	0.23* (3.1)
xpr	0.07* (3.5)	0.07* (4.1)	0.05 (0.6)
lpop	0.12 (0.5)	0.1 (0.5)	0.7 (0.8)
tindi	-0.03 (-1)	-0.007 (-0.3)	
tdiri	0.01 (0.5)	0.0032 (0.2)	
tpropi		-0.04 (0.2)	
tsoci			-0.02 (-0.3)
Country	yes*	yes*	no
Period			period
Robust R^2 in %	55	56	56
Number of obs.	401	398	79
Smoothing method	5 year moving average	5 year moving average	5 year averages from 1971 to 75, 76 to 80, etc.
Chi-square test for bias of LS (p-value)	biased (0)*	biased (0)*	non-biased (0.4)

: 5%-significance-level; ^ 10%-significance-level; t-values in parentheses; R^2:= the percentage of variation of GDP which can be explained by the estimations; country:= country fixed effects – if possible: yes, if not possible: no, and if significant: yes (5%) or yes^ (10%); period:= period fixed effects in 5 year average models – if significant: period* (5%) or period^ (10%); the bias of least squares (LS) is tested relative to the MM estimator.

Four kinds of revenues have been included in the estimations: direct, indirect and property taxes, as well as social contributions. A significant relationship could not be identified for any of them (see table 6). The analysed tax ratios do not affect economic growth in a statistically measurable way. Thus, with respect to taxes and social contributions the predictions of new growth theory are not met (see section 3.2). This may be due to the fact that human beings do not behave perfectly rational as assumed in the models of new growth theory.

4.6 The question of an optimal government size

Apart from the question of the relationship between the structure or quality of government spending, a lot of economists try to answer the question of the optimal size of

29 Since the estimation, which includes social contributions (tsoci) breaks down with a 5-year moving-average approach, five year averages are used (see table 6, model 9c).

30 Unfortunately, it has not been possible to perform instrumented MM-regressions with 3 lags for the equations in table 6 due to computational limitations. The instrumented versions with one lag for the fiscal variables are shown in the appendix. Instrumentation of the fiscal variables with one lag has only been possible for the equations 9a and 9b of table 6. The results which do not differ substantially from the ones in table 6 are reported in the appendix (see tables A2 and A3).

government activity as a whole. Usually this size is measured by the expenditure ratio, which includes government and social expenditures in relation to GDP. Although there are considerable doubts that an optimal level of government activity could be determined, there are still a lot of empirical studies which attempt to tackle this problem. The outcome of table 7 provides two important reasons why the question of an optimal government size would appear to be empirically not solvable.

Table 7: Expenditure and revenue ratio[31]

	Model 7a	Model 7b	Model 8a	Model 8b
Government level	General	General	General	General
Method of estimation	MM	OLS biased!	MM	OLS biased!
ginv	0.2* (17.6)	0.18* (16)	0.3* (20.3)	0.18* (16)
xpr	0.08* (3.6)	0.06* (2.8)	0.07* (4.1)	0.08* (3.6)
lpop	0.2 (1.1)	0.22 (0.2)	0.12 (0.8)	0.08 (0.5)
expi	*-0.003 (-0.8)*	*-0.006^ (-1.8)*		
trevi			*-0.004 (-1.1)*	*-0.008^ (-2)*
Country	yes*	yes*	yes*	yes*
Robust or cor. R^2 in %	55	68	57	67
Number of obs.	390	390	388	388
Smoothing method	5 year moving average	5 year moving average	5 year moving averages	5 year moving averages
Chi-square test for bias of LS (p-value)		biased (0)*		biased (0)*

: 5%-significance-level; ^ 10%-significance-level; t-values in parentheses; R^2:= the percentage of variation of GDP which can be explained by the estimations; country:= country fixed effects – if possible: yes, if not possible: no, and if significant: yes (5%) or yes^ (10%); period:= period fixed effects in 5 year average models – if significant: period* (5%) or period^ (10%); the bias of least squares (LS) is tested relative to the MM estimator.

In table 7, four regressions are presented. Two estimations use a robust MM-estimator and the other two an ordinary least squares estimator (OLS) usually applied in economic analysis. Moreover, two different indicators for government size, i.e. the expenditure ratio and the revenue ratio, are used. A look at the outcome of the OLS regressions indicates that the expenditure ratio as well as the revenue ratio exert a negative influence on government growth which is statistically significant at the 10% level (see table 7,models 7b, 8b). This outcome is not very surprising for two reasons: (i) every tax is supposed to affect growth negatively and (ii) revenues and expenditure are expected to become parallel in the long-

[31] Unfortunately, it has not been possible to perform instrumented MM-regressions with 3 lags for the equations in table 7 due to computational limitations. The instrumented versions with one lag for the fiscal variables are shown in the appendix (see tables A2 and A3). The results do not differ noticeably from the outcome of table 7.

term (see section 4.4.1.1; correlation between expi and trevi amounts to 92%). However, what is the economic conclusion? Is government expenditure too high and thus government size too large? Or does this merely express the fact that taxes are expected to affect growth negatively? Besides, as there are certainly also economically stimulating government activities, the net effect of government activities is relevant. But due to the parallelism of expenditures and revenues in the long-term, this question cannot be answered by the regressions in table 7.

In addition, economic data cannot be deemed to be high quality data (see Zaman et al. 2001, 1-2). But this causes the data to have a non-Gaussian distribution. As a consequence, the OLS estimator is non-efficient and can be biased. For the regressions above a Chi-square test showed that the OLS is biased. As a result the statistical tests are biased, too. This is obviously the case as the MM-regressions show. In contrast to the OLS regressions, the statistical significance of the expenditure and revenue ratio vanish in the case of the robust estimations (see table 7, models 7a, 8a). Based on the outcome of the latter, neither the revenue ratio nor the expenditure ratio affect growth negatively. Since these ratios vary in time and between countries in the applied sample considerably (revenue ratio between 10% and 58%; expenditure ratio between 15% and 74%), government size seems not to matter too much for economic growth. Consequently, the question of government size is not the most relevant. Instead it is more important to take into account the economic effects of the structure of government activities. Thus, the analysis of government actions on economic growth should be much more micro-focused.

The robust estimation result with respect to the revenue side conflicts with some studies of economic growth (see table 7, model 8a and appendix, table A1).[32] But these studies apply an OLS estimator, which is non-efficient and expected to be biased in the case of non-Gaussian distributed data. This probably explains the different outcome.

5 Conclusions and outlook

This study suggests that the relationship between government activities and economic growth is generally weak. Only for transport and communication infrastructures has a stable correlation to economic growth been identified. Also significant but less stable, growth effects have been asserted for expenditures for water and sewer systems and

[32] In the case of the expenditure side, the result of the robust regression contradicts e.g. the outcome of Fölster/ Henrekson (2001) (see table 7, model 7a and appendix, A1). However, the study of Fölster/ Henrekson (2001) does not withstand examination by Agell et al. (2003) which affirms the conclusions of this analysis (see appendix, table A1).

educational expenditures. For educational expenditure the positive growth connection is only found at central government level. But it has to be taken into account that primarily the performance of educational systems and not the expenditure side should be relevant for economic growth. Unfortunately, adequate indicators have not been available so far. Additionally, a significant correlation of public R&D expenditures to growth have been found.

Policy conclusions for the expenditure side cannot be clear-cut due to possible non-linearities. If non-linearities exist, one should note that there is some upper limit at which the growth effects of a public expenditure category can become negative. But at the same time, two low expenditures can leave growth potentials unused. If non-linearities exist or not, public expenditures for which positive growth effects are ascertained should at least be kept constant. Finally, the interpretation of results of the non-significant public expenditures coefficients depends on the non-linearity assumption, too. In the latter case these expenditures are provided optimally, whereas for a linear link they are simply neutral to government activity. Probably, some expenditure categories are neutral and others show a non-linear relationship to growth.

However, checking for possible non-linearities will have to be dealt with by future research, though a few authors have already analysed this question (e.g. Aschauer, 2001). But provided that non-linearities exist, the even more important question is to detect the optimal spectrum for an individual government expenditure category, which is a difficult if not an impossible task (see below). Since no significant growth effect of taxation could be verified, endogenous growth theory is not corroborated for the revenue side.

Moreover, this analysis suggests that government size does not matter too much for economic growth. Also, the question of an optimal government size seems to be not empirically solvable. As a consequence applied economic analyses of the public sector should be focused more on micro issues. This study can be viewed as a first step in this direction.

Although non-linearities between government expenditures and economic growth have not been tested, the results of this study can be viewed as stable. Finally, one should consider, as Kneller and Gemmell (2001, 112) point out with respect to recent empirical growth studies, that there are still sufficient doubts concerning the reliability and generality of results.[33]

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[33] For the results of a few recent growth studies, see appendix, table A1.

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Appendix

Table A1: Outcomes of a few recent empirical growth studies

Author(s)	Method		Statistical Significance		Database
	Data and Smoothing	Estimator	Taxation	Government Expenditures	1. fiscal 2. economic
Kneller et al., 1999	22 OECD countries, panel data, 5-year averages, 1970-95, fiscal data as percentage of GDP	country & time-specific fixed effects OLS	negative: sum of income, payroll and social security contribution	positive: sum of general public services, defence, educational, health, housing, transport & communication (productive expenditure) positive: health, education no significance: public consumption and social welfare	1.GFS 2. WBT
Bleaney et. al., 2001	22 OECD countries, panel data, annual, 8 lags, 1970-95, fiscal data as percentage of GDP	country & time-specific fixed effects OLS, Anderson-Hsiao IV-Estimator as well as Jones-technique to control for parameter endogeneity	negative: sum of income, payroll and social security contribution	positive: sum of general public services, defence, educational, health, housing, transport & communication (productive expenditure) positive: health, education no significance: public consumption and social welfare	1.GFS 2. WBT

Bassanini et al., 2001	21 OECD countries, panel data, annual, 1971-1998 fiscal data as percentage of GDP, response: GDP per capita between age of 15 and 64	country-varying short-run OLS-coefficients and pooled-OLS for long-run coefficients (pooled mean group estimator)	negative: sum of tax and non-tax revenues	positive: government consumption, human capital proxied by the average years of schooling of population from age 25 to age 64 negative: R&D	1. OECD 2. OECD
Fölster and Henrekson, 2001	22/23 OECD and 28/29 rich countries respectively, panel data, 5 year averages, 1970 to 1995, fiscal data as percentage of GDP	country & time-specific fixed effects OLS, Two-stage-least-squares to account for endogeneity problems	negative: total tax revenues	negative: total government expenditure	1. GFS, OECD 2. IFS, OECD
Agell et al., 2003, test of the Fölster/Henrekson, 2001-outcome	22/23 OECD countries, panel data, 5 year averages, 1970 to 1995, fiscal data as percentage of GDP	Two-stage-least-squares to account for endogeneity problems	no significance and highly unstable coefficients with respect to total taxation	no significance and highly unstable coefficients with respect to total government expenditure	Dataset of Fölster/Henrekson, 2001
De Ávila and Strauch, 2003	EU member states, panel data, annual, 1960 to 2001, fiscal data as percentage of GDP	Polynomial distributed lag least squares models with 8 lags and 5 leads (to be made: assumption for the lag and lead structure)	no robust negative effect of direct taxation on growth ascertained (but on physical capital accumulation)	negative: public consumption and government transfers; positive: public investment	1.+2. EU Commission AMECO data set, autumn 2002

Abbreviations:
OLS:= ordinary least squares,
GFS:= Government Finance Statistics, IMF,
IFS:= International Financial Statistics, IMF,
WBT:= World Bank Tables.

Instrumented equations

Instrumental variables are used to detect reversed causality or endogeneity of a variable. If there is reversed causality in the case of a fiscal variable, the following equations are true:

$$GDP(t) = \beta_0 + \Sigma\beta_i * \text{economic variable}(t)_i + \Sigma\beta_j * \text{fiscal variable}(t)_j + e(t) \quad (1)$$

$$\text{Fiscal Variable}(t)_j = \gamma_0 + \gamma_1 * GDP(t) + u(t) \quad (2)$$

With: e(t), u(t):= error terms and t:= time period.

Stochastically this is expressed by the fact that the covariance of the fiscal variable and the error term of equation (1) is not equal to zero. Thus, in the case of reversed causality the fiscal variable is correlated with the error term of equation (1). This can cause an estimator to become inconsistent. The testing of reversed causality has been done with a non-parametric correlation test, which uses a Spearman's rank correlation. The latter is robust against non-normally distributed data.[34]

[34] In the case of LS-regression the Hausman specification test is usually applied.

Table A2: Correlation tests for the instrumentation of models 3, 4, 7a, 8a, 9a and 9b

	Spearman's rank correlation					
	Model 3	Model 4	Model 7a	Model 8a	Model 9a	Model 9b
gtrevi and residuals	0 (-0.006)					
iv(gtrevi) and residuals	-5 (-0.8)					
gtrevi and iv(gtrevi)	87* (15)					
gtranshi and residuals	4 (0.6)	3 (0.4)				
iv(gtranshi) and residuals	7 (1)	4 (0.4)				
gtranshi and iv(transhi)	69* (10)	69* (10)				
generghi and residuals	-4 (-0.6)	-7 (-1.2)				
iv(generghi) and residuals	-3 (-0.4)	-4 (-0.6)				
generghi and iv(generghi)	70* (10)	70* (10)				
ghoushi and residuals	8 (1.3)	5 (0.9)				
iv(ghoushi) and residuals	12 (1.6)	7 (1.1)				
ghoushi and iv(ghoushi)	56* (8.6)	56* (8.6)				
geduhi and residuals	7 (1.2)	5 (0.9)				
iv(geduhi) and residuals	4 (0.6)	3 (0.5)				
geduhi and iv(geduhi)	79* (12)	79* (12)				
trevi and residuals			0.6 (0.1)			
lag(trevi,-1) and residuals			0.9 (0.2)			
trevi and lag(trevi,-1)			99.8*(19)			
expi and residuals				-5 (-0.9)		
lagt(expi,-1) and residuals				-2 (-0.3)		
expi and lag(expi,-1)				99.4* (19)		
tindi and residuals					-8 (-1.5)	-4 (-0.8)
lag(tindi,-1) and residuals					-3 (-0.6)	-2 (-0.4)
tindi and lag(tindi,-1)					99.5* (20)	99.5* (20)
tdiri and residuals					-8 (-1.5)	-6 (-1.1)
lag(tdiri,-1) and residuals					-6 (-1.1)	-4 (-0.7)
tdiri and lag(tdiri,-1)					99.6* (20)	99.6* (20)
tpropi and residuals						-9^ (-1.8)
lag(tpropi,-1) and residuals						-6 (-1.1)
tropi and lag(tpropi,-1)						99.5* (20)

*: 5%-significance-level; ^ 10%-significance-level; normalised z-values in parentheses; iv(·):= instrumented variable with three lags.

Table A3: Instrumented models

	Model 7a IV	Model 8a IV	Model 9a IV	Model 9b IV
Government level	General	General	General	General
ginv	0.2* (21)	0.2* (17)	0.21* (24.7)	0.21* (24.5)
xpr	0.07* (4.4)	0.08* (4.2)	0.07* (4.7)	0.07* (4.6)
lpop	0.11 (0.9)	0.18 (1)	0.09 (0.6)	0.13 (0.9)
trevi	0.003 (0.9)			
expi		0.004 (1.2)		
tindi			0.03 (1.4)	0.02 (1.2)
tdiri			-0.02 (-1.5)	-0.02 (-1.6)
tpropi				0.03 (0.4)
tsoci				
Country	yes*	yes*	yes*	yes*
Robust R^2 in %	56	56	58	58
Number of obs.	383	396	406	403
Smoothing method	5 year moving average	5 year moving average	5 year moving average	5 year moving average
LS test for bias (p-value)	biased (0)*	biased (0)*	biased (0)*	biased (0)*

: 5%-significance-level; ^ 10%-significance-level; t-values in parentheses; R^2:= the percentage of variation of GDP which can be explained by the estimations; country:= country fixed effects – if possible: yes, if not possible:: no, and if significant: yes (5%) or yes^ (10%); period:= period fixed effects in 5 year average models – if significant: period* (5%) or period^ (10%); the bias of least squares (LS) is tested relative to the MM estimator.

Table A4: Collinearities measured in terms of R^2 (in %)

Variables	Economic equation with:	Model 4 with:		Model 5 with:		Model 6 with:		Model 9a with:
	per capita growth rates and rates resp.	per capita magnitudes of fiscal variables	per capita growth rates of fiscal variables	per capita magnitudes of fiscal variables	per capita growth rates of fiscal variables	per capita magnitudes of fiscal variables	per capita growth rates of fiscal variables	ratios of fiscal variables to GDP
ginv	11	15	15	12	17	24	23	7
xpr	18	8	9	11	11	17	25	4
lpop	19	15	7	14	21	35	14	16
real exchange rate	42							
interest rate (long term)	46							
transhi		41	11					
energhi		87	2					
houshi		86	5					

Variables	Economic equation with:	Model 4 with:		Model 5 with:		Model 6 with:		Model 9a with:
	growth rates and rates resp.	per capita magnitudes of fiscal variables	per capita growth rates of fiscal variables	per capita magnitudes of fiscal variables	per capita growth rates of fiscal variables	per capita magnitudes of fiscal variables	per capita growth rates of fiscal variables	ratios of fiscal variables to GDP
eduhi		66	5					
socialhi				87	6			
defhi				87	19			
mconstrhi				80	6			
genhi				86	10			
safehi						94	24	
healhi						96	15	
culthi						60	6	
agrhi						60	23	
tindi								23
tdiri								29
tpropi								27