Does the Composition of Public Expenditure Impact Economic Growth?

Evidence from Switzerland using a robust cointegration approach

by

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Abstract

Because heterogeneity between countries is substantial, the relevant literature proposes performing time-series analyses to examine the long-term effect of fiscal policies on output growth. Following this advice, I study the impact of the composition of public expenditure on growth using Swiss data. My findings provide strong evidence that government outlays for transport infrastructure, justice and general government are vital for output growth. Whereas the evidence for a growth effect of education is weak and therefore a reversed causation effect could be ascertained. This indicates that public education epitomises Baumol's cost disease. The evidence concerning the growth effect of social policies and health care is not clear-cut. Finally, this paper shows that only a few outlying observations can severely distort classical OLS estimators so that the usage of robust estimators is strongly recommended.

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1. Introduction

Endogenous growth theory gives governments a theoretical basis for actively fostering growth. Not surprisingly, many empirical studies have been carried out to test the predictions of endogenous growth theory. The vast majority of these studies are cross-country- or panel-data studies. Though these studies have their merits, they suffer severely from the heterogeneity of the underlying data set. Countries differ from each other in many respects such as in their political-economic systems, cultures, histories, geographies etc. As Durlauf (2000, 252) put it: "…heterogeneity is a key feature of national experience". The resulting econometric problem is coined "parameter heterogeneity" (e.g. Temple. 2000). As a result, it has so far proved quite difficult to empirically show a robust long-term correlation between

government variables and economic growth (e.g. Sala-i-Martin, 1997). To avoid parameter heterogeneity, time series studies such as that of Kocherlakota and Yi (1997) for U.K. and U.S. data should be carried out and are likely to lead to more robust results. Kocherlakota and Yi (1997) propose extending time series analysis concerning the growth effects of fiscal variables to other countries and to a broader range of government policy variables. Following this proposal appears to be particularly apt for Switzerland because the political system of direct democracy clearly distinguishes Switzerland from the majority of other industrialised countries.

This study focuses on analysing the impact of the composition of public expenditure on economic growth because this aspect could be crucial for long-run economic policy. The majority of OECD countries face demographic burdens due to the ageing of societies, which probably have a strong impact on public finances. Due to tightening budget constraints non growth-enhancing expenditures may crowd out outlays that possibly boost economic growth. This would certainly cause "budget crowding out" (e.g. Roloff, 2002). Therefore, the issue of which government expenditures can foster permanent movements in economic growth rates becomes increasingly important.

Recently, some authors have pointed to the fact that economic data are quite frequently not approximately Gaussian distributed. This can cause estimators widely used in econometric studies, such as least squares estimators, to be biased and inefficient (Temple, 2000; Zaman et al., 2001; Sturm and de Haan, 2001). Therefore, these authors propose using robust estimation methods. This approach, though relevant, has so far, to the best of the author's knowledge, only been applied by Colombier (2009) to analysing the impact of fiscal policy on growth. In this study I apply a robust unit root test proposed by Abadir and Lucas (2000) and make classical cointegration tests outlier-robust by using a simple approach. First, outliers are identified through estimations with robust modified M-estimator. Second, the classical

cointegration test using OLS estimator is run without the identified outliers. The paper shows that elimination of outliers changes the results dramatically.

This paper is organised as follows. Firstly, I outline some theoretical predictions with respect to the growth effects of fiscal policies. Secondly, I briefly review some recent empirical studies. In section four the methodology used and the data are described. In section five the empirical results are reported and section six concludes.

2. Theoretical Predictions

It is common knowledge that fiscal policies cannot bring about changes in long-run growth of output in a neoclassical growth model. The introduction of endogenous growth models that incorporate the government sector has led to the opposite conclusion that fiscal policies can affect the long-run growth rate of an economy (e.g. Barro and Sala-i-Martin, 1992).

In models of endogenous growth, government policies can improve the factor allocation of the market due to market failure. As a result, private factor productivity and the accumulation of physical capital and human capital respectively can be increased. Public inputs, natural monopolies or spill-over effects are the main justifications for government provision. In theory, these publicly provided goods enter the production function so that they can boost the steady-state growth rate (see e.g. Barro and Sala-i-Martin, 1992, for a clear theoretical exposition). Of course, there is some debate over the question of which particular expenditures should be classified as productive and which not (see Kneller et al. 1999, 173). Certainly, empirical studies should shed some light on this debate. Public expenditures on infrastructures such as transport networks, water and sewer systems, on education and on defence spending are quoted as typical examples of possibly growth-enhancing publicly provided inputs (see e.g. Nijkamp and Poot, 2004, 101). Apart from these typical examples of potentially growth-boosting public expenditures, other government-provided goods exist that bear a resemblance to Meade's creation of atmosphere. Meade's creation of atmosphere

corresponds to a public input that is factor-augmenting (see e.g. Colombier and Pickhardt, 2002, 264). For example, security and social and political stability can create an atmosphere that is favourable to economic growth. Social as well as security measures can contribute to this public input by reducing the risks of criminal offences and social unrest so that a safe and stable institutional environment, e.g. guaranteeing property rights, for economic activity can be created (see Gerson, 1998, 22; Nijkamp and Poot, 2004, 107). Moreover, social expenditure may have a positive impact on human capital accumulation, for example, by providing financial assistance to enable access to the education system. Due to credit market imperfections, particularly those having low or no incomes may face insurmountable hurdles in obtaining access to the credit market to fund their education (see Gerson, 1998, 9). On the other hand, inordinately generous entitlements may reduce incentives to work (see e.g. Nijkamp and Poot, 2004, 107). In health care, government intervention can be justified by several specific characteristics of this sector such as asymmetric information, externalities etc. (see Hurley, 2000, 67). Improvements in health care raise a labour force's productivity by reducing absenteeism and illness and by enhancing the capacity to work over the life cycle (see Gerson, 1998, 10). As a result, government expenditure for health care may boost economic growth. Overall, there is a whole range of types of government expenditures that may be growth-enhancing. This supports the assertion that the composition of government outlays may be more relevant than the level (see Nijkamp and Poot, 2004, 107).

3. Some time series evidence

In a recent study reviewing the empirical evidence of 93 economic journal articles about the impact of fiscal policy on economic growth, Nijkamp and Poot (2004) come to the conclusion that only for public expenditures on infrastructure and education can a robust and positive impact on economic growth be found. However, only a minority of the reviewed studies, 21 out of 93 reviewed articles, are time series studies.

Among the time series studies is the seminal study of Kocherlakota and Yi (1997) who analyse how public capital and taxes affected economic growth in the United States and the United Kingdom in the period from 1891 to 1991 and from 1831 to 1991 respectively. They find that public capital boosts economic growth and taxes hinder economic growth as is predicted in endogenous growth theory. Kocherlakota and Yi (1997) only take into account physical investment and not investment in human capital. Cullison (1993) analyses the growth effects of the composition of public expenditures for the United States. According to Cullison's findings, government expenditure for education, active labour-market policies, justice and diverse benefits provided by the state boosted economic growth in the period from 1952 to 1991. Singh and Weber (1997) who analyse Swiss data from 1950 to 1994 come to the conclusion that only education but not public infrastructure is growth-enhancing. Moreover, Singh and Weber (1997) find that healthcare expenditure is unfavourable to growth.

Recently, Ramirez (2004) comes to the conclusion, using Mexican data for the period from 1955 to 1999, that public infrastructure, which comprises transport, communications, water and sewer systems, education and health care; positively affects growth. A study for Turkey in the period from 1963 to 1999 by Ismihan et al. (2005) ascertains a significant impact of both public and public core investment on growth in the medium- but not in the long-term.

Overall, these studies provide some evidence that public infrastructure and education are growth-enhancing. Moreover, some evidence has been found that expenditure typically not characterised as productive, such as certain kinds of social benefits and justice, may well be conducive to growth. Only two studies have been found, which analyse the composition of public expenditure (Cullison, 1993; Singh and Weber, 1997). Thus, there is a lack of time series studies analysing the effects of the composition of government expenditures on growth. This study aims to fill this gap.

4. Methods and data

4.1. Some general considerations

As mentioned in section 3, another time series study about the impact of the composition of public expenditure on growth has been carried out by Singh and Weber (1997) for Switzerland. The present paper extends the observed time period by eleven years. But the approach applied by Singh and Weber (1997) is not adopted due to various reasons. Singh and Weber (1997) use a polynomial distributed lag model (pdl-model) to estimate the growth effects of public expenditures. It seems that using longer time spans allows a better capture of long-run growth effects of fiscal policies. Growth effects of public expenditures such as infrastructure expenditure may emerge rather gradually over time because infrastructure expenditure may be complementary to private investments that are undertaken only at a slow pace (see Nijkamp and Poot, 2004, 105). Moreover, as business cycles last on average at least five years, a minimum of five lags should be taken into account in distributed-lag models. This, along with the rather, compared to other OECD countries, short time series of fiscal data available for Switzerland, leads to a considerable loss of the number of degrees of freedom if a pdl-model is applied. Therefore, to have a reasonable number of degrees of freedom, which is statistically recommended, another approach is chosen (see Stahel, 2004, 180).[1]

In addition, continual data on government expenditure are only available back to 1960. Although, since the datapoints of 1950 and 1955 are available interpolated data could have been used for the estimations, as Singh and Weber (1997) have done, I abstain from this option due to possible structural breaks. Eyeballing the public expenditure series of

[1] For example, the polynomial-distributed-lag approach used by Singh and Weber (1997) implies that the number of degrees of freedom is at maximum 13, which is rather small. In contrast, the regressions of this study could be estimated on average with at about 30 degrees of freedom.

Switzerland reveals that four out of six time series might have had a structural break between the 1950's and 1960's.[2]

Therefore contrary to Singh and Weber (1997) I use an autoregressive distributed lag (ARDL) model with an error-correction representation. Applying an error-correction framework makes it possible to test for a long-run relationship between public expenditure and economic growth. By using a cointegration approach, a considerable number of degrees of freedom can be saved.

4.2 Dealing with non-Gaussian distributed data

To deal with non-Gaussian distributed data and the related problem of outliers I apply robust estimation methods. This is not only strongly advocated by statisticians (Hampel, 2000) but recently also by some economists (Temple, 2000; Zaman et al., 2001, Colombier, 2009). Statisticians have demonstrated that even for high-quality data, which deviate only slightly from a Gaussian distribution, least square estimators (LSE) show substantial losses in efficiency (from 10% to 100%) compared to good robust procedures (see Hampel, 2000, 2). As a result, LSE is no longer the best unbiased estimator (see Hampel, 2000, 19). But economic data usually cannot be deemed high-quality data (see Zaman et al, 2001,1). Occasionally, outliers can increase the degree of precision of regressions. In these cases they are called good leverages which exert a strong influence on LSE in beneficial ways. In contrast, bad leverages, but also vertical outliers - although to a lesser extent -, can severely bias LSE regressions and can cause inefficient LSE estimates (see Hampel, 2000, 19; Hubert *et al.*, 2005). Furthermore, the LSE can completely break down and therefore be biased due to only one outlier (see Hampel, 2000, 16). Thus, the widely used LSE is not a robust estimator. Moreover, LSE masks outliers in multiple regressions, as it tends to make the residuals look like a Gaussian distribution (the masking effect) and valuable observations may thereby be

[2] The figures of these time series are available on request from the author.

identified as outliers by conventional outlier diagnostics like Cook's distance plot (the swamping effect), (see e.g. Temple, 2000, 191-192; Hubert et al., 2005, 266). In contrast, the robust estimator that is used for this analysis, the modified M-estimator (MME) (M stands for generalised maximum likelihood estimator (see Hampel, 2000, 8)), can deal with non-Gaussian distributions and has the maximal breakdown point of 0.5 (see Yohai *et al.*, 1991, 369). This means that MME is robust against a fraction of 50% outliers in the underlying sample and is thus a high-breakdown estimator (see Yohai *et al.*, 1991, 369). This feature enables the MME to identify the most coherent part of the data so that the MME is well-suited for estimating empirical models that are of an approximate nature such as those in economics (see Temple, 2000, 183).

However, to the best of the author's knowledge, a cointegration test with robust MME is currently not available. To benefit from the advantages of MME and to detect possibly harmful outliers I run the error-correction models not only with the widely used ordinary least squares (OLS) but also with MME. In contrast to cointegration, unit root tests using robust estimation methods have recently been proposed in the econometric literature (e.g. Abadir and Lucas, 2000).

4.3 Estimation approach and time-series characteristics of fiscal variables

The estimations are carried out using Swiss data of government expenditure by function, real gross domestic product (GDP), population and employment for the period from 1960 to 2005. Due to data availability this period has to be shortened to 1965 to 2005 if private investments are included in the regressions. Private investments are chosen as an indicator for private capital accumulation because official data for capital are only available from 1990 onwards.[3] In contrast to the common practice of using public expenditure ratios in terms of nominal GDP public expenditure variables are expressed in real per capita terms. Proceeding

[3] Note that the series for private investments is calculated by substracting public investment from total investment. However, these series originate from different databases (see Appendix).

in this way is justified by the fact that public expenditure ratios in terms of nominal GDP may have a negative correlation to GDP due to the following reversed causality problem. Public expenditures are budgeted on the basis of GDP forecasts. Experience shows that growth rates of GDP are underestimated in an economic downturn whereas the opposite is true in an economic upswing. This can establish a negative relationship between public expenditures and economic growth, which brings about reversed-causality (see Kirchgässner, 2004, 12). Furthermore, to exclude reversed-causality due to Wagner's law real GDP per worker, which is a proxy for labour productivity, is chosen as an indicator for economic output.

In order to test whether public expenditures exert an influence on labour productivity growth I choose an ARDL-based error-correction approach. Labour productivity as defined above corresponds to an AR(1) process. To save a considerable amount of number of degrees of freedom and to take into account business cycle fluctuations simultaneously, five lags of fiscal variables are included in the regression. The error-correction representation of the resulting ARDL(1,5) process can be written as follows:

$$\Delta y_t = \alpha_i + \gamma_i (y_{t-1} - \beta_i g_{i,t-1}) + \sum_{j=0}^{5} \lambda_{i,j} \Delta g_{i,t-j} + u_{i,t} \qquad (1)$$

with: t: = year t; j:= lag j; i: = public expenditure category; Δ:= first differences; y_t:= real GDP per worker at t, $g_{i,t}$:= real public expenditure per capita i at t, e.g. expenditure on education, etc.; γ:= speed of adjustment to long term equilibrium, β:= long term impact of public expenditure g_i, $\sum\lambda_j$:= total short term impact of public expenditure g_i, u_t:= error term at t.

The possible long- term impact of a public expenditure item i on economic growth is estimated by the parameter β_i. Also, short run effects can be identified (sum of $\lambda_{i,j}$). To test whether Swiss public expenditure has impacted on labour productivity those government expenditure items that might affect productivity growth are considered (see section 2). These are government outlays for education, transport, health care, social welfare, general

government and justice.[4] Apart from public expenditure on transport all fiscal variables are strongly correlated with each other, i.e. more than 95% (see Appendix, Table A1). This can lead to severe multicollinearity. As is well-known, multicollinearity makes it difficult to identify the impact of a single regressor on the dependent variable. Furthermore, it would not appear to be economically reasonable to assume that public expenditure items are mutually cointegrated. Therefore, separate regressions are performed for each public expenditure item. Moreover, to analyse the sensitivity of results private investment is included as additional regressor. To test for cointegration the well-known test of Banerjee et al. (1996) and the bounds testing approach of Pesaran et al. (2001) are used. The bounds testing approach of Pesaran et al. (2001) allows for more than one cointegrating relationship in a single equation model. Moreover, regressors need not be integrated by order one but can also be stationary. However, if the test statistics do not fall outside the critical bounds it is not possible to decide upon the null hypothesis of no cointegrating relationship (see Pesaran et al., 2001, 299). Recent research suggests that public expenditure on education and transport is conducive to private capital accumulation (Colombier, 2009). Based on a view commonly held in economics, private investment should be stationary in the long run. Consequently, although no cointegrating relationship between government expenditure items and private investments could be ascertained for Swiss data and private investment seems to be integrated by order 1, to be on the safe side, the bounds testing approach is used for regressions including public expenditure and private investment (see Table 1 and Appendix Table A2).

To test the order of integration of every variable a robust unit root test is used, which is outlined in the next section.

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

4.4 Evaluating time series characteristics with a robust unit root test

The test most widely applied for testing the integration of time series is the Augmented Dickey-Fuller test (ADF). A shortcoming of this approach is that it does not account for structural breaks. The latter can severely bias classical unit root tests such as ADF (Silvapulle, 1996). In particular in the case of fiscal variables structural breaks are assumed to occur very often because of continuous shifts in the legal framework (see Singh and Weber, 1997, 626). Under the null hypothesis of a unit-root of the ADF-test structural breaks can be triggered from outliers, which has been underscored by Lucas (1995, 167). As a consequence, outlier-robust estimators such as MME can adequately cope with structural breaks without resorting to dummy variables. Therefore, I apply a robust unit root test proposed by Abadir and Lucas (2000) and compare the results with the ADF test. The lags of the variables for unit roots are chosen on the basis of the AIC criterium and t-tests of OLS regressions for the ADF test and MME regressions for the robust unit root test. As Table 1 shows, differing lag lengths are found for general government expenditure and private investments.

Insert Table 1 about here

According to the results of the robust unit root test, all variables are integrated of order one (see Table 1). The last column of Table 1 indicates that outliers are present that can cause structural breaks. Consequently, the ADF test may be biased. This seems to be the case for public expenditure on education and general government. Contrary to the findings of the robust unit root test, the results of the ADF test suggest that public expenditure on education is integrated of order one and outlays for general government are stationary. These results show that robust unit root tests can be a useful tool, provided the time series under consideration are supposed to have structural breaks.

5. Empirical evidence

The estimations are organised as follows: Firstly, I run separate regressions on all fiscal variables before I include private investments as a further regressor to test the sensitivity of

results. Finally, the issue of feedback effects is addressed. Overall, the tests provide evidence that in most cases all the assumptions of the econometric model but one are fulfilled. The Shapiro-Wilk test statistic is statistically significant at a 1% level in about 80% of regressions with labour productivity as regressand. This finding provides strong evidence that the data are generally non-Gaussian distributed so that complementing classical cointegration methods with robust estimations, as is done in the present paper, is strongly recommended (see section 4.2). Moreover, the fit of regressions improves considerably, i.e. the adjusted R^2 increase on average by 14 percentage points, if possible outliers identified by MME regressions are left out. Thus, the approximate nature of the estimated model improves markedly.

5.1 Growth effects of public expenditure

Turning to the analysis of growth effects of public expenditure, it is striking that the detection of outliers through robust MME regression changes the results in two out of six estimations substantially (see Table 2). Eliminating the identified outliers from the regressions on general government and on justice leads to highly significant estimates of the speed-of-adjustment parameters. This suggests a long-run relationship between these expenditure categories and labour productivity growth. Whereas in the case of general government non-Gaussian distributed data seem to cause inefficient standard deviations, in the case of public outlays for justice outliers does not only induce inefficient standard errors but would also appear to bias the coefficient of justice. The estimations without outliers on justice and general government show that a 1%-change in one of these expenditure categories would spark off labour productivity growth of about 0.3% (see Table 2). Obviously, expenditure on security has created a safe and stable institutional environment so that these expenditure items could have been conducive to labour productivity growth. In addition, regulation and administration in Switzerland would appear to be quite efficient because public expenditure on general government seems to be favourable to productivity growth. This could partly be explained by the institutional effect of direct democracy because referenda are commonly

thought to be a more effective means of controlling public expenditure than parliamentary voting (e.g. von Arnim, 2000). An immediate conclusion would be that the administration of a direct democracy such as Switzerland should also be organised more efficiently.

*** Insert Table 2 about here***

Moreover, the estimations show that public expenditure on transport infrastructure exerts the strongest long-term impact on productivity growth. A 1%-increase of transport expenditure would lead to an additional labour productivity growth of about 0.4 percentage points (see Table 2). In contrast to transport expenditure only weak evidence for a long-term impact on educational growth is found. The null hypothesis of no cointegration is only rejected at a 10%-level. Furthermore, neither government outlays for health care nor for social welfare would appear to affect labour productivity growth. Short-term effects of government expenditure on growth could only be verified for transport outlays.

5.2 Sensitivity analysis

So far, growth effects of public expenditure have been analysed by testing a cointegrating relationship between fiscal variables and labour productivity. Nonetheless, in order to test if the obtained results are stable I include private investment as an additional growth driver in the regressions. As outlined in section 4.3, including an additional regressor may mean having more than one cointegrating relationship. Therefore, the bounds testing approach of Pesaran et al. (2001) is used. This test encompasses two bounds tests, an F-test and a t-test. Pesaran et al. (2001, 304) emphasise that strong evidence for cointegration is only provided if the null hypotheses of both tests are rejected. As outlined above, if the test statistics fall inside the range between the critical bounds values no decision upon the null hypothesis is possible. This is indicated by the abbreviation "ud" behind the F- and t-statistics in Table 3.

As the normality tests for all regressions suggest non-Gaussian distributed data and the results changes in 4 out of 6 regressions if the outliers identified by robust estimations are eliminated from the regressions, I concentrate on the result of OLS regressions without

outliers (see Table 3). Moreover, the implausible negative sign of the long-term impact of private investments in the regressions with outliers vanishes if the identified outliers are left out.

*** Insert Table 3 about here***

It is striking that the adjusted R^2 increases dramatically, on average by about 12 percentage points, in contrast to the regressions without private investment. From this it can be inferred that irrespective of the findings concerning cointegration, private capital accumulation plays, not surprisingly, a crucial role for labour productivity growth.

Concerning education, the result of the first estimations are supported. Again weak evidence for a long-term impact of education along with private investments is given by the estimations. However, there is also some evidence for autocorrelation of residuals. The Box-Ljung test is significant at a 10% level. Autocorrelation would cause the bounds testing approach to be invalid.[5] Thus, the findings regarding public expenditure on education remain inconclusive. As for public expenditure on general government and justice, the above obtained results are supported. The estimated long-term effects are again at about 0.3 (see Tables 2 and 3). Also the finding that transport infrastructure is conducive to productivity growth is supported.[6] Moreover, the long-term elasticity of transport infrastructure does not change enormously. Contrary to the results without a private capital regressor, the bounds testing approach provides strong evidence that health care and social welfare expenditure

[5] Note that the problem of autocorrelated residuals could be diminished by excluding the lagged first differences of the educational variable and introducing leads of the first differences of private investments. In the regressions with social welfare adn private investments the same proceeding leads to an elimination of autocorrelations (see Table 3 and Appendix, Table A3).

[6] Note that if outliers are eliminated only the perfomance of the regression with transport infrastructure worsens and does not substantially exceed the one exlcuding private investments in terms of adjusted R^2 (see Tables 2 and 3). Therefore, only the results of the model excluding the lagged differences of transport infrastructure, which vastly outperforms the model with lagged differences in terms of adjusted R^2, are reported in Table 3 (see also Appendix, Table A3).

impacts productivity growth. Nonetheless, the long-term impact is comparatively low, less than 0.2 in both cases. Consequently, the results concerning health care and social welfare are inconclusive.

Finally, the long-term impact estimated for private investments need to be explained further. In comparison to the effect of public expenditure the long-term elasticity of private investment is comparatively low, at about 0.1. However, the comparatively dramatic change of the private investment coefficient due to the elimination of outliers could imply that though the investment regressor shows the correct sign it is still underestimated.

5.3 Feedback effects

However, so far I have not examined possible feedback effects between government expenditures and labour productivity. In particular, most government functions are quite labour-intensive (Baumol, 1993). If one assumes that wages of the public sector rise approximately in line with productivity growth of the overall economy, it is reasonable to surmise that labour productivity growth should affect public expenditure.

Insert Table 4 about here*

Turning to the estimations in Table 4, one can see that, except for educational expenditure no long-run impact of labour productivity growth on public expenditure can be ascertained. But labour productivity growth would appear to exert a strong influence on public expenditure on education. A one percent increase in labour productivity would trigger a change in public expenditure on education of about 3% (see Table 4). According to Baumol (1993) education epitomises a sector that allows only abrupt productivity growth, in contrast with continuous productivity growth in manufacturing. This is because substituting labour with capital is difficult in education. Consequently, the results suggest that education epitomises Baumol's cost disease.

Labour productivity also affects expenditure on public education in the short run. This shows that the wage development in education is also influenced by the business cycle. At the

same time, labour productivity constitutes a drag on public expenditure on social welfare in the short run. This may also be due to business cycles. Normally, in a recession more people receive social benefits than in an upturn. Consequently, the short-term impact of labour productivity on social benefits is counter-cyclically.

5.3 Overall empirical evidence

To sum up, the estimations provide strong evidence that expenditures on public transport, justice and general government are growth-enhancing. Even though the robustness of the findings concerning social expenditure and health care is inconclusive, overall, the view that social equity and public health is beneficial to productivity growth is not falsified (see Nijkamp and Poot, 2004, 107). The evidence regarding the growth effects of spending on education is weak. But one should bear in mind that the transmission channel from education outlays to actual education and through human capital accumulation to economic growth is complex and may have long lags. Moreover, the cantons of Switzerland are responsible for public education. Consequently, Switzerland's education system consists of 26 different regimes. Overall, this may explain the rather weak empirical evidence with respect to education outlays. Furthermore, feedback effects are only found for education. Since the production of education is typically labour intensive this results indicates that education suffers from Baumol's cost disease.

6. Conclusion

This paper has shown that researchers using typical econometric time series tools such as unit root and cointegration tests should be aware of the fact that a few outlying observations may severely distort the classical OLS estimator. Consequently, applying robust unit root tests and identifying outliers with robust MME is strongly recommended.

Overall, the empirical evidence suggests that the composition of public expenditure matters for growth. Governments that will face tightening budget constraints due to imminent demographic burdens should be aware of the fact that outlays for transport infrastructure,

justice and general government can be growth-enhancing. The result that social expenditure and health care expenditure may foster economic growth is in line with some recent research (e.g. Hurley, 2000; Nijkamp and Poot, 2005). But since the evidence is inconclusive, further examination is needed. Regarding the growth impact of education expenditure, the evidence is weak. This may be due to the complex relationship between education expenditure and economic growth but also due to the decentralised education system in Switzerland. In order to reach a clear-cut conclusion, future research could be devoted to the complex transmission channel leading from education outlays to growth. Moreover, this study shows that education epitomises Baumol's cost disease.

Furthermore, the findings of this paper differ to some degree from the results of Singh and Weber (1997). For example, the latter find only temporary growth effects of transport infrastructure. The differences to the present study could inter allia be due to the lower number of degree of freedom and to the inclusion of the interpolated data of the 1950's by Singh and Weber (1997) .

To sum up, the results of this paper emphasise that the composition of government expenditure is crucial for economic growth. Thus, in view of political challenges such as the demographic burden and climatic change, it becomes increasingly important to explore further what portfolio of government outlays is optimal in growth and welfare terms.

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Table 1: Unit Root Tests

Variable (in real per capita terms and logarithms)	Levels or differences	ADF test	Lags	Deterministic component	Robust Unit Root test with MME	Lags	Deterministic component	Number of Possible Structural Breaks
Labour productivity	Levels	3.33	1	none	4.28	1	none	2
	First D.	-2.78***			-2.53**			
GDP per capita	Levels	3.09	2	none	3.98	2	none	4
	First D.	-2.55***			-2.21**			
Education	Levels	2.25	2	none	2.95	2	none	2
	First D.	-1.45			-2.5**			
	Sec. D.	-4.41***						
Transport	Levels	1.98	1	none	-1.60	1	none	5
	First D.	-3.14***			-5.20***			
Health	Level	3.94	1	none	4.34	1	none	5
	First D.	-2.86***			-3.44***			
Social	Levels	-2.56	1	none	2.73	1	none	7
	First D.	-5.10***			-8.47***			
General	Levels	-3.45**	1	drift and trend	2.11	3	none	4
	First D.				-4.26***			
Justice	Levels	4.45	1	none	4.08	1	none	2
	First D.	-2.28**			-2.12**			
Private Investment	Levels	0.15	2	none	0.40	2	none	1
	First D.	-3.56***			-3.53***			

Notes: ***:= 1% significance level; **:= 5% significance level; *:= 10% significance level. Robust unit root tests with MME, i.e. robust modified M-estimator, are performed according to the approach of Abadir and Lucas (2000), D.:= differences.

Table 2: Impact of fiscal variables on productivity growth

ECM: OLS Regressions of GDP per worker on per capita government outlays in real terms; Period 1960-2005, all variables in logarithms

Fiscal Variables	Number of Outliers: MM esti-mation	Normality Test	Adjustment speed	Impact Fiscal variable		Adj. R^2 (%)	Box-Ljung Test
				long term	short term		
Education	1	**0.80*** **	-0.28 (-2.35)	0.27	none	18	11.5
without outliers & with leads		0.99	-0.25* (-3.26)	0.38	L2: -0.17* (-1.77)	50	21.4
Transport	2	**0.88*** **	**-0.37*** (-4.03)**	**0.46**	**L2: -0.12** (-1.19)**	33	14.5
without outliers		0.98	**-0.21** (-3.45)**	**0.39**	**L5: -0.06** (-2.06)**	40	14.8
Health	2	**0.85*** **	-0.12 (-1.41)	0.07	none	14	9.5
without outliers		0.99	-0.11 (-1.95)	0.11	none	28	18.2
Social	1	0.83	-0.22 (-2.82)	0.13	none	20	10.0
without outliers		0.98	-0.12 (-2.18)	0.13	none	31	18.0
General	1	**0.86*** **	-0.17 (-2.57)	0.22	none	22	14.5
without outliers		0.98	**-0.17*** (-3.82)**	**0.27**	none	39	12.1
Justice	3	0.86	-0.16 (-2.09)	0.13	none	15	10.4
without outliers		0.99	**-0.17***(-3.28)**	**0.27**	none	35	20.3

Notes: ***:= 1% significance level; **:= 5% significance level; *:= 10% significance level; t tests: figures in parentheses are t-values; values at at least 5% level in bold; L0:= lag 0, etc.; cointegration test: critical values according to Banerjee et al. (1996) are applied; Shapiro-Wilk normality test: H0: Gaussian distribution, W test statistic; Box-Ljung test: H0: no autocorrelation of residuals, Box-Ljung statistic.

Table 3: Impact of fiscal variables and private investment on productivity growth

ECM - Bounds testing approach: OLS Regressions of GDP per worker on per capita government outlays in real terms; Period 1965-2005, all variables in logarithms

Fiscal Variables	Number of outliers: MM esti-mation	Norma-lity Test	Bounds test F-test	Bounds test t-test Adjust-ment speed	Impact Fiscal variable long term	Impact Fiscal variable short term	Impact Investment long term	Impact Investment short term	Adj. R^2 (%)	Box-Ljung Test
Education	3	**0.85*** **	4.22*	-2.71*	0.31	none	-0.08	**L0: 0.12*** (2.97)**	43	20.2
without outliers & lags 1 to 5, with leads		0.97	**6.72*****	-3.33* (ud**)	0.28	**L0: 0.19** (2.45)**	0.01	**L0: 0.06** (2.26)**	60	23.7*
Transport	1	**0.90*** **	**6.10****	**-3.73****	**0.53**	L1: -0.15* (-1.91) **L2: -0.19** (-2.67)** **L3: -0.12* (-2.01**)	**0.08**	**L0: 0.12*** (3.37)**	45	10.9
without outliers & lags 1 to 5		0.96	**8.36*****	**-4.05****	**0.45**	**L0: 0.08** (2.55)**	**0.10**	**L0: 0.08*** (0.02)**	48	20.8
Health	1	**0.85*** **	**5.14****	-2.90*	0.18	none	-0.08	**L0: 0.11** (2.55)**	32	10.3
without outliers		0.98	**5.08****	**-3.36****	**0.19**	none	**0.06**	**L0: 0.10*** (3.27)**	34	17.0
Social	3	**0.82*** **	2.64	-2.09	0.14	none	-0.05	**L0: 0.10** (2.68)**	33	8.6
without outliers & lags 1 to 5, with leads		0.97	**8.27*****	**-3.98****	**0.16**	**L0: 0.07** (2.50)**	**0.11**	**L0: 0.12*** (2.88)**	61	21.4
General	2	**0.90*** **	**5.92****	-2.92ud**	0.26	L0: 0.15* (1.93)	-0.16	**L0: 0.10*** (2.78)**	40	15.5
without outliers		0.97	**9.24*****	**-4.72*****	**0.31**	L0: 0.09* (1.78)	**0.08**	**L0: 0.09*** (3.77)**	54	21.8
Justice	1	**0.84*** **	4.07ud**	-2.41	0.20	none	-0.11	**L0: 0.09** (2.37)**	25	11.8
without outliers		0.97	**5.13****	**-3.65****	**0.29**	L0: 0.19* (1.98)	**0.03**	**L0: 0.08*** (3.45)**	41	20.7

Notes: see notes Table 2; "ud" behind the value of the F-test or the cointegration coefficient means that based on the bounds test no decision at the indicated decision level can be reached for the H0; cointegration test: critical F- and t-values according to bounds testing approach of Pesaran et al. (2001) are applied.

Table 4: Feedback effect of productivity growth on public expenditure

ECM: OLS Regressions of per capita government outlays on GDP per worker in real terms; Period 1960-2005, all variables in logarithms

Fiscal Variables	Number of Outliers MM esti-mation	Normality Test	Adjustment speed	Impact Labour productivity long term	 short term	Adj. R^2 (%)	Box-Ljung Test
Education	1	0.99	-0.06 (-0.98)	2.18	**L3: 0.56** (2.57)**	47	18.2
without outliers		0.98	**-0.18*** (-4.18)**	**2.93**	**L0: 0.96*** (3.54)** **L3: 0.80*** (3.01)**	67	12.3
Transport	1	0.98	-0.24 (-2.02)	1.25	none	-5	11.2
without outliers		0.97	-0.07 (-0.73)	1.76	L1: 0.65* (1.78)	-11	20.8
Health	none	0.97	-0.05 (-1.72)	3.26	none	30	13.0
without outliers		-----	-----	----	----	----	----
Social	3	0.97	-0.03 (-0.49)	-7.31	**L2: -1.66*** (-3.02)** L3: 1.04* (1.85)	31	9.9
without outliers		0.99	-0.06 (-1.19)	1.65	**L4: -1.14** (-2.65)**	15	8.6
General	6	0.96	-0.11 (-1.85)	2.73	none	-0.4	13.8
without outliers		0.97	-0.06 (-1.54)	0.09	none	20	7.5
Justice	1	0.99	-0.08 (-2.24)	1.73	none	14	8.1
without outliers		0.98	-0.07 (-2.24)	1.81	none	16	15.4

Notes: see Notes Table 2.

Appendix

Table A1: Robust correlation matrix of used variables 1960-2005 (except for investment)

Variable	Labour productivity	GDP per capita	Education	Transport	Investment 65-05
Labour productivity	1.00	0.85	0.82	0.75	-0.15
GDP per capita	0.85	1.00	0.95	0.77	-0.01
Education	0.82	0.95	1.00	0.88	-0.25
Transport	0.75	0.77	0.88	1.00	-0.45
Social	0.83	0.97	0.99	0.84	-0.24
Health	0.78	0.91	0.96	0.88	-0.40
General	0.78	0.96	0.98	0.86	-0.22
Justice	0.80	0.97	0.99	0.83	-0.22
Investment 65-05	-0.15	-0.01	-0.25	-0.45	1.00

Table A1 *continued*

Variable	Social	Health	General	Justice
Labour productivity	0.83	0.78	0.78	0.80
GDP per capita	0.97	0.91	0.96	0.97
Education	0.99	0.96	0.98	0.99
Transport	0.84	0.88	0.86	0.83
Social	1.00	0.96	0.98	0.99
Health	0.96	1.00	0.96	0.97
General	0.98	0.96	1.00	0.99
Justice	0.99	0.97	0.99	1.00
Investment 65-05	-0.24	-0.40	-0.22	-0.22

Table A2: No cointegration between government expenditure and private investment

ECM: OLS Regressions of private investments in real per capita terms on public expenditure in real per capita terms; Period 1965-2005		
Fiscal variable	Adjustment speed	Box-Ljung Test
Education	-0.16 (-1.65)	15.1
Transport	-0.17 (-2.00)	15.1
Health	-0.06 (-0.67)	16.1
Social	-0.10 (-1.23)	12.4
General	-0.22 (-2.56)	18.7
Justice	-0.15 (-1.51)	14.6

Notes: see notes Table 2.

Table A3: Impact of fiscal variables and private investment on productivity growth

ECM - Bounds testing approach: OLS Regressions of GDP per worker on per capita government outlays in real terms; Period 1965-2005, all variables in logarithms

Fiscal Variables (without outliers)	Norma -lity Test	Bounds test		Impact Fiscal variable		Impact Investment		Adj. R^2 (%)	Box-Ljung Test
		F-test	t-test Adjust-ment speed	long term	short term	long term	short term		
Education	0.96	3.25ud*	-2.91ud*	0.31	**L0: 0.24** (2.62)**	0.02	**L0: 0.08** (2.72)**	48	**39.3*** **
Transportation	0.98	3.31	-2.46	0.46	**L0: 0.09** (2.42)**	0.10	**L0: 0.07*** (2.85)**	41	20.4
Social	0.84	2.10	-2.40	0.16	none	0.14	**L0: 0.11*** (4.34)**	51	**27.9** **

Notes: see notes Table 3.

Data and software

Fiscal data are taken from Swiss Public Finance Statistics 2007 of the Swiss Federal Finance Administration, whereas GDP data come from Swiss National Accounts 2007 and population data come from Swiss Population Statistics 2007 of the Swiss Federal Statistic Office. For all estimations the open source statistical software R (version 2.3.0) is used (see http://stat.ethz.ch/CRAN/welcome.html).