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THE IMPACT OF PUBLIC BUDGETS ON OVERALL PRODUCTIVITY GROWTH

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Abstract

To fulfil their tasks, governments rely on public expenditures and taxes. Both influence the incentives and shape the decisions and actions of private economic agents. As governments resort to both instruments simultaneously, their combined theoretical impact on economic performance is a priori indeterminate. Clarification can only come from empirical evaluations. This paper reviews the recent literature trying to quantify the impact of fiscal policies on productivity and growth. Unfortunately, this survey shows that the empirical literature too is inconclusive: although the growth and composition of public expenditures and taxes as well as the fiscal stance seem to have some effect in the short run, their long-run implications cannot easily be quantified because of, e.g., reverse causation and crowding-out effects. The empirical evidence on the growth effects of government size points at a non-linear relationship: For small governments additional public expenditures seem to have a positive impact on growth, while for large governments further additions tend to be growth-retarding. It is an open question, however, where the optimum is located.

1. Introduction

The prime objective of governments is to further the well-being of the citizens, which can be achieved either by providing goods and services or by facilitating economic growth. Basically, three types of public policies are available for governments to achieve their aims: public expenditures, taxes, and regulations shaping the general framework in which the decisions and actions of economic agents take place. This paper is concerned with the links through which

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governments may have an impact on the growth performance of the private sector and focuses on the size and composition of public budgets and neglects regulations and institutions as well as the performance of government per se.[1]

The public provision of goods and services exerts the most visible and direct impact of government on overall productivity. Public expenditures for infrastructure, education, research and development, and health, for instance, are widely expected to improve the quality of inputs as well as the general conditions under which private production takes place, and thereby can be expected to positively impact on private sector performance. In order to finance public expenditures, governments have to levy taxes. However, taxation may distort economic incentives and decisions and lead economic agents to substitute their most preferred activity by a less preferred alternative. As governments simultaneously employ revenue and expenditure policies, their theoretical impact on economic performance is a priori indeterminate. More concrete results can only be expected from empirical analyses.

Before discussing these issues in more detail, it seems important to recognise that there can be significant disparities between the development of productivity and of welfare in an economy. Productivity is an important factor determining welfare, but it should be complemented by some measure of capacity utilisation, in particular unemployment. The following discussion of empirical studies is based on the theoretical interconnections between public policies, productivity, and unemployment.

The most interesting ingredient to overall economic growth is the growth of total factor productivity (TFP) which represents the growth of output that cannot be explained by the growth in inputs. The original framework for measuring TFP growth simply included factor inputs such as capital and labour. It was extended in the 1970s to take into account the fact that inputs are not allocated arbitrarily, but are driven by relative price changes. Morrison (1992) for example uses a model which shows that changes in productivity growth in Canada, Japan, and the US can partly be attributed to scale effects, capacity utilisation, and markups. This framework can be further extended to allow for the effects of public policies on the behaviour of economic agents. The related literature stresses that input and output growth are driven by the shift in technology and the way in which public policies impact on the technological choices of private agents; the reaction of firms and consumers to a variation in input prices, represented by

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a movement along the technology frontier; the reaction of prices and wages to changes in taxation, regulations, and other public policies; and changes in taxes, institutional constraints, and other exogenous variables (see Diewert and Nakamura, 2003, for an overview).

The aim of this paper is to review the recent literature evaluating the impact of public expenditures and taxation on productivity and, more generally, on economic performance. Section 2 surveys empirical results obtained in the literature and presents them for various expenditure categories, concentrating on key areas which are assumed to be particularly relevant for private sector activities: physical infrastructure, education, R&D, and health care. Section 3 is concerned with the financing of public policies through taxation and its impact on growth and productivity. It specifically looks into the relationships between taxation and the labour market, human capital formation, and entrepreneurial activities, and addresses also the issue of international tax competition. In section 4, the literature dealing with the impact of fiscal policy and the size of government on overall productivity is screened. Concluding remarks are presented in section 5.

2. Evaluating the impact of public expenditures

Over the last 40 years, economists profoundly changed the way in which they investigate the impact of public expenditures on economic performance. They abandoned the traditional Keynesian and neoclassical macroeconomic frameworks and adopted an empirically-oriented approach instead. As advanced by Ram (1986), there can be a complementary role of the growth and the level of public expenditures in explaining economic performance. Ram's estimates show that economic growth is positively correlated with the rate of change in total public expenditures, while it is negatively correlated with the expenditure level or – which is about the same – the size of government. In order to evaluate specific rates of return, economists began to break down overall public expenditures into more precisely defined spending components. However, solid and robust empirical regularities have been difficult to detect. In the following overview, outlays on public infrastructures, education, research and development, and health are taken as examples to demonstrate the empirical relevance of public expenditures on overall economic performance. With respect to government size, see the deliberations in section 4.

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[1] For an overview of some of these issues, see Handler, Koebel, Reiss and Schratzenstaller (2005).

2.1 Public expenditures on physical infrastructure

Physical infrastructure can by and large be seen as a public good, as users usually cannot be excluded from consumption, and one user's consumption does not reduce the amount available to others. Of course this is not true for all types of infrastructure at all times. Exclusion is technically feasible for certain publicly provided goods and services, so that user fees can be charged. Other publicly provided goods are characterised by some degree of rivalry in use (e.g. a congested road). In many instances, the state provides reasonable amounts and qualities of infrastructures without directly charging consumers and firms for the services provided, because even if the exclusion of users is technologically feasible, it may be economically inefficient (when additional users cause zero marginal costs), or because exclusion is not desirable for equity considerations (e.g. schooling).

Empirical studies analysing the impact of infrastructure provided by the public sector usually concentrate on roads and motorways, water and sewer systems, dwellings, and sometimes public research and development capital. Because of the lack of data on public capital stock, its influence on private productivity is often not estimated directly, but by investigating the output effects of public investment. In general, with regard to the functional relationship employed, some studies rely on aggregate production functions, while others use cost and profit functions. More recent studies have also resorted to vector autoregressive (VAR) models that refrain from imposing causal relations between the variables investigated (e.g. Voss, 2002). The advantage of these models is that they explicitly account for dynamic impacts and feedbacks between the variables considered. Empirical studies show that public infrastructures lower firms' costs and improve their production possibilities, and that they are an important factor for attracting firms and start-ups.

Considerably more empirical work has been done for the *US* than for other economic regions. This reflects the limited availability of relevant data outside the US. In the attempt to discern effects of the accumulation of non-defense public physical capital on US private productivity, Aschauer (1989a) and many papers following his seminal study employ an aggregate production function approach, which tries to estimate the output elasticity of public capital. Using data for the period from 1949 to 1985, Aschauer produces rather high elasticity estimates (between 0.38 to 0.56), and he concludes from his analysis that the slowdown in US private sector productivity during the 1970s and 1980s was largely due to relatively slow growth in public capital accumulation. His results suggest that additions to public capital increase the

output of private firms by more than 1½ times the magnitude that can be achieved by additions to a firm's own capital.

Aschauer's approach was criticised because of high data aggregation, likely spurious regression, endogeneity, and other estimation problems. In this *public capital hypothesis controversy*, Munnell (1990) also uses a production function approach, but instead of highly aggregated time series data she bases her estimates on cross-sectional state-level data. Munnell estimates public capital stocks of 48 US states for the period 1970 to 1986 and, like Aschauer, finds overwhelming evidence for positive effects of public capital on private output, investment and employment, although her estimated effects are smaller than those of Aschauer. Pereia and Andraz (2004) also find that the large effects on the aggregate level are not matched at the regional level and attribute this gap to regional spillover effects. When estimating the impact on output of public highway spending on a state level in the US (covering the period 1977-1999), the direct effects account for only 20%, while the spillover effects correspond to 80% of the total effects.

A number of contributions estimate the impact of public capital on production and rely on panel data for the 48 states of continental USA for the period from 1970 to the end of the 1980s. Stephan (1997) provides a survey of 15 studies using such data (Table 1). Early investigations conclude that public capital has a positive impact on production, with an estimated output elasticity with respect to public capital included between 0.05 and 0.30. However, more recent studies have not been able to confirm these findings. Holtz-Eakin (1994), for instance, argues that an apparent impact of public capital on value added could be due to neglecting individual heterogeneity in panel data analysis.

Table 1: The impact of infrastructure on production

Studies	Data	Results
15 contributions reviewed by Stephan (1997)	Panel of 48 US states for the period 1970 to the end of the1980s	$\varepsilon(y;g)=0.15$ on average in studies prior to 1994. This elasticity is not significant in post 1994 studies
9 papers reviewed by Stephan (1997 and 2003) and Picci (1999)	Panel of regions for different European countries	$\varepsilon(y;g)=0.20$ on average and almost always significantly different from zero
7 studies reviewed by Stephan (1997)	Panel of OECD or G7 countries	$\varepsilon(y;g)$ is only significant in 3 out of 7 studies, in which case $\varepsilon(y;g)=0.30$ on average
9 studies reviewed by Stephan (1997)	Time series (economy wide or at sector level), different countries	$\varepsilon(y;g)=0.30$ on average and often significant

Note: ε(y;g) is the output elasticity with respect to public capital.

Two recent studies shed some new light on this controversy and find that the contribution of public capital to productivity is significant, though rather small. Zegeye (2000) uses detailed data for a sample of 1,514 US counties covering the years 1982, 1987, and 1992, and comes up

with relatively small (between 0.022 and 0.133), but statistically significant elasticities of output to public capital. Fernald (1999) considers a longer time period (1953 to 1989) for 29 US sectors and finds that roads had an important impact on productivity for the sub-period 1953 to 1973 only; in the years thereafter it declined to become very small eventually. The detailed data Fernald uses, containing information on vehicles used for production, allow him to conclude that "correlation between productivity and public capital primarily reflects causation from public capital to productivity".

The impact of public capital on US regional productivity growth is still subject to debate. The effect, however, is certainly not as large as presumed, based on earlier studies, at the beginning of the 1990s. Overall, the public capital hypothesis controversy, growing out of the numerous and contradictory contributions using similar data, only resulted in the insight that more careful model specification and testing was required.

Most contributions for *European regions* report a positive impact of public infrastructure on production. Regional data are available for France, Germany, Italy, Spain, and Japan, yielding estimates for the output elasticity with respect to public capital between 0.08 and 0.65 (see Stephan, 1997, 2003). There are a number of studies on Germany, but only scarce information has been produced on other European countries (among the few exceptions are France and Sweden). Aubert and Stephan (2000) compare the regional impact of road infrastructure investment in regional output for 21 French and 11 German regions. Elasticities from panel data are significantly positive only for French, but not for German regions.

The evidence is similar also in *Japan*. Yamano and Ohkawara (2000) estimate output elasticities for Japanese prefectures within the range of 0.16 to 0.19. Annala, Batina and Feehan (2004) report elasticities of 0.12 for the overall economy and 0.24 for the manufacturing sector.

National data have also been used to investigate the impact of variations in the level of public capital on productivity growth differentials between countries. From such cross-country comparisons, however, no clear pattern could be derived: in most cases (4 out of 7 studies), the impact is insignificant.

Instead of relying on data for different geographic areas, *time series data* for a country or for different industries within a country have been used by other authors to relate intertemporal variations in the level of the public capital stock to variations in the level of production (see Stephan, 1997). Empirical analyses using this kind of data find a positive impact of public capital on productivity growth. The mean value of the production elasticity with respect to

public capital is about 0.30 and mostly significant. However, two important limitations have to be considered for this kind of empirical research that uses time variation only: time series variables are often non-stationary, and it is difficult in this context to cope with reverse causation from productivity to public investment. Neglecting these issues may yield biased estimates for the impact of public capital on productivity.

In a recent study, Kamps (2004) estimates data on public capital stocks which are internationally comparable for 22 OECD countries for the period 1960 to 2000. Capital stocks are accumulated from investment data according to the perpetual inventory model with geometric depreciation. The data reveal that public capital to GDP ratios have tended to decline since the late 1970s. Separate regressions for each country based on the production function approach indicate that the elasticity of output with respect to public capital is positive and significant for most countries. However, these elasticities are quite large (e.g., for Germany 0.88, for the US 0.79, for France 0.78, for Austria 0.63), while for some countries the output elasticities of private capital are negative – an outcome which is not plausible at all. In a panel estimate for all 22 countries, the output elasticities for public and private capital are 0.22 and 0.19, respectively, which, because of the large sample, are more reliable and by and large conform to a priori expectations.

As an alternative to estimating the impact of public capital on the output level, a number of studies consider the effect exerted on the (private) cost of production (e.g., Demetriades and Mamuneas, 2000). In fact, it can be shown that any production-enhancing public infrastructure also decreases the private costs of production. Since cost and input demand functions are related, this framework allows to derive the impact of public infrastructure on private input demand directly. Already as an outgrowth of the Aschauer-Munnell debate, a number of studies resorted to the cost function approach. The US Congressional Budget Office (CBO, 1991) was particularly critical about Aschauer's high production function elasticities and concluded that cost-benefit studies found private output to respond more to private than to public investment. Cullison (1993) concludes from this discussion that it is not efficient for government to increase investment spending across-the-board, but that each investment project should withstand a cost-benefit analysis. This would also help to set priorities according to the expected effects of individual investment projects on growth.

Berndt and Hansson (1992) provide an early estimate for Sweden using a dual cost function approach and annual data for the period 1960 to 1988. They find that additions to public infrastructure reduce private costs. However, the amount of public infrastructure capital that

would rationalise the cost savings incurred by the private business sector was lower than the actually available capital in 1988, although the extent of excess infrastructure capital was shrinking since the early 1980s. Sturm and Kuper (1996) use the duality between production and cost functions to see whether public capital affects private sector production costs. They estimate translog cost functions for 5 manufacturing sectors of the Dutch economy and explicitly incorporate energy in their production function. They conclude that the cost function approach does not provide reliable estimates of the optimal level of public capital. Their results indicate that, although infrastructure investment is important, not all investment in public capital reduces cost for the private sector. More recently, Musolesi (2002) reviews 22 papers (published during the last 15 years) using the cost function approach. The empirical estimates of the cost saving impact of public infrastructure are in line with those obtained from the production function approach: on average, one percent additional public capital reduces private costs of production by 0.16 percent.

There has been some debate on possible crowding out or crowding in of private investment by public investment, stimulated by Aschauer (1989b). The European Commission (2003) has performed Granger causality tests (for annual investment data ranging from 1970 to 2002) with the result that some crowding in seems to prevail in Spain and Portugal, whereas crowding out can be found in the UK and no such effects are visible in the other EU15 countries. In Spain and Portugal, the stock of public capital was still rather low (and therefore its marginal productivity relatively high) during the observation period. In the UK, the privatisation process of the 1980s and 1990s may have led to the purely statistical phenomenon of a reduction of public investment over time and a simultaneous increase of private investment.

The empirical findings from these studies can be summarised as follows: First, the outcomes are different for the US and Europe. Whereas recent studies for the US find either no significant or only a small positive impact of public infrastructure on productivity, the estimated impact is higher and mostly significant for European countries. Second, public infrastructure seems to have decreasing marginal returns. This could explain the variety of empirical results for US regions. Decreasing returns in public infrastructure may also be relevant for European countries, but do not seem to have surfaced yet. Third, although public infrastructure in many instances reduces the cost of private production, public expenditures in this field should be based on project-related cost-benefit analyses rather than consist of spending across-the-board.

2.2 Public expenditures on education

A vast theoretical literature stresses the importance of human capital for economic growth: a skilled workforce is more likely to develop and adopt new technologies, thereby shifting productivity upwards. The economic rationale for government involvement in education rests on four main pillars (Hanushek, 2002): externalities, economies of scale, other market failures, and redistribution motives. In the case of higher education, it is argued that, because of imperfect capital markets, students cannot borrow sufficiently from banks to finance their education. Therefore, governments must subsidise higher education, all the more as later on the funds will be recovered anyway when taxes fall due on the higher incomes associated with higher education (Diewert, 2001).

Empirical investigations to assess the impact of the quality of human capital on growth are usually confined to variables representing just education, often in terms of schooling years. Following Barro (1991), many empirical contributions report some positive correlation between schooling and growth. This literature, however, is subject to three important qualifications. First, the positive correlation may be a consequence of omitting other relevant variables from the analysis. Second, reverse causality may exist, as anticipated economic growth may induce more people to stay longer at schools (Bils and Klenow, 2000). Third, and more importantly, some studies (e.g. Acemoglu and Angrist, 2000) are unable to find significant evidence for the presence of externalities in schooling. This is in line with Hanushek (2002, p 2066) who notes that "little evidence exists that distinguishes externalities in economic growth from simply the impact of better workers and more human capital", suggesting that the existence of a positive relationship between schooling and growth is per se not sufficient to justify government involvement.

The main body of empirical work, which overall is not able to find a significant and robust positive relationship between the level of education and income growth, is based on endogenous growth models treating human capital not as an input in the production function, but as a determinant of innovation. In such a setting, Benhabib and Spiegel (1994) cannot find a positive contribution of changes in years of schooling to economic growth in developing countries. However, Pritchett (2001) argues that the failure to detect such a positive contribution was largely due to the poor institutional setting, low quality and excess supply of schooling in these countries.

In another strand of the literature, based on an extended version of the neoclassical growth model in the tradition of Mankiw, Romer and Weil (1992), human capital is regarded as a factor

of production. Soto (2002) subjects this model to empirical estimation and, after treating a number of model specification and measurement error problems, concludes that years of schooling fit well in a neoclassical production function. The long-term effect of one additional year of schooling is about a 12 to 16 percent increase in income. He attributes his results to the more careful treatment of the variables, the functional form of the growth equation and the consistency of the estimates.

Bassanini and Scarpetta (2001) estimate human-capital augmented growth equations for a panel of 21 OECD countries over the period 1971 to 1998. They also arrive at a positive impact of human capital on economic growth and conclude that an additional year of schooling would increase output in the long-run by some 6 percent. This result is interpreted as being out of line with the predictions of the human-capital augmented Solow model, but rather being consistent with endogenous growth models.

Whereas most contributions consider the relationship between *schooling quantity* and growth, Hanushek and Kimko (2000) show that *schooling quality* matters too. To measure schooling quality, the authors use the cognitive performance of students from six international tests for the period 1965 to 1991. They find that different schooling qualities contribute significantly to the explanation of differences in overall economic performance. Barro (2001) reports similar results, although the robustness of his findings has not yet been confirmed. Neri (2003) extends the model of Hanushek and Kimko by adding a life expectancy variable as another indicator for the quality of the labour force. As expected, this substantially reduces the impact on growth of the schooling quality variable. Above all, reestimating the extended model for the period 1985-1998 further reduces the importance of the quality variable, while the health variable continues to be important for growth. Other results concerning the health of a country's population and economic performance are reported below in section 2.4.

2.3 Public research and development activities

R&D expenditures are held to be one of the key engines of economic growth. Product enhancing R&D allows to produce new goods, cost reducing R&D allows to produce a given amount of output with less input. In both cases, innovations increase overall productivity. When commercial exploitation of an innovation cannot be confined to the firm conducting an R&D project, also competing firms will benefit from the resulting externalities. As a consequence, the aggregate level of R&D expenditures will be below the socially optimal one. This allocative inefficiency justifies government intervention, either through direct government research at

universities or in government laboratories, or by financing or subsidising R&D activities in the business sector.

This raises the question whether government assistance is complementary and thus additional to private R&D, or just substitutes for it by *crowding out* private research activities. No straightforward answer can be given, as the outcome crucially depends on the particular field of R&D activities as well as on the incentive mechanism provided. Russo (2004) analyses various forms of tax incentives for R&D and concludes that incremental and comprehensive R&D tax credits produce comparatively large increases in private sector research efforts and welfare. David, Hall and Toole (2000) review the available econometric evidence accumulated over more than 35 years on possible crowding-out of private R&D and arrive at an ambivalent picture: one third of the 33 studies reviewed (conducted on all levels of aggregation) report some kind of substitution, while two thirds do not. These results are not fully reliable, however, as the studies reviewed tend to neglect a possible selection bias which arises when governments subsidise the innovative rather than the average firm. Bassanini, Scarpetta and Hemmings (2001) in their analysis of 15 OECD countries over the period 1981 to 1998 also arrive at a negative impact of public sector R&D on output growth. In the survey provided by Czarnitzki and Hussinger (2004), the pendulum swings more in the direction of rejecting the crowding-out hypothesis. In their own micro-level estimates for Germany (project funding data cover the period 1992-2000), they find no evidence for full or partial crowding-out. The implication for economic policy is that additionality is reported by the majority of recent studies, but it is not automatically secured. It needs a proper institutional setting and is probably confined to specific types of R&D expenditures. In particular, defence research performed by the public sector tends to crowd out private R&D.

Insufficient incentives for carrying out private R&D projects were first noticed by Arrow (1962), and empirical studies trying to establish a positive private rate of return of R&D appeared soon afterwards (e.g. Mansfield, 1965). Estimations of the difference between the private and the social rate of return of R&D conducted in the early 1980s are surveyed by Griliches (1992) and Griffith (2000). Interestingly, the empirical framework used to evaluate the impact of public infrastructure on private productivity can be easily extended and applied to the analysis of the effects of R&D on productivity. A relatively robust finding from empirical investigations is that the social rate of return to R&D is above and about twice the private one. It should be noted, however, that the findings are not always significant.

A number of studies attempt to distinguish empirically the effects on growth of business R&D, government R&D, and foreign R&D. Guellec and van Pottelsberghe (2001) estimate regressions for 16 OECD countries for the period from 1980 to 1998, explaining total factor productivity by the various R&D aggregates. It turns out that the long-term elasticity of government and university performed research on productivity is 0.17, compared to 0.13 for business R&D and 0.45 to 0.50 for foreign R&D. Part of the impact of public research on overall productivity is indirect, depending on the extent to which its discoveries are used by the business sector. The results also suggest that foreign R&D matters more for productivity growth than domestic R&D (which is usually much more costly to create), provided that the country has the capacity to absorb technology from abroad. In an attempt to sort out the relationship between public sector and private sector R&D, Yoo (2004) applies Granger-causality tests on data for Korea covering the period 1970 to 2002. The result is bidirectional causality in the short run and long-run causality running from public to private R&D. The implications for policymakers would be that changes in public R&D policies would in the long run exert an impact in the same direction on private R&D.

2.4 Health care services

Health care services are usually provided by the public sector for social rather than purely economic reasons. There are, however, various links to the performance of the economy. Major channels through which the health care system influences productivity are the well-being of the population in general which impacts on labour productivity, the reduction of sickness days and the related increase in productivity, the increase in life expectancy which permits better exploitation of acquired skills, the potential misallocation of resources in the case of overfinancing the health sector, the increase in labour costs via taxes and social insurance contributions which are levied to finance health care services, and a reduction in the mobility of the labour force when occupational insurance schemes prevail.

The empirical literature usually covers efficiency aspects of health care provision and the impact of good health on overall economic performance. One branch of the literature is devoted to the quality of health care (as measured, e.g., by death rates after treatments), which has a direct influence on private productivity. As a recent example, Propper, Burgess and Green (2004) examine the introduction of payer-driven competition in 1991 as one of the primary elements of health care reform in the United Kingdom. The result is that more competition tends to reduce quality, though the impact is small. These findings differ from others, in particular for

the US, which suggest, at least for the 1990s, that more competition in the health sector furthers quality and lowers costs (Kessler and McClellan, 1998).

Bloom, Canning and Sevilla (2001) view health as an often neglected component of human capital. They incorporate health variables in production function models of economic growth and find evidence that health expenditures have a positive, sizeable, and statistically significant effect on aggregate output: each extra year of life expectancy leads to an increase of 4 percent in output. Rivera and Currais (1999) attribute at least part of the effect to reverse causation.[2] They also criticise the use of mortality rates or life expectancy data as indicators for the health status of the population; in their view these variables do not capture the steady improvements in the quality of life, at least not in developed countries. They therefore prefer health expenditures as a proxy for the health status (which can be questioned as well). Empirical estimation is based on an extension of the augmented Solow growth model where the growth of per capita income is a function of determinants of the steady state and the initial level of income. Estimating the effects of health investment in OECD countries over the period from 1960 to 1990, the result is a positive and significant impact of health expenditures on income growth. However, the Hausman test indicates the existence of endogeneity, which means that the association between income growth and the health status represents causality in both directions.

These findings conclude our review of the expenditure side of fiscal policy. Of course, the "public capital hypothesis" does not tell the whole story about the interrelationship between the public sector and economic growth. Although government spending is an important factor in this context, it should be complemented, as demonstrated by Cassou and Lansing (1999), by information from the tax side as well. In the next section, we therefore turn to the impact of taxation on economic performance.

3. Evaluation of the impact of taxation on productivity

In all developed countries, public expenditures are largely financed by taxes. Since the end of the 1990s, attempts have been made to reverse the trend of a steadily rising tax-to-GDP ratio, which could be observed in many EU and OECD countries during the last decades (Joumard, 2002), or at least to bring the permanent rise to a halt. These efforts are part of a general move in many industrialised countries to scale down the size of the government, and are mainly

[2] A positive impact of income on health can be assumed and has empirically been confirmed e.g. by Prichett and Summers (1996).

motivated by two arguments: first, a high tax burden is associated with distorting effects and disincentives for economic activities of private households and firms. Related to this argument is a general conjecture shared by many economists that economic growth and productivity may be hampered by high overall tax burdens, because resources are extracted from the private sector where they could be used more efficiently. Second, growing integration of national goods and factor markets challenges high national tax burdens, as high taxes on internationally mobile tax bases are considered a serious disadvantage in international locational competition.

Besides the overall tax burden, as depicted by aggregate tax burden measures, also the tax mix is viewed as relevant for growth. Direct taxes are connected with distorting effects on the decisions of private households and firms, leading to a sub-optimal usage of a country's resources, whereas indirect taxes are neutral and therefore do not exert any negative influence on growth (OECD, 2003). From this perspective, reducing the tax burden as well as changing the tax structure is beneficial for a country's economic growth. Empirical work on the connection between the tax mix and growth is scarce, however. One interesting exception is the paper by Mendoza, Milesi-Ferretti and Asea (1997), which shows that the growth effects of changes in the tax structure (captured by implicit tax rates on capital, labour, and consumption) are negligible. Kneller, Bleaney and Gemmell (1999) on the other hand do find a growth-reducing impact of distortionary taxes.

This section follows a more microeconomic approach. It examines several areas of tax systems independently of each other that appear to be of particular relevance for a country's productivity performance. Also the basic dispute between proponents of neoclassical and endogenous growth theory will not be addressed here: namely whether tax policy, or public policy in general, can have an impact on the long-run level of growth of productivity and GDP at all (as endogenous growth models would argue) or – as implied by neoclassical growth theory based on the conventional Solow growth model (1956) – whether they can only affect the level of income and the growth rate in the transition to the steady-state growth rate.[3] The focus in this section of the paper is on the central question in which ways taxation can influence productivity (and growth) via affecting incentives to work, to invest, or to engage in entrepreneurial activities.

[3] According to neoclassical growth theory, productivity growth is exogenous, therefore by assumption it cannot be affected by tax policy.

3.1 Taxes, (labour) productivity, and unemployment

Taxes exert an influence on (labour) productivity mainly via two channels: first, they can affect incentives to work and thus the labour supply and the employment rate, respectively. In addition, the relationship between labour taxation and unemployment – i.e. the impact of labour taxation on labour demand – is of interest. Second, labour taxes are relevant with respect to human capital formation. The following section will elaborate on these two aspects.

3.1.1 Taxation and the labour market

Taxation and work incentives

Traditionally, the practical design of income tax systems has been primarily led by distributional objectives, whereas the issue of work incentives connected with the taxation of labour is a relatively new concern of policy makers (Duncan, 2003). Recently, the low participation rates of unskilled or low-skilled workers and of (married) women are of increasing concern for European policy makers, who are worrying about possible negative effects on overall productivity and growth.

Within the pure neoclassical framework, marginal and average labour productivity decrease with an increased utilisation of labour. In turn, labour productivity increases if individuals are excluded from the labour market. However, this productivity-enhancing effect may be overcompensated by the concomitant underutilisation of a considerable segment of the labour force. Raising the employment ratio of low-skilled workers or the employment ratio in general increases productivity via a changing factor intensity, as argued within standard neoclassical models of growth, and/or spill-over effects which enhance the productivity of the skilled workers and of capital, as argued within some models of endogenous growth (e.g. Barro and Sala-i-Martin, 2003). Moreover, non-participation or the underutilisation of a part of the labour force depreciates the existing stock of human capital and may cause productivity losses: directly, as a devaluation of human capital deteriorates the quality of labour and therefore its productivity, and indirectly, due to externalities connected with human capital.

This section concentrates on the effects of labour taxation on overall labour supply as well as on the labour supply of specific groups. The literature dealing with the impact of labour taxation on labour supply mostly does not directly address its effects on productivity. Rather it focuses on work incentives and tries to identify in which ways labour taxes may have a negative effect on work incentives and thus on labour supply in general and on labour supply of specific segments

of the work force in particular. The following survey therefore also concentrates on work incentives which may have an indirect influence on (labour) productivity via affecting labour supply.

According to the standard neoclassical textbook labour-leisure model, at a given gross wage labour taxes affect individual labour supply decisions through an income and a substitution effect. Theoretically, the total effects of labour taxes on labour supply are indeterminate (Zagler and Duernecker, 2003). The compensated labour elasticity and the shape of the labour supply curve, and consequently the wage tax elasticity of labour supply, are still an unresolved issue in the empirical literature. Most of the empirical results reported in Hausman (1985) point at an – albeit small – positive wage elasticity for males. In contrast, Pencavel's (1986) survey presents a number of studies arriving at (also limited) negative wage elasticities of male labour supply. Meanwhile a fairly far-reaching consensus seems to have emerged in the literature that the sensitivity of labour supply of (married) males with respect to changes in the wage rate – and thus also to variations of labour taxes – is rather limited (Lindert 2003).

If one distinguishes, however, between the participation decision and the decision on marginal hours worked, empirical evidence suggests that the former is more sensitive to the (net) wage rate and thus to labour taxes (Triest, 1990; Heckman, 1993). Across-the-board cuts in marginal income tax rates as undertaken by a number of European countries in recent years, for example Austria, Germany, Ireland, the Netherlands, Spain, Sweden, and the United Kingdom (Joumard, 2002), thus appear as an effective instrument to create work incentives and to increase labour supply: and – under the assumption of positive spill-overs – to raise productivity.

A high responsiveness of labour supply and particularly of the participation decision to changes in the net wage seems to hold especially for married women. Whereas the labour supply of unmarried women generally is fairly insensitive to taxes, similar to male labour supply (Eissa, 1996), estimates of wage elasticities of married women derived in empirical studies are mostly positive (e.g. Killingsworth and Heckman, 1986, Blundell et al., 1998). As Mroz (1987) points out, these estimates strongly depend on the specification of the econometric model used:[4] he argues that a correct specification would yield only a small influence of taxes on working married women. However, Mroz only considers women who are already in the labour market, thus neglecting the participation decision, which might well be negatively influenced by high labour taxes.

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[4]) For a methodological critique also see MaCurdy et al. (1990).

An empirical study by Jang (1998) finds that the wage elasticity of both single females and married women in the US differs between high-paid and low-paid earners: it is negative for higher hourly wage rates, but positive for lower ones. This result suggests that labour taxes have a non-negligible impact on work incentives for women with low incomes and impact on their work incentives to a larger extent compared to high-earning women. In light of this finding, income tax systems that tax spouses individually (as in the United Kingdom for example) fare better with respect to working incentives of married women than split income tax systems that pose a larger tax burden on the second earner (e.g. in Germany): a result which is confirmed by a recent empirical study by Smith et al. (2003), who show that individual income tax systems are positively associated with labour market participation of married women and therefore have a positive impact on overall labour supply.

Another specific labour market segment, which is drawing increasing attention of both economists and policy makers, are low-wage workers. There is some empirical evidence of a significant labour supply elasticity of low-wage workers (e.g. Aaberge, Colombino and Strom, 1999). Empirical evidence suggests that high taxes on low-skilled work induce individuals to exit the labour force rather than to adjust their hours worked (Boone and Bovenberg, 2002), a behaviour which is similar to that of (married) women. This provides a general rationale for applying progressive income tax schedules with low marginal tax rates and thus low tax wedges on labour for the low-income spectrum (Roed and Strom 2002) in order to minimise negative tax incentives for low-skilled individuals' labour supply.

Two options to decrease the marginal tax wedge on labour and thus to increase work (and particularly participation) incentives for low-paid earners are discussed in the literature and have been implemented by several countries in past years: first, cuts in marginal income tax rates for low-paid earners (e.g. Denmark, France, Finland, Italy, and Portugal; Joumard, 2002). Second, tax relief for lower income groups which decreases marginal income tax rates for low-paying jobs: prominent examples are the Earned Income Tax Credit (EITC) granted in the US or the Working Tax Credit (WTC) offered in the United Kingdom (Bennett, 2002, Duncan, 2003, Moffitt, 2003).

Using simulations based on an econometric model, Duncan and Harris (2002) show that an Employment Tax Credit would increase employment rates of lone parent households in Australia. This result is confirmed by Blundell (2000), who examines the effectiveness of the Working Families Tax Credit in Great Britain (the forerunner of the WTC). A positive effect of the EITC on the labour market participation of single parents is also reported by Eissa and

Liebman (1996). The impact of this kind of tax relief is, however, quite different for the labour supply of married women, as demonstrated by Blundell (2000) and Bennett (2002) for Great Britain and by Eissa and Hoynes (1998) for the US. These studies find a negative effect of the tax relief on the labour supply of married women, which, according to the authors, can be explained by a negative income effect.

To sum up, it can be stated that the empirical results obtained by current studies suggest that labour taxation can indeed influence the participation decision of certain segments of the labour force, particularly of low-income earners, married women, and lone parents. Male labour supply and the supply of labour in the high-wage segment of the labour market appears to be quite insensitive to labour taxation (see also Moffitt and Wilhelm, 1998).

Taxation and the shadow economy

Taxes can improve welfare by financing public goods, social welfare provisions etc. Individual net gains are, however, even larger for economic agents who benefit from public expenditures without paying for them. This provides an incentive for economic agents to engage in shadow economic activities in order to avoid taxation. A heavy tax burden on labour may make exit options for individuals out of the official labour market more attractive and thus have further consequences for the supply of labour when the standard labour-leisure model is extended by the option to engage in the shadow economy, i.e. to allocate total available time not only to leisure and income-earning activities in the official labour market, but also to unofficial activities.

The existence of an informal sector in an economy blurs official measures of its overall growth and productivity performance, as shadow economy activities do not show up in official statistics used within the national accounting framework. With a large informal sector, a given tax ratio must be financed by higher tax rates, thus increasing the tax burden on official activities of workers and lowering incentives in the formal sector of the economy, with possible negative productivity effects, as discussed above.

By definition, inofficial activities are difficult to observe and to estimate, and there is a variety of methods to estimate their quantitative importance. In their recent survey, Schneider and Klinglmair (2004) present estimations (based on the currency demand approach) which show that in OECD countries shadow economies generally are of considerable size and represent between 8 and 30 percent of total GDP. The GDP-share of shadow economies is below 10 percent in the US, close to 18 percent in European countries, and even larger in transition and

developing countries. The authors' estimations also show a trend of increasing informal sectors in many countries. Other estimations, using different estimation methods, yield mixed results (Enste and Schneider, 2000, OECD, 2004), altogether showing no clear pattern over time and often obtaining smaller estimations. [5]

A number of studies investigating the causes for the emergence of informal sectors show that – besides other important factors as the extent of regulation, unemployment, forced reductions of weekly working time, and early retirement – the burden of tax and social security contributions is of some importance (Enste and Schneider, 2000, and the literature cited herein; Giles and Tedds, 2002; Davis and Henrekson, 2004). The literature dealing with the causes for the evolution of shadow economies particularly stresses the relevance of tax wedges on labour, which represent an incentive to shift income earning activities into the shadow economy (Enste and Schneider, 2000).

However, cross-country studies suggest that there is no unambiguous relation between the tax burden and informal employment (OECD, 2004). Thus predictions about the extent to which the above-mentioned efforts of many European and OECD countries to lower the overall tax burden as well as marginal income tax rates will succeed in reducing the engagement in the "hidden economy" are hard to make.

In this context it is worth mentioning that also the progressivity of the income tax schedule may work in different directions. High marginal (top) income tax rates could on the one hand be associated with incentives to shift (self-)employment from the formal to the informal sector. If on the other hand marginal tax rates on profits are higher than marginal tax rates on wages (which is often the case with progressive income tax schedules), business owners have an incentive to declare wages and salaries as they reduce taxable profits. Progressive tax schedules may induce self-employed who are employing workers to do so officially, so that they can act as a barrier to inofficial employment.

Taxation and unemployment

Labour taxes also affect the demand side of the labour market. By depressing firms' labour demand they may cause unemployment. Unemployment is an important source of allocative inefficiencies in an economy, as available resources, in this case labour, are not used in the most

[5] For an extensive review of measures for the informal sector and in particular for informal employment and the empirical trends see OECD (2004).

productive way or are not used at all. Since unemployment is an aggregate problem, it affects an economy's aggregate output per capita. Moreover, sustained unemployment may reduce the overall level of skills: with increasing duration of unemployment (which generally increases with the level of unemployment), the existing stock of human capital is depreciated at an increasing rate, and labour productivity is reduced accordingly.[6] In addition, high unemployment may reduce the incentive for human capital formation, as expected future returns to human capital investment become more uncertain.

Recently, several studies have examined the impact of public policy, as compared to exogenous economic shocks or secular trends, on unemployment. These studies have mainly focused on identifying the sign and magnitude of the impact of different policies empirically, using data from OECD countries over a time period dating back to the 1960s. Among various institutional variables, clear results were obtained with respect to the influence of unemployment insurance systems, labour market regulation and labour taxes. This section will restrict its focus on labour taxes and illuminate their impact on unemployment both theoretically and empirically.[7]

The effect of taxes on unemployment crucially depends on the characteristics of labour markets. In a competitive labour market, the gross wage will adjust so that the supply of labour equals labour demand. If taxes on labour income are raised, they are completely borne by workers through a reduction in their net wage. Only if this lower net wage causes labour supply to decrease, the remaining workers can shift some of the burden onto firms through higher gross wages. The resulting unemployment, however, is "voluntary" – some workers are not willing to supply labour at the going (net) wage. Nevertheless it causes an underutilisation of the labour force potential, including the devaluation of the existing stock of human capital, and therefore may have productivity-decreasing effects. This problem is of special importance for low-paid work, as basic social security systems often introduce an effective wage floor below which the net wage cannot fall. In this case, labour taxes on low-paid work will lead to higher gross wages and more unemployment.

The impact of taxes is different in a unionised labour market. The trade union is interested in the wedge between net wages and the alternative income, e.g. unemployment benefits (UB). If UB are not taxed, a labour tax will decrease this wedge. This as well as the interest of union

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[6] Also public expenditures on unemployment benefits may indirectly be productivity-decreasing if they are financed by an increase in wage taxes with the negative effects mentioned above.

members to get a compensation for the reduction in the net wage incites the union to demand higher wages, which caused a rise of unemployment. Of course, in economies with centralised bargaining such an effect should not be present, as unions internalise the social costs of unemployment. Moreover, if UB are also subject to the labour tax, the positive effect of taxes on gross wages vanishes. As tax changes affect net UB to the same extent as they affect net wages, the relative wedge stays constant and the union will not change its gross wage demand. Summing up, changes in labour taxes within this framework should cause unemployment to rise only if the labour market is characterised by decentralised union wage setting and if UB remain untaxed.

A number of studies have examined whether these theoretical results are supported by the data. Daveri and Tabellini (2000) analyse 14 industrialised countries from 1965 to 1995. In estimating the effect of labour taxes, they roughly distinguish between the different types of labour markets that can be found in the countries analysed. The countries are divided into three groups: Anglo-American (competitive), Continental Europe (decentralised unions), and Scandinavian (centralised unions). The authors estimate that a one percentage point increase in the labour tax raises the unemployment rate in Anglo-American countries by 0.25 percentage points. As could be expected by the preceding analysis, the effect is stronger in continental Europe: the same increase in tax rates would raise the unemployment rate by 0.54 percentage points.

Belot and van Ours (2000) use data for 18 OECD countries from 1960 to 1995. According to their estimations, a one percentage point rise in labour taxes causes the unemployment rate to increase by 0.27 percentage points. When interacting the tax effect with an index of bargaining centralisation, the authors find that higher centralisation is associated with a larger impact of taxes on unemployment. This is somewhat surprising, since theory would suggest that this only holds for a movement from a completely decentralised, atomistic wage setting to a decentralised union wage setting, but not for the eventual move to centralised union wage setting. However, since a linear effect was imposed on the theoretically concave interaction effect, this distinction cannot be captured by this analysis.

Nickell and Layard (1999) obtain considerably smaller estimates for the OECD countries for the period from the beginning of the 1980s and the middle of the 1990s. Scarpetta (1996) finds that

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[7] Nickell et al. (2005) find that about 55 percent of the change in European unemployment between 1960 and 1995 can be explained by institutional factors. Of these factors, most important are changes in the unemployment benefit system and labour taxes, which explain about 21.5 percent and 14.3 percent of this change, respectively.

the tax effect is significantly positive only for long-term unemployment. It is argued that long-term unemployment is mainly a problem of low-skilled workers for which even in competitive labour markets effective wage floors might prevent net wages to fall and tax increases cause gross wages to rise. According to Blanchard and Wolfers (2000), labour taxes have no impact at all on unemployment.

Table 2: Labour taxes and the unemployment rate

Study	Labour taxes	Data
Daveri and Tabellini (2000)	Anglo-American countries: 0.25 (++); Cont. Europe: 0.54 (++) ; Scandinavian countries: (0)	14 industrialised countries, 1965-1995
Nickell and Layard (1999)	0.027 (++)[a]	20 OECD countries, 1983-1994
Belot and van Ours (2000)	0.27 (++)	18 OECD countries, 1960-1995
Scarpetta (1996)	generally: (0); on long-term unemployment: 0.11 (++)	17 OECD countries, 1983-1993
Nickell et al. (2002)	0.1 (++)[b]	OECD countries, 1960-1990
Blanchard and Wolfers (2000)	(++)[c]	20 OECD countries, 1960-1996

Note: (++)/(--) means significant at the 5 percent-level, (+)/(-) means significant at the 10 percent-level, (0) means insignificant at the 10 percent-level. [a] dependent variable is log unemployment rate, [b] due to the interaction effect, these estimates are valid for average values of the interacted variables, [c] due to methodological differences, the magnitude of the results is not directly comparable to the other values in the table.

Summing up, most studies reviewed show that labour taxes cause unemployment to rise, though the estimates obtained lie within a broad range. Empirically, it remains an open question whether the effect of labour taxes is larger in unionised economies per se or whether centralised wage setting has a significantly offsetting effect. In any case, however, it can be concluded that the high tax wedges on labour must not be neglected when trying to explain the European productivity slowdown and the high unemployment in the EU (Planas, Roeger and Rossi 2003).

3.1.2 Taxation and human capital formation

Theoretical contributions as well as empirical evidence stress that (labour) productivity is considerably spurred by increases in human capital; a result that has become conventional wisdom in economic theory as well as among policy makers. An increase in human capital formation directly improves the quality of the factor labour and therefore its productivity (Harberger, 1996). Furthermore, as the growth literature points out, additional human capital is connected with spill-overs indirectly affecting labour and capital productivity. Accordingly, sizeable investments in education and the upgrading of skills in the labour force have been made in many OECD countries in the 1990s (OECD, 2003).

Two main arguments are commonly used to justify public interventions to further human capital formation: first, the economic activities of high-skilled workers (production, research) are

connected with externalities or – to put it more generally – individual productivity also depends on co-workers' productivity (Lucas, 1988). Therefore a higher level of individual human capital should not only enhance individual earning capacities, but also improve overall productivity growth in an economy (Caucutt, Imrohoroglu and Kumar, 2003). Several empirical studies have indeed found a significant positive correlation between measures of human capital and a country's growth performance (e.g. Romer, 1990; Mankiw, Romer and Weil, 1992), although the magnitude of this effect is disputed (Barro and Lee, 1992), as well as the quantitative contribution of possible human-capital externalities. If externalities do exist, which cause the social rate of return on human capital to exceed the private one and which are not rewarded at the individual level, individuals' investment in their human capital may be sub-optimal. Second, capital market imperfections may impede a socially optimal investment of individual agents in their human capital. Besides public expenditures (e.g. the free provision of education or subsidies for higher education), also tax instruments play a role as devices to further human capital formation. Tax instruments relevant in this regard are tax credits for tuition and fees or the possibility to deduct interest paid on student loans, for example (Hoxby, 1998).

In addition to specific tax instruments to support individual investment in human capital, tax rates and the design of income tax systems have been found to impact on human capital formation. The primary economic incentive for individuals to invest in human capital is the expectation of higher future wages (Zagler and Duernecker, 2003). As higher tax wedges on labour are connected with lower future net earnings, they dampen the incentive to acquire additional skills. On the other hand also the current net wage foregone by engaging in schooling activities is reduced by higher tax wedges; but – due to the fact that the costs caused by education do not only consist of foregone income – this offsets the first effect only partly, so that the overall incentive effect is negative (Heckman, 1976).

Also the importance of the progressivity of the tax schedule has been pointed out in the literature (e.g. Poterba, 2002, Gentry and Hubbard, 2002): a more progressive tax schedule is connected with higher disincentive effects, as the future returns to human capital investment are taxed at a higher tax rate than the lower current earnings without additional schooling that would be foregone when engaging in the acquisition of additional knowledge. However, Heckman, Lochner and Taber (1998) show for the US that replacing the progressive income tax by a proportional tax can be expected to have only small effects on skill formation.

Heckman (1976) points out that taxing income from physical capital may induce firms or households to substitute investment in tangible capital by human capital investment, thus

making capital income taxation appear less harmful for economic growth as suggested in the optimal taxation literature.

Based on a simulation study, Trostel (1993) shows that a one percentage point decrease in the marginal tax rate induces a long-term increase in human capital of 0.97 percent. Glenn and Hubbard (2002) present evidence that the probability of individuals to switch to higher paid (and more productive) jobs is negatively correlated with the progressivity of the tax schedule. The recent decreases in marginal income tax rates in many EU countries as well as the decrease of progressivity that can be observed in the tax schedules of a number of EU countries therefore may well have positive effects on human capital formation and thus raise productivity.

3.2 Taxes and firm decisions

Taxes may influence firm decisions and entrepreneurial activity via a number of different channels. Most relevant with respect to productivity are the impact of taxes on entrepreneurial activity and the implications of international tax competition for mobile firms or investments. Both aspects are addressed in this section.

3.2.1 Taxes, innovations and entrepreneurial activity

Innovations made by (new) firms have been found to be an important driver of productivity and growth, both in the theoretical growth literature and in empirical work. Especially endogenous growth theory focuses on spill-over effects from entrepreneurial activity fostering overall economic productivity and growth. In recent years, the crucial role of entrepreneurship for innovation, growth and employment has been repeatedly underlined by the European Commission (1999) and the OECD (e.g. 1999).

According to an empirical investigation by the OECD (2003), based on a firm-level database and comprising a sample of OECD countries, most of the observed industry productivity growth in the countries included can be attributed to already existing firms. It turns out, however, that there are considerable cross-country differences concerning the contribution of new firms to productivity growth. Generally, new firms contribute positively to industry productivity growth in European countries, and they do so to a larger extent than in the US.

Due to capital market imperfections, caused by asymmetric information and lacking collateral, start-up firms often face credit rationing and therefore are heavily dependent on the financial engagement of venture capitalists providing capital in return for an equity share (eg.

Keuschnigg 2003). Taxes may have a certain influence on the market entry of new and innovative firms. Several authors stress the importance of capital gains taxes under imperfect capital markets. They claim that taxes on capital gains realised by venture capitalists providing capital to start-ups can lead to a sub-optimal supply of venture capital and therefore dampen innovation and entrepreneurship. Thus, cuts of capital gains taxes are expected to stimulate innovation and therefore productivity growth (Gordon 1998, Fuest and Huber 2003).

Empirical evidence on the relationship between capital gains taxation and the supply of venture capital is inconclusive, however. According to Poterba (1989), cuts in capital gains taxes are not an effective instrument to spur innovative activities, as venture capital only accounts for a small share in investors' total capital income. Anand (1996) on the other hand shows that the taxation of capital gains has a significant influence on the supply of venture capital in the telecommunication industry.

Entrepreneurial activity is relevant also from another perspective. If self-employed workers employ formerly unemployed individuals, if they offer more productive occupations than other firms, or if their entrepreneurial activity is associated with positive externalities for other firms or industries, they can increase an economy's productivity. Carroll et al. (2000) demonstrate – on the basis of US panel taxpayer data – that there is a significant negative correlation between the marginal tax rate and the likelihood of hiring employees. This suggests that lower tax rates induce entrepreneurs to hire more employees, which may in turn positively affect productivity.

Moreover, the incentives to become self-employed in the first place can be influenced by taxation. Generally start-ups face certain risks, so that the tax treatment of losses is certainly an important factor for the decision to engage in entrepreneurial activities (Gordon, 1998, Cullen and Gordon, 2002). Gentry and Hubbard (2000) point at the role of the progressivity of the tax schedule: a more progressive taxation of business incomes disproportionately reduces the after-tax return of successful entrepreneurs and thus lowers average returns, thus creating negative incentives for entrepreneurial activity.

Studies engaging in the empirical investigation of the influence of taxes on entrepreneurial activity come up with mixed results. Long (1982) and Blau (1987), using time series regressions to explore the relationship between marginal federal tax rates and the rates of self-employment in the US, find a positive correlation. The explanation offered for this result is that high tax rates induce workers to shift from paid employment to self-employment, where taxes can be evaded more easily. These results are contradicted by a study of Robson and Wren (1999) who show that higher marginal tax rates lead to a decline in self-employment rates as they reduce the

return to effort and therefore discourage entrepreneurial activity. For the US, Gentry and Hubbard (2000) show that the probability of entry into self-employment is negatively correlated with the progressivity of the tax schedule. That the correlation between tax rates and self-employment is generally weak and of limited size is confirmed by several more recent studies (e.g. Fairlie and Meyer, 2000, Briscoe, Dainty and Millett, 2000).

In sum, the literature surveyed leads to the tentative conclusion that structural aspects of the taxation of business incomes and financiers of start-ups are of greater importance than the overall tax burden imposed on income and profits of start-ups and self-employed. Particularly the tax treatment of losses – i.e. the willingness of governments to take over a part of the considerable risks connected with the start-up of firms and with self-employment – should be given special consideration.

3.2.2 International tax competition and productivity

With the growing integration of capital markets and the increasing international mobility of firms and investment, the issue of international tax competition is attracting increasing attention from economists and policy makers. Although a substantial part of the vast theoretical and empirical body of literature on international tax competition and its economic consequences that has evolved during the last 25 years does not directly address productivity aspects related to international tax competition, this section tries to derive some implications for productivity all the same. It has to be noted beforehand, however, that the theoretical tax competition literature yields inconclusive results, and that the empirical research concerning the mode of operation of international tax competition and its economic consequences lags far behind the theoretical literature (Zodrow, 2003).

A first source of potentially negative productivity effects of international tax competition is its possible impact on the supply of public inputs for enterprises. Based on an optimal taxation model, Beck (1983) argues that in a situation in which governments can only levy a distortionary enterprise tax, taxation of mobile enterprises will be below the optimum: tax revenues will be insufficient to finance an efficient level of productivity-enhancing public inputs. Inefficiently low levels of public services are also predicted by the basic tax competition model as summarised recently by Zodrow (2003) and Wilson and Wildasin (2004). Keen and Marchand (1997) focus on the structure of the overall supply of public goods and demonstrate theoretically that under the assumption of mobile enterprises and immobile households an inefficiently high level of productivity-enhancing public inputs is provided. If both households

and firms are equally mobile, Matsumoto (2000) shows that there is no bias towards the provision of public inputs for firms, but the overall level of public goods is inefficiently low.

Taking into account the existence of different kinds of taxes, international competition for mobile tax bases may induce a shift of taxes on mobile bases (i.e. capital) to immobile bases (i.e. labour), thus increasing the tax wedge on labour and accordingly decreasing labour supply and employment (Beck 1983), with the aforementioned detrimental effects on productivity.

Also possible effects of company taxation on the location of multinational corporations (MNC) and foreign direct investment (FDI) are relevant with respect to the general theme of this paper. The endogenous growth literature as well as the new trade literature (see Griffith 2003, and the references cited herein) suggest that MNC and FDI, respectively, play an important role regarding the transfer of technology and resulting spill-over effects, which can increase overall productivity in an economy. Several empirical contributions focusing on the US and the United Kingdom find that foreign-owned firms have a higher labour productivity than domestically-owned firms (e.g. Doms and Jensen, 1998, Griffith, 2003).

Empirical investigations show that FDI display a certain sensitivity towards international tax differentials (for a review of a number of empirical contributions see Hines, 1999, and de Mooij and Ederveen, 2003), although the magnitude of the correlation is disputed. In an empirical analysis of the sensitivity of the operations of MNC to host country taxation, Mutti and Grubert (2004) show that the location decision of US majority-owned foreign affiliates oriented to export markets is considerably and increasingly influenced by host country taxation. In a recent study including the EU member states, Gorter and Parikh (2003) find that a one percentage point reduction of the effective corporate income tax rate in an EU-country relative to the European mean induces investors from the other member states to increase their FDI position by about 4 percent. In their meta analysis, which includes 25 empirical studies on the impact of corporate taxes on the allocation of FDI, de Mooij and Ederveen (2003) find that the median value of the tax rate elasticity of FDI is about -3.3, i.e. a one percentage point reduction in the host-country tax rate increases FDI in that country by 3.3 percent.

Consequently, countries have been engaging in tax competition for investment over the past quarter of the century: a development which is reflected in decreasing and downward converging statutory corporate income tax rates and effective corporate tax rates in the EU and

the OECD, respectively.[8] It is disputed in the literature whether statutory, effective marginal or effective average tax rates are the strategic competition parameter set by countries engaging in international tax competition (e.g. Devereux, Lockwood and Redoano, 2002). Also the respective importance of statutory and effective tax rates for location decisions is not clear. Thus no straightforward conclusions can be drawn regarding the optimal design of a national company tax system. In any case, however, tax policy does have to take into account the increasing international mobility of firms and investment.

Whether international tax competition in general is to be judged as harmful or as beneficial altogether, is a controversial issue within the literature. A first approach stresses that tax competition forces governments to cut wasteful and unproductive expenditures and limits "fiscal exploitation" by governments perceived as Leviathans maximising public revenues and their own utility, respectively (Brennan and Buchanan, 1977). The opposite approach perceives governments as benevolent dictators maximising some kind of social welfare function (Zodrow and Mieszkowski, 1986). From this perspective, tax competition restricts a government's possibilities to raise sufficient tax revenues and thus leads to a sub-optimal provision of public goods and services as well as to the dismantling of welfare provisions which could have negative distributive effects (e.g. Sinn, 1994, 2002).

With specific regard to international company tax competition, Gorikh and Parikh (2003) point out that cross-country differences of corporate taxes result in a wedge between after-tax and pre-tax marginal productivity of capital. International tax differentials may distort the international allocation of capital, impeding the equalisation of the marginal productivity of capital across countries. This implies that overall (global) productivity could be increased by a re-allocation of capital from low-tax to high-tax member states. Whether this – together with potential negative productivity-consequences of tax competition regarding the provision of public inputs and the tax burden on labour sketched above – provides a rationale for internationally co-ordinated measures to harmonise corporate tax systems or whether tax co-ordination or harmonisation brings about even larger negative effects for welfare, productivity, and growth is, however, heavily disputed in the literature.[9] Apart from the general expectation of socially desirable restrictions of the taxing power of Leviathan-governments, the proponents of tax competition point out that welfare gains by corporate tax harmonisation in the EU are likely to be fairly

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[8] For the development of nominal corporate income tax rates in the OECD see KPMG (2004); for a survey of a number of recent studies on effective tax rates based on different methodologies see Schratzenstaller (2003).

[9]) For a discussion of the initiatives on company tax harmonisation currently contemplated on the EU level see e.g. Cnossen (2003), Zodrow (2003), Sorensen (2004), and Devereux (2004).

modest altogether (Sorensen, 2004) and to be unevenly distributed among EU member states, which will make it politically difficult to reach a common harmonisation agreement (Zodrow, 2003).

4 Fiscal policy, government size, and economic performance

In recent years, a lot of empirical research concentrated on possible relations between the share of taxes in national income and a country's growth performance. These studies use tax-to-GDP ratios as one measure of the aggregate extent of government involvement and attempt at finding empirical evidence for the assumption of a negative correlation between the overall tax burden and economic performance. Empirical research both using time-series relationships for given countries and cross-country studies, however, does not yield conclusive results. For example, Slemrod (1995) shows a positive correlation between the level of GDP per capita and the tax-to-GDP ratio for the US in the period 1929 to 1992. Such a positive relationship is also obtained in a comparison of OECD countries. However, it is not clear in which direction the causality runs and whether there is any causality at all. Looking at the relation between the growth rate of GDP per capita and the tax-to-GDP ratio, the findings by Barro (1991) suggest a negative impact of the tax burden on a country's growth performance: a result that was contested by a number of subsequent studies showing a slightly positive or insignificant correlation (e.g. Easterly and Rebelo, 1993).

Besides the isolated effects on economic performance of the structure and growth of public expenditures and taxes, a part of the literature is also concerned with the combined budgetary effects and the size of government in absolute terms or as a fraction of overall economic activity. Tanzi and Zee (1997) review the literature on the impact of expenditures and taxes as well as on the separate growth effects of the *budget balance*. Such effects may stem from stability implications of budget imbalances or from behavioural responses from the private sector due to such imbalances. In a cross-country study, Easterly and Rebelo (1993) find a significant and negative correlation between budget deficits and economic growth. More recently, Cassou and Lansing (1999) accept the dual role of government spending and taxes and therefore investigate, in their general-equilibrium endogenous growth model, simultaneously the observed public capital policy and the observed tax policy. Simulations which combine the two sides do a better job in explaining actual developments than the separate treatment of either side.

In addition to the stability and expectational effects of budget imbalances, the impact of the size of government on economic performance has been investigated empirically. Among the empirical studies available are, e.g., Barro (1991), Hansson and Henrekson (1994), and Fölster and Henrekson (2001). In general, these studies suggest that large governments are associated with slower growth. Theoretical arguments behind this adverse impact of a large public sector reflect a number of possible transmission channels, such as superfluous policy-induced distortions and the associated higher tax burden, the crowding-out of private investment, and inefficient resource use due to insufficient market forces (see Dar and AmirKhalkhali, 2002). Above all, governments are often large only because they are inefficient themselves (see Handler et al., 2005).

However, the relationship between government size and economic performance is likely to be non-linear, and the negative effects mentioned are most likely to be visible only when government size exceeds some *optimal size*. Furthermore, as already suggested by Barro (1990), an increase in public spending tends to raise the marginal productivity of capital, while an increase in taxes reduces it. The positive spending effect seems to dominate when government is small, and the negative tax effect when it is large. From his theoretical and empirical investigations, Barro concludes that *economic performance is an inverted U-shaped function of government size*, with an increasing cumulative impact on growth as long as government is small, and a decreasing cumulative impact as soon as government exceeds a certain threshold (see Figure 1 below).[10]

Heitger (2001) argues in a similar way and attributes the declining leg of the inverted U-curve partly to the necessary tax financing and partly to crowding-out effects. He investigates the relationship between the scope of government and economic development in OECD countries starting with the 1960s, using ten-year averages to abstract from business cycle fluctuations. Economic growth is measured as the growth rate of GDP per member of the labour force. Growth regressions represent an augmented neoclassical growth model in which output growth is a function of physical capital formation, labour force growth, human capital formation, and initial relative per capita income. One of the results is that a reduction of the government's share in economic activity by some 10 percentage points would be associated with an increase in the average growth rate by about 0.5 percentage points per year; the author mentions Ireland as an example that such an effect was not totally implausible.

Similar conclusions can be drawn from the empirical work done by Gwartney, Lawson and Holcombe (1998) who observe that government does exert a positive influence on economic growth as long as it is confined to such *core activities* as the provision of the legal and physical infrastructure for the operation of a market economy and a limited set of public goods.[11] As governments move beyond these core functions, they are likely to adversely affect economic growth because of (i) the disincentives emerging from higher taxes, (ii) diminishing returns as governments expand their activities into areas for which they are ill-suited, and (iii) an interference with the market-driven wealth creation process. For the period from 1960 to 1996, the authors show that the US economy developed into a "pattern of more stability, but less rapid growth". An empirical analysis of 23 OECD countries exhibits a strong negative relationship between the size of government and GDP growth, but in addition also between increases in government expenditures and GDP growth: an increase in government expenditures as a share of GDP by 10 percentage points is associated with roughly a one percentage point lower growth rate of real GDP.

One of the more striking results of Gwartney et al. (1998, p.27) is that "the level of government that maximises the performance of the economy would place government expenditures at 15 percent or less of GDP". From the point of view of the average European society with public expenditures of around 50 percent of GDP (see Handler et al., 2005), this seems unduely low. The actual division of competencies between the public and the private sectors reflects the history in the power struggle between the various social groups and usually cannot, without incurring heavy costs, be reverted at once. Thus, the determination of the optimal size of government must take into account the socio-economic environment which determines the core tasks of government. Gwartney et al. proceed the other way round: They collect theoretical arguments which result in an inverted U-shaped relationship between the rate of economic growth and the size of government (Figure 1): Assuming that governments are installed to perform core functions (which are defined to assist growth), their early expansion contributes to economic growth until the optimal size of government is reached; further expansion into non-core functions is subject to diminishing or even negative returns to economic growth. In their empirical assessment, the authors earmark certain expenditure categories as "core", and thereby arrive at their 15% or so "optimal" government size.

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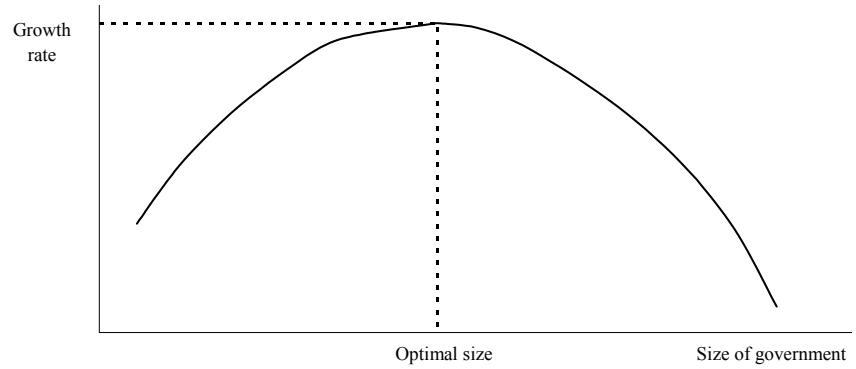
[10] The notion of an optimal size of government is not new, of course. An early example could be seen in the exchange of views between John Maynard Keynes and Colin Clark (1945) who agreed that the maximum level of spending and taxes an economy could sustain over longer periods was around 25 percent of gross national income.

[11] The list of core functions used in the calculations comprises protection of persons and property, national security, education, highways, sewage, sanitation, environmental protection, and the Federal Reserve System.

Rather low estimates are also obtained by Scully (1994) who employs an econometric model for the US for the period 1929 to 1989; the growth-maximising average ratio for federal, state and local taxes combined lies between 21.5 percent and 22.9 percent of gross national product. Chao and Grubel (1998) apply Scully's methodology to Canada in the period from 1929 to 1996; they estimate the optimal government size at an expenditure volume of 34 percent of GDP.

Figure 1: Government Size and Economic Growth



Source: Adapted from Gwartney et al. (1998), Exhibit 2.

Pevcin (2004) reviews a number of studies that attempt to determine empirically the optimal size of government. For 12 EU countries[12], he also estimates an inverted U-shaped curve depicting economic growth as a stylised function of general government spending in the period from 1950 to 1996. Employing an error components model, the optimal government spending point lies at 42 percent of GDP, as compared with an actual average figure for the countries concerned of 52 percent of GDP in 1996. The difference between the two values is interpreted as potential scope for reduction of government spending. Pevcin admits that no unique optimum level of government spending is applicable to all countries. He therefore estimates, separately for 8 out of the 12 countries,[13] ARIMA models which indicate optimum ratios in the range of 37 to 46 percent of GDP with a potential scope for reducing public spending by some 19 percent of GDP on average.[14]

Vedder and Gallaway (1998) perform separate estimates for the federal level and the sub-federal levels of the United States. They use ten-year averages of very long time series (1801 to 1996)

[12] Austria, Belgium, Denmark, France, Finland, Federal Republic of Germany, Republic of Ireland, Italy, Netherlands, Norway, Sweden and the United Kingdom.

[13] No statistically significant results were obtained for Austria, Denmark, Norway and the UK.

[14] It is, however, not clear from the Pevcin paper to what extent these estimates are statistically reliable. For Ireland, the estimates suggest that spending should be increased to reach the optimum.

and come up with an optimal size of US federal spending of 13.4 percent of GDP, as compared with an actual share of some 20 percent of GDP around the mid-1990s. Similar estimates for state and local public expenditures result in an optimal share of public spending of 11.4 percent of GDP as compared with 15.7 percent of GDP actually observed in 1993. Therefore they conclude that constraining the growth of public spending at all levels of government below output growth would have positive effects on overall economic growth. Similar results were found for Canada (covering the period 1926-1988), Denmark (1854-1988), Italy (1862-1988), Sweden (1881-1988) and the United Kingdom (1830-1988). Inverted-U regressions of ten-year averages of the share of total output absorbed by government spending on ten-year averages of real output growth rates yielded lower optimal than actual (1988) sizes of government for all countries considered. The authors' general conclusion is that the government growth in newly emerging nations with still small governments tends to have positive effects on growth, as additional public sector activities reduce transaction costs and improve (in combination with a rule of law and enforceable property rights) the environment for private investment. In countries with already large governments, in particular in those with sizeable transfer payments as in European countries, economic growth would be enhanced by constraining public spending.

Tanzi and Schuknecht (2003) investigate the relationship between changes in per capita growth and changes in total government spending as percent of GDP. For OECD countries, there is a strong negative correlation over the period 1960 to 2000, which is mirrored in a similarly negative correlation between gross fixed capital formation and total public spending in the 1990s. Although this evidence cannot replace thorough analyses of causal relationships, it leads to the prima facie impression that reductions in public spending are favourable to long-term growth.

In an earlier work, Tanzi and Schuknecht (2000) obtain similar results when investigating, for the period from 1960 to 1990, groups of industrial countries according to the size of their public sectors:, Countries with small governments (with public spending in 1990 of less than 40 percent of GDP) are similarly well endowed with desirable socio-economic institutions as countries with big governments (with public spending in 1990 exceeding 50 percent of GDP). Countries with smaller governments produce better results than big government countries even in areas such as general economic performance, labour markets, public debt, governance, and the regulatory environment. The authors conclude that progress in terms of economic and social objectives is unlikely to arise from additional public spending and that even traditional stabilisation policies have failed to achieve their objective of reducing output variation. These results are not necessarily seen to back laissez-faire policies, but indicate that additional public

spending might not be the answer to many socio-economic problems as soon as governments exceed a certain size, and that public spending could be reduced by applying "intelligent policies". Table 3 contains a selection of indicators used by Tanzi and Schuknecht and an update for the year 2000. The data show that the country classification is perhaps a bit crude, as on average there would not have been large government countries any more by the year 2000.

Table 3: Economic and social indicators according to government size

	Year	Big governments[1]	Medium-sized governments[2]	Small governments[3]
Total public expenditure[4]	1960	31.0	29.3	23.0
	1990	55.1	44.9	34.6
	2000	48.3	43.2	35.9
Expenditure by function: Health[4]	1960	2.6	3.0	2.3
	1990	6.6	5.9	5.2
	2000	6.3	6.2	5.9
Expend. by function: Education[4]	1960	4.5	2.9	3.4
	1990	6.4	5.6	5.0
	2000	5.7	5.3	4.8
Exp. by fcn: Social security[4]	1960	13.5	9.6	6.2
	1990	19.5	13.9	7.9
	2000	18.3	17.4	13.0
Exp. by fcn: R&D[4]	1990	2.0	1.6	2.0
	2000	2.0	1.8	2.3
Exp. by fcn: Environment[4]	1990	0.6	0.8	0.7
	2000	0.7	0.6	1.1
Real GDP growth, in percent	1960-68	4.1	4.0	3.7
	1986-94	2.0	2.6	2.5
	2000	3.5	4.8	3.5
Public sector debt[4]	1970	47.5	37.4	46.4
	1990	79.0	59.9	53.3
	2000	80.1	61.2	65.8
Unemployment rate, in percent	1960	2.9	4.6	2.7
	1990	5.6	8.2	4.1
	2000	5.7	7.1	4.6
Infant mortality per 1000 births	1960	23.0	29.0	22.4
	1990	6.7	7.1	6.4
	2000	4.1	4.6	5.2
Secondary school enrolment in percent	1960	55.0	51.0	61.0
	1990	96.0	100.0	92.0
	2000	99.0	100.0	99.0
Size of shadow economy[4]	1990	17.7	12.0	9.4
	1996/1997	20.4	14.8	11.0

Source: Tanzi and Schuknecht (2000) and own calculations.
[1] Countries with a share of total public expenditures in GDP of more than 50 percent in 1990: Belgium, Italy, Netherlands, Norway, Sweden.
[2] Countries with a share of total public expenditures in GDP between 40 percent and 50percent in 1990: Austria, Canada, France, Germany, Ireland, New Zealand, Spain.
[3] Countries with a share of total public expenditures in GDP of less than 40 percent in 1990: Australia, Japan, Switzerland, United Kingdom, United States.
[4] In percent of GDP.
[5] Ranking between 0 (worst) and 10 (best).

The result concerning stabilisation policy is not confirmed by Andrés, Doménech and Fatás (2004), who follow, however, a completely different approach: taking it as given from previous studies (e.g. Fatás and Mihov, 2001) "that there is a negative correlation between government size and business cycles", they search for the appropriate model to reproduce this evidence

which is based on the log of the share of total government expenditures in GDP as a measure of government size and on data covering the period 1960 to 1997. High cyclical volatility is assumed to have an adverse effect on economic growth. Andrés et al. find that only models with Keynesian features, i.e. allowing for a number of nominal and real rigidities in the economy, are able to capture the evidence, while a real-business-cycle model does not. Would the implication be that large governments, to be sustainable, need to introduce rigidities? The paper refrains from drawing any policy conclusions from this exercise.

Fu, Taylor and Yücel (2003) examine the short-term to medium-term effects of changes in the size of the public sector for the US and conclude that "growth in government stunts general economic growth". Economic growth for the period 1983 to 2002 is measured by the monthly growth in non-farm employment. Fiscal policy indicators are government expenditures, taxes and public sector deficits, all expressed as shares in GDP. They are not analysed individually, but in pair-wise combinations, as the effects of, say, public expenditures depend on the way of financing them. The authors develop a vector-autoregressive methodology for estimating the time paths of the growth variable following a simultaneous shock to such pairs of fiscal indicators. In a policy experiment with simultaneously increasing government spending and taxes (holding the deficit constant), employment growth is persistently reduced.

Another VAR approach is used by Perotti (2005) to study the effects of fiscal policy on GDP and other macroeconomic variables in five OECD countries (Australia, Canada, Germany, UK, and USA). The data sample consists of quarterly data, covering the period from the early 1960s to 2001 (for Germany only up to 1989), and is divided into two parts with a break at the end of 1979 (for Germany at the end of 1974). The impulse response of GDP to a spending shock is positive and significant in all countries except Australia, but larger than 1 only in Germany and the US. A tax cut exhibits consistently positive effects on output in the first subperiod only for the US and in the second subperiod only for Canada. The main overall conclusions drawn by Perotti are (i) that the estimated effects of fiscal policy tend to be small, and (ii) that the effects of government spending shocks and tax cuts on GDP have become weaker, and partly negative, over time.

The overall impression from this strand of the empirical literature is that in industrial countries with already well developed public sectors additions to government size probably have a negative impact on economic growth. There seems to be an optimal size of government beyond which additional public expenditures are not productive at all. This of course depends on the

level and quality of the already accumulated public capital, on the structure of additional public spending, and on the way of financing it.

5. Concluding remarks

Major channels of government influence on private sector activities are related to public budgets. There is, however, no uniform impact of public expenditures, taxes and the overall fiscal position on the behaviour and decisions of private entities. Also, empirical investigations do not show a simple and straightforward relationship between government activities and overall productivity and the growth performance of a nation. In a number of policy-oriented empirical studies, government size, the growth and composition of public expenditures and taxes as well as the fiscal stance seem to play a role in determining overall economic performance. The effects can be direct or indirect, but neither theory nor empirical evidence are unambiguous about the sign, extent and robustness of the correlation and the direction of causality. In the present study, the literature has been screened with respect to the evidence relevant for policy making.

Taking the empirical evidence on the *impact of government expenditures* on productivity and growth together, a mixed picture emerges which mirrors the substitutability and externality issues of government intervention. Although public sector expenditures per se have in all relevant cases some positive direct effect on overall economic performance, in empirical investigations which also account for secondary effects it often remains ambiguous whether or not these activities exert a net positive impact on the economy in the medium term. To produce more concrete results, one has to consider various groups of public expenditures separately. To keep the current study manageable, it has only reviewed the literature concerned with public physical infrastructure, education, research and development, and health services.

With respect to the physical infrastructure, the overwhelming part of it exhibits the characteristic features of public goods, i.e. they are non-excludable and non-rival in consumption. The literature surveyed concentrates on the effects of public investment in highway construction, water and sewer systems, and dwellings. Empirical studies show that public infrastructures lower firms' costs and improve their production possibilities, and that they are an important factor for attracting firms and start-ups. Most of the empirical work available concerns the US and yields positive and significant output elasticities from aggregate production functions in the range of 0.40 to 0.55. This seemed implausible and triggered the "public capital hypothesis controversy" which is still ongoing. Major refinements of the

estimation method concerned the level of aggregation and adaptions allowing for regional heterogeneity, inter-regional spillover effects, reverse causation, and non-stationarity in the data. The conclusion was that the contribution of public capital to output growth was significant and positive, though rather small. Empirical studies for European countries confirmed the positive impact of public infrastructure on production with a wide range of elasticities (from some 0.10 to 0.65), elasticities for Japan are around 0.20. An overall impression from these estimates is that public infrastructure seems to have a positive impact on private production, but with decreasing marginal returns.

A vast literature stresses the importance of human capital for economic growth. Empirical contributions report some positive correlation between schooling and growth, although this per se is not sufficient to justify government involvement, as there is little evidence for the presence of externalities in schooling. The estimated positive impact of human capital on economic growth is often measured in quantity terms by the impact of an additional year of schooling; a typical estimate would predict that an additional schooling year would in the long run increase income by some 15 percent. In addition to schooling quantity, the literature advocates the consideration of schooling quality, as measured by the cognitive performance of students (similar to the regular PISA survey of the OECD) and the quality of human capital in general (perhaps measured by a health variable), to arrive at meaningful estimation results.

R&D expenditures are held to be one of the key engines of economic growth. A major subject of theoretical and empirical investigation is whether government research will crowd out private research and whether government assistance of private research will induce companies to engage in otherwise not profitable research. Whereas several empirical studies report substitution between public and private R&D expenditures, the majority of estimates reject the crowding-out hypothesis. The implication for economic policy is that although public and private R&D are additional, this outcome is not automatically secured. It needs a proper institutional setting and is probably confined to specific types of R&D expenditures.

Health care services are provided by the public sector for social rather than purely economic reasons, but there are important links to the performance of the economy. The empirical literature usually is concerned with efficiency aspects and discusses the impact of more competition within the sector on the quality of services. Many studies see health as a component of the quality of human capital which is introduced in estimates using a production function approach. The evidence is mostly that health expenditures have a positive, sizeable, and

statistically significant effect on aggregate output. Other studies question the size of estimated effects and claim that reverse causation may prevail.

To determine the *impact of taxes on productivity and growth* is a task which is hard to solve theoretically as well as empirically. The literature review on partial effects of taxes on the decisions of individuals and firms concerning labour demand and supply, on the engagement in entrepreneurial activities, and on the international allocation of capital provided in this section often yields inconclusive empirical evidence. One central problem with which empirical studies are confronted is the appropriate measurement of the marginal tax burden (Engen and Skinner 1996). However, the cuts in marginal income tax rates as undertaken by a number of European countries in recent years appear to create work incentives and increase labour supply, particularly of low-income earners, married women, and lone parents. Male labour supply and the supply of labour in the high-wage segment appear to be rather insensitive to changes in labour taxation. There is also some evidence that the burden of tax and social security contributions is of importance for the emergence of informal sectors in the economy. General recommendations for a tax system, which brings about optimal results with respect to a country's productivity performance, can hardly be derived. It seems, however, safe to conclude that a reduction in the tax wedge on labour can be associated with positive productivity effects, particularly if achieved for low-wage earners in countries with high unemployment.

With regard to entrepreneurial activities, the income tax burden is of particular relevance for the market entry of new firms. Even greater importance is attached to structural aspects of business taxation, such as the tax treatment of losses. Company taxation in general has become an important instrument of international competition for mobile tax bases. This has led to a discussion within the EU on harmonising the corporate tax systems, although the welfare gains to be reaped are likely to be modest.

A number of empirical evaluations suggest that *larger governments* are associated with lower growth. The dominant strand of the relevant literature, however, finds that economic performance is an inverted U-shaped function of government size, which means that the marginal productivity of government activity is positive as long as government is small and turns negative beyond a certain threshold. Empirical estimates of the optimal size of public expenditures vary according to the assumptions and model specifications used and can be as low as 15 percent of GDP. This seems unduely low from the point of view of the average European society with public expenditures of around 50 percent of GDP. The actual division of competencies between the public and the private sectors reflects the history in the power

struggle between the various social groups and usually cannot, without incurring heavy costs, be easily reverted. Thus, the determination of the optimal size of government must take into account the socio-economic environment which determines the core tasks of government. Under such conditions, the optimum for European countries is estimated to be in the range of 40 percent, which for most of the contries concerned is still significantly lower than their actual government sizes.

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