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2003

***document version***
Publisher's PDF, also known as Version of record

TI 2002-028/3
Tinbergen Institute Discussion Paper

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Version March 2003

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# Meta-analysis of the impact of fiscal policies on long-run growth

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**Abstract**

The issue of whether the public sector enhances or retards long-run economic growth has been debated passionately in recent years. We use meta-analysis to shed light on the issue. A sample of 93 published studies, yielding 123 meta-observations, is used to examine the robustness of the evidence regarding the impact of fiscal policy on growth. Five fiscal policy areas are considered: general government consumption, tax rates, education expenditure, defence, and public infrastructure. Several meta-analytical techniques are applied, including descriptive statistics, contingency table analysis and rough set analysis. On balance, the evidence for a positive impact of conventional fiscal policy on growth is rather weak, but the commonly identified importance of education and infrastructure is confirmed. The results are sensitive to several research design parameters, such as the type of data, model specification and econometric technique. The top two tiers of journals appear less supportive of the conventional priors with respect to government and growth than lesser-ranked journals.

*JEL classification:* C49, E62, H50, O23, O57
*Keywords:* Endogenous growth; Fiscal policy; Meta-analysis; Rough set analysis

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## 1. Introduction

A popular research topic during the last two decades has been the question whether government policies enhance or retard long-run economic growth. However, given the many ways in which government policies can influence the economy, it is perhaps not surprising that no consensus has been reached on the issue. The commonly-held view that there are few robust generalizations possible on this issue led *The Economist* to proclaim in a 1999 commentary: "What is the main thing governments must do to spur economic growth? Ah, well, that remains a mystery" (March 6th, p. 84).

A natural question to ask is whether this uncertainty prevails equally across all areas of government policy and, more specifically, across areas of conventional fiscal policy. Research on this question took off since the emergence of the endogenous growth models, for which the by now classic contributions of Romer (1986) and Lucas (1988) provided the initial impetus and the textbooks by Barro and Sala-i-Martin (1995) and Aghion and Howitt (1998) are the evidence of the maturity of the field by the second half of the 1990s.

The theoretical literature on endogenous growth has generated plenty of testable hypotheses on the impact of fiscal policies on long-run growth (see e.g. Klenow and Rodriguez-Clare 1997 and Agell et al. 1997 for surveys). Empirically, the hypotheses are commonly tested by means of cross-country growth regressions, but the results are often inconclusive or at least debatable. A good example is the debate between Fölster and Henrekson (1999) and Agell et al. (1999). Fölster and Henrekson find evidence that – when estimated correctly by their criteria – the relationship between public expenditure and growth is negative. However, Agell et al. argue that these results are econometrically flawed (e.g. due to incorrect instrumentation to control for endogeneity and simultaneity) and that the growth effect of the public sector is in fact statistically insignificant. Yet Fölster and Henrekson (2001) concluded more recently by means of the extreme bounds criterion in regression analysis that government size and growth were inversely related in a panel study of a sample of rich countries.

Rather than undertaking yet another panel data study of cross-country growth differentials we take a different approach in this paper. While there are clearly limitations in the use of cross-country growth regressions to inform on the issue (see also Temple 1999), we believe that a large sample of such empirical studies that test the same hypothesis cannot be disregarded altogether. We use meta-analysis to assess whether variations in results are due e.g. to differences in the data, the number of observations, or different specifications. Moreover, by contrasting the results of cross-section growth regressions with alternative approaches (such as time series analysis and CGE modelling) it is also possible to assess whether the conclusions are sensitive to the adopted methodology.

The paper does not aim to provide a broad literature survey on the role of government policies in the process of economic development, as many such surveys already exist (for example, Slemrod 1995, Agell et al. 1997, Glomm and Ravikumar 1997, Temple 1999, Tanzi and Schuknecht 2000, Easterly and Levine 2001). Instead, in meta-analysis a sample of empirical studies on a specific issue is codified and subsequently analysed by means of statistical techniques. Meta-analysis has a long tradition in medicine and the experimental behavioural sciences, but has in recent years gained in popularity in economics. Using *EconLit* and other sources, we estimate that, by the end of 2002, about 100 applications of meta-analysis in

economics had been published. Stanley (2001) argues that while the methodology is by no means flawless, it provides a more systematic and objective assessment of an existing body of findings than a traditional narrative literature survey.

Section 2 describes the data set to which meta-analysis is applied in the present paper. Five fiscal policy areas are distinguished (viz. general government consumption, tax rates, education expenditure, defence and public infrastructure). A sample of 93 refereed articles was drawn from the large number of published and unpublished papers that have been produced by the scientific community. Because many studies inform on more than one policy issue, the sample yielded 123 distinct observations. Because the sample encompasses a wide range of alternative approaches, it is in the present context not possible to measure the effect of policy by means of a single elasticity, partial correlation coefficient or some other statistical measures of association. Researchers often conduct a type of sensitivity analysis by assessing the consequences of varying their model specification in a number of ways. The personal assessment of article author(s) as to the general conclusion that can be drawn from such sensitivity analysis determined our categorisation of the study findings in a "conclusively positive effect", a "conclusively negative effect" or an "inconclusive result".

Various meta-analytic approaches were deployed to examine the robustness of the empirical evidence. In Section 3, a conventional statistical approach is taken. The findings regarding the impact of fiscal policy on growth are compared by means of relative frequency counts and related statistics. We find broad support for the view that the empirical evidence on the impact of conventional fiscal policies is rather fragile, although the commonly identified importance of education and infrastructure is confirmed. The results of conventional growth regressions appear more fragile than those of other methodologies, and articles in the highly ranked journals are less likely to proclaim the importance of fiscal policy for growth than those in the lesser-ranked journals.

The use of standard statistical techniques imposes certain assumptions that may be inappropriate in the present context. For example, we interpret the proportion of studies in our sample that draws a certain conclusion as informative about the population of published and unpublished studies. Although we believe that our sample is broadly representative of the studies that have been carried out during the last two decades, our meta-analytic sample was not randomly selected. It is therefore useful to also consider an alternative approach. The alternative approach adopted in this paper is rough set analysis, which is essentially a non-stochastic classification technique (see Pawlak 1992 and Slowinski 1995). The technique is briefly described in Section 4, while Section 5 reports on the application of rough set analysis to our sample of 123 growth studies. We find that rough set analysis broadly reinforces the earlier findings, but also provides some additional insights. The paper concludes with some remarks on policy perspectives and research methodology.

## 2. The sample of growth studies

The relationship between government and growth cannot be studied properly without a formal theoretical framework, suitable cross-section and/or time series data and appropriate econometric methods. Empirical research in this area has actually been a relatively recent phenomenon. Landau (1986) noted, "There are virtually no empirical

studies of the general impact of government on economic growth. An extensive literature search turned up only three papers" (p.35). However, since the mid 1980s there have been many empirical analyses of the relationship between government and growth, either as a by-product of tests of conditional convergence of per capita income among countries or regions, or to address the issue explicitly.

Before a meta-analysis can be carried out, a selection must be made from the available empirical literature. There are two important issues in this respect, namely *coverage* and *precision*. Coverage is defined as the extent to which the retrieved documents are representative of the population of published and unpublished literature. Precision is the defined as the extent to which the retrieved documents provide high quality information on the issue at hand. Unfortunately, coverage and precision tend to vary inversely (White 1994).

Hence, in this paper we are attempting to strike a balance between coverage and precision as defined above. We use 93 refereed journal articles published between 1983 and 1998 that were reviewed in a literature survey of empirical research on the impact of government on growth (Poot 2000). As mentioned above, Landau (1986) found that the pre-1983 literature on this topic was rather limited. Figure 1 clearly demonstrates that the 1983-1998 period is largely representative of this literature. Since the end of the 1990s, the number of relevant documents has dropped noticeably.[1] While our choice of sample has obviously excluded some recent journal articles, we are not convinced that this has affected our results. As will be shown later, splitting our selected sample into two different time periods did not yield any noticeable differences in the distribution of conclusions.

FIGURE 1 ABOUT HERE

Apart from Barro's (1997) well-known book on the determinants of economic growth and a chapter by Dunne (1996) from Gleditsch et al.'s edited volume on the 'peace dividend', all publications in the sample consisted of refereed journal articles. While we readily accept that peer review is an imperfect form of quality control, the publication outlet can provide a signal about the quality of the research document and we categorize journals into broad classes that resulted from citation analyses.

The selected articles were primarily retrieved by means of search in the *EconLit* electronic database. References of retrieved articles were scanned for additional useful references. How representative is our sample relative to the available literature? This can be gauged from Table 1. "Pure theory" articles were excluded, as were those that were hard to retrieve. The latter included articles published in languages other than English. Table 1 shows that our sample covers most of the relevant articles published over this period, with the possible exception of some studies on taxation and education.[2] The list of articles used is given in part (a) of the references.

TABLE 1 ABOUT HERE

[1] The high level of research documents on government and growth in recent years is actually exaggerated by the presence of a number of publication outlets (paper series and journals) that are now captured by *EconLit*, but were not included before the mid 1990s.

[2] Among studies not in the sample we could mention Stokey and Rebelo's (1995) study, which concluded that tax reform would have little impact on the U.S. growth rate, and Jones (1995) who rejected the endogenous growth model (and the role of policy) for the reason that U.S. growth rates exhibit no large persistent changes.

The desirability of including post-1998 publications remains an open question, but we are confident that our sample is sufficiently large on most issues such that additional observations are unlikely to affect the results. Once again, taxation may be the exception. We analyse relatively few, namely ten, studies on the impact of tax rates and there have been a number of recent empirical studies on this topic. For example, Padovano and Galli (2001, 2002) and Widmalm (2001) show that marginal tax rates and tax progressivity have a negative effect on growth, although Myles (2000) maintains in a survey that the tax effect on growth is very weak. A deeper investigation into the implications of (marginal) tax rates and the tax structure on growth deserves a separate paper.

Table 2 contains coded information derived from each of the studies. Because the table provides the basic information for the rough set analysis discussed in Sections 4 and 5, the terminology of this technique is used to describe the information in Table 2. Each individual empirical analysis is referred to as an *object* (i.e. observation) and the features of the studies that are reported in Table 2 are referred to as *attributes* (A1 to A9). The conclusion is referred to as the *decision variable* (D1). Because several growth studies considered more than one policy area, or used more than one data set, the 93 articles yielded 123 observations.

TABLE 2 ABOUT HERE

As noted in the introduction, five fiscal policy areas are considered: general government consumption in relation to overall GDP (also referred to as government size[3]), defence spending, taxation policy, investment in public infrastructure, and education expenditure. These are coded as values 1 to 5 respectively of study attribute A1. Quantitative research characteristics that are included in Table 2 are the following variables: the year of publication (A2), the number of observations (A4)[4], the year of the earliest observation (A5) and the year of the most recent observation (A6). The qualitative (categorical) variables included in the table are: the spatial level of the data - country or region - (A3), the level of development (A7), the method of research (A8) and the ranking of the journal in which the results were published (A9).

Before a detailed analysis of the data is undertaken in the next section, it is useful to point out some general features of this body of research. Descriptive statistics are reported in Table 3.

Firstly, a vast majority of studies (88.6 percent) used regression models. Thirty-five of the 123 observations (28.5 percent) relied on cross-section data, but there has been an increasing use of panel data that pool time series across a number of countries or regions, as the availability of such data gradually improved. Forty-six studies (37.4 percent) used panel data. This is a welcome trend, as the panel data studies tend to show that location (country, region) and period fixed effects are important.

[3] It is not always clear from the articles whether public transfers are included in the measure of government size. However, as far as could be ascertained, only one tenth of the 41 studies concerned with government size used gross expenditure including transfers rather than government consumption. See also Section 4.

[4] In the case of panel data, the recorded number of observations is the maximum feasible given the number of cross-sectional units and time periods. The regressions that were reported in the articles may have used fewer observations, as researchers often take sub samples of cross-sectional units or time periods as a form of sensitivity analysis.

The pooled data sets have naturally the largest number of observations. The largest data set, with 3304 observations, consisted of pooled time series from 1870 to 1988 for 28 countries (Easterly and Rebelo 1993). At the other extreme, Lin (1994) used a cross section of only 20 developed countries in a study of government size and growth, while Sanchez-Robles (1998) used a cross section of 19 Latin American countries in a study of the impact of public capital. The shortest time-series analysis was based on 17 annual observations (1974-1990) on military spending in Greece (Chletsos and Kollias 1995). The average number of observations is 389.

TABLE 3 ABOUT HERE

Of the regression models with cross-sectional or panel data, 52.0 percent can be referred to as conventional growth regressions, i.e. linear regression models with the growth in real national output or income (per capita) as the dependent variable and some measure of government policy on the right hand side. The size and statistical significance of the coefficient on the policy variable is likely to depend on the adopted model specification. A wide variety of specifications can be found in the literature, but there are some commonalities. Most growth studies accounted for population or labour force growth (93.8 percent in the sample). The effect of population growth on growth in GDP per capita tended to be negative in some studies, but this finding is rather fragile (Levine and Renelt 1992). Many studies (81.3 percent) controlled for capital accumulation by including the rate of investment or savings. Levine and Renelt (1992) argue that the positive correlation between growth and the share of investment in GDP is one of the few robust findings from the cross-country growth regressions literature.

Another robust finding from this literature is the importance of initial income: controlling for other variables, high income countries grow slower than low income countries, which is referred to as conditional convergence. However, the appropriate way in which to test for convergence with cross-sectional and panel data growth regressions, and the findings of such studies, remain controversial (see e.g. Evans and Karras 1996; Quah 1996). In our sample, just over half (56.3 percent) of growth regression-type studies included an initial income variable. The effect of this specification choice on the policy impact will be investigated in Section 3.

Many of the cross-section and panel regression models calculated the coefficients by means of ordinary least squares (OLS). In the cross-section models, two thirds were estimated by OLS. While authors appeared sometimes aware of potential econometric problems, this was not always pursued further by the appropriate diagnostic tests. One sixth of the cross-section studies corrected for heteroscedasticity.

An important issue in this context is the potential endogeneity of government consumption due to the fact that the demand for public services is likely to be income elastic. This is referred to in the literature as Wagner's Law, based on the 19$^{th}$ theory of public finance by Wagner (1883, 1890). This law, combined with the price-inelastic demand for public services is responsible for the growth in the share of government expenditure in relation to GDP (also referred to as the "size" of government) that has been commonly observed among developed economies during the post-war period. As productivity growth has tended to decline at the same time, an inverse correlation between government size and growth emerges that may have been interpreted by researchers as evidence of causation running from government size to

economic growth. Wagner's Law may apply at the sub-national level too (Gerking and Morgan 1998).

In the regressions with cross-sectional data, endogeneity of the government variable(s) is controlled for by means of instrumental variable estimation and other simultaneous equation estimators in one sixth of the studies. In the panel models, the endogeneity/simultaneity problem was addressed in a larger proportion of studies, namely about one third. Some authors using OLS justified their choice by noting that system estimators made little difference in parameter estimates.

Among the 28 time-series studies (22.8 percent), the use of OLS was much less frequent (one-seventh of studies) and control for the commonly encountered autoregressive errors by means of the standard Cochrane-Orcutt method was often observed. Endogeneity of government activity was corrected for by means of a system estimator, or alternatively there was a growing use of Granger causality tests (Chowdhury 1991, Kusi 1994, Ansari and Singh 1997, Kollias and Makrydakis 1997). The cointegration framework also became increasingly popular. Examples included in the sample are Bajo-Rubio and Sosvilla-Rivero (1993) and Lau and Sin (1997), but see also, e.g., Anwar et al. (1996).

Only 14 studies (11.4 percent) that satisfied the selection criteria adopted other, less conventional, methods. For example, two studies used a calibration/simulation approach (van Sinderen 1993, Berthélemy et al. 1995). Within our sample period, relatively few studies in the literature adopted a computable general equilibrium (CGE) model approach to investigate the impact of government on *long-run* growth (as compared with the impact on sectoral allocation and welfare in the short run). None were included in our sample, but an example of a dynamic CGE model of the impact of infrastructure on growth is Kim (1998).

An additional weakness of many past regression studies is that these purport to provide information on long-run growth, but use only observations over a relative short time span of 5 to 10 years.[5] The mean time span in the sample is 28 years. It is possible that public infrastructure does raise the (local) long-run growth rate, *ceteris paribus*, but that the effect only emerges very gradually over time, e.g. because of a complementarity with certain types of private capital that may, for various reasons, only be undertaken at a slow rate. In this case it may be very hard to detect the effect of an additional amount of public investment compared with the (unobservable) counterfactual. There is indeed some evidence that an increase in the time span increases the likelihood that a study shows up a significant effect of infrastructure on growth.[6]

In their influential paper, Levine and Renelt (1992) use Extreme Bounds Analysis (EBA) to show that many of the results from cross-section regression analyses of the determinants of long-run growth are not robust. However, their conclusion does not appear to have discouraged others from continuing to carry out regression analyses, although time series and panel data analyses have become far more prominent in recent years. Indeed, Sala-i-Martin (1997) argued that the EBA criterion of fragility is too strict to be of any use. Assessing instead the robustness of a variable by the probability that the coefficient is on one side of zero in the cumulative distribution function of the regressions that include this variable, Sala-i-Martin found that 22 out of 59 possible determinants of growth were "significant". Interestingly, no measure of

[5] See Bleaney et al. (2001) for a recent study attempting to separate short-run and long-run effects.

[6] In a logit model of the impact of infrastructure (positive or not) on growth with 39 observations, the variable "time span" is significant at the 10 percent level.

government spending (including investment) was among these 22 variables. Moreover, Evans (1996) found by means of very long-run data (1870-1989) for thirteen countries, that there was much evidence that these countries convert to a common trend, i.e. that policies and other shocks influence the growth rate only temporarily.

Researchers in this field face the dilemma that the widest range of variables and the longest time series are available for developed economies. Consequently, it is not clear that the results of many of the published paper that use the most innovative approaches with data of the best quality can be readily transferred to the case of developing countries (see also Brock and Durlauf 2001). Thus, the available findings may inform policy in developing economies only to a limited extent. Only 22.8 percent of our 123 study objects are empirical analyses of developing countries, 28.5 percent relate to mixed samples of economies and nearly half (48.8 percent) to developed economies (G7 or OECD).

With respect to the publication outlet, four categories are defined. These are based on the Towe and Wright (1995) classification. These authors distinguish four groups: the top 12 journals in terms of citations, a second-ranked group of 23 journals, a third-ranked group of 36 journals and a fourth group of all other journals (see Table 3). The relative frequencies of these journals in our sample of articles are 17.1 percent, 16.3 percent, 24.4 percent and 42.3 percent respectively.

Virtually all studies of government and growth are *primary* analyses (Glass 1976). Each study has rather unique features in terms of the specification of the model, the sample of countries or regions considered, the time period of observation and the range and definitions of the variables used. Few authors have carried out replications or extensions of earlier research by means of the same data (so-called *secondary* analysis). The two cases in our sample are Eisner (1991) and Mohammed (1993). *Tertiary analysis* in the form of a survey is more common. Among the articles included in our sample, there is only one example of *meta-regression* analysis, a study by Button (1998) on infrastructure and growth. In meta-regression analysis, a set of parameter estimates is obtained from a range of studies and the variation in these estimates is decomposed in a part due to sampling variability or unknown factors, and a part that can be explained by characteristics of each of the studies.

A final feature of our sample of publications is that most of the studies on the relationship between government and growth focused on government at the national level (82.1 percent) and consequently used country data. Only 17.9 percent of the studies use regions as the spatial unit of observation. However, the studies that used regional data do not appear to “stand out”. The rough set analysis discussed in Section 5 shows that regional studies do not produce results that differ systematically from the patterns of results from national-level studies.

In what follows it will be often useful to aggregate the different types of fiscal policy. For this purpose we define the conventional prior belief regarding the impact of fiscal policy on growth as the hypothesis that increases in government consumption, defence, or increases in tax rates, lower growth; while increases in government expenditure on education or infrastructure enhance growth. Of the 123 observations listed in Table 2, 55.3 percent of studies provide support for this conventional prior, while only 8.9 percent reject this prior. However, 35.8 percent of the published case studies declared the overall result of their statistical endeavour to be inconclusive. This is quite a high percentage given that our sample undoubtedly suffers from *file drawer bias* or *publication bias* in that significant findings are likely

to be more prominent in our sample than in the excluded papers (Begg 1994). However, the ultimate objective of our exercise is to assess the relative difference in robustness of the findings *across* different areas of government fiscal activity and it is not clear that publication bias would systematically differ across these different areas. Yet on balance, the evidence for the conventionally expected impact of policy on growth is rather weak. In the remainder of this paper we use meta-analytic techniques to examine links between the overall conclusions and the features of the studies.

## 3. Meta-analysis of the sample of growth studies

Meta-analysis is a quantitative tool for comparative research. A well-established set of techniques for meta-analysis is now available in the medical and natural sciences, which can be helpful in the comparative analysis of (semi-) controlled experiments. Overviews can be found in, for example, Hedges and Olkin (1985) and Cooper and Hedges (1994). However, controlled experiments are often impossible, or at least rare, in the social sciences and the need for establishing robust findings from widely varying types of data and theoretical models is great. Increasingly, meta-analytic techniques are being developed or modified for use in the social sciences.

The use of these techniques in economics is still rather less common than in other social sciences, but applications can already be found in a range of fields. These include: macroeconomics (Stanley 1998), industrial organisation (Djankov and Murrell 2002), innovation and productivity (Görg and Strobl 2001), environmental economics (van den Bergh et al. 1997), transportation (Nijkamp and Pepping 1998), agriculture (Nijkamp and Vindigni 2000), tourism (Baaijens et al. 1998) and labour markets (Card and Krueger 1995, Ashenfelter et al. 1999). We will now proceed with putting our sample of 123 case studies (based on 93 published articles) on government and growth "under the metascope".

The most commonly studied issue regarding the impact of fiscal policy on growth is the effect of overall government "size". Our sample contains 41 studies that reported empirical evidence regarding this issue (see Table 3(viii)). The vast majority (about 90 percent) of these studies measured government size by means of government consumption as a percentage of GDP. Many country studies used national accounts data that have been made comparable internationally by means of the Penn World Table project (see e.g. Summers and Heston 1991). Only one tenth of studies in the sample measured government size by means of gross expenditure, i.e. including public financial *transfers* (social security payments and subsidies).

Net and gross measures of expenditure may be expected to have quite different impacts on growth, although the sample of studies using the latter measure was too small to test this formally in the meta-analysis. With respect to public consumption and transfers, there are a number of forces at work that may have opposite effects on the macro relationship between government and growth. On the one hand, generous social security benefits may reduce growth through their effect on labour supply, or through the distortionary taxes required to fund the transfers (see, e.g., de Groot 2000). On the other hand, social security may have a positive effect on growth through enhancing human capital formation (see, e.g., Bellettini and Ceroni 2000 for recent evidence). Moreover, inequality appears to be bad for growth (e.g. Deininger

and Squire 1998 and Persson and Tabellini 1994), so that some redistribution of wealth may be growth enhancing.[7]

With respect to government consumption of resources, the *composition* of this claim on resources may be more important than the level. For example, public expenditure on education, R&D and health care are forms of capital accumulation rather than current consumption and therefore sources of growth, but current consumption expenditures that ensure the right institutional environment (in terms of property rights and safety) may also be growth enhancing (e.g. Barro 1997). Moreover, public funds allocated to environmental policy may also benefit growth in the long run (e.g. Bovenberg and Smulders 1996).

At the same time, it has been increasingly recognized in growth studies that the way in expenditures are financed matters too. For example, Kneller et al. (1999) define a range of taxation and expenditure variables and explicitly take account of the budget constraint. By means of a panel of 22 OECD countries, 1970-95, they find – firstly – that distortionary taxation reduces growth, while not-distortionary taxation does not, while – secondly – productive government expenditure enhances growth, but non-productive expenditure does not.

Among our sample of studies, 29 percent of the 41 studies concluded that "big government" appeared to be detrimental to growth, as compared with 17 percent of studies that concluded that an increase in government size had a positive impact on growth. Consequently, more than one half of the studies were inconclusive. These, and other, statistics can be found in Table 3(viii) in the row labelled "Government consumption or "size"". The degree of uncertainty regarding the conclusions of studies on government size and growth can also be expressed in a statistical way. Consider an inverse relationship between general government expenditure and growth as the null hypothesis and assume that the sample used here is representative of the population of research projects on this topic. It is then easily calculated that the 95 percent confidence interval for the proportion of studies that support the null hypothesis is (0.15, 0.43). This interval lies far away from unity. Consequently, we conclude by means of our sample that the relative distribution of economic activity between the private and public sectors across countries and regions appears to have no clear impact on long-run growth at the macro level.

Is the likelihood that a study supports the null hypothesis affected by study characteristics? Since the study conclusion is a discrete variable, a logit model was applied to the data for each of three available quantitative study characteristics. These are: the number of individual observations in the study (cross-section observations times number of points in time), the time span (most recent year present in the data set minus the earliest year plus one) and the actual year of publication of the study. Because of the limited number of observations, the logit regression was simply intended to yield a rough measure of correlation. However, the effect of the quantitative study characteristics turned out to be insignificant in all cases.

With respect to qualitative features of the studies, we simply compared the observed proportions of studies that supported the null hypothesis when the study attribute took on a particular level. Here we might consider an effect to be important when the proportion of studies that support the null hypothesis changes markedly.

[7] Recent evidence by Forbes (2000), who finds that an increase in inequality has a positive correlation with subsequent economic growth, contradicts this conclusion. However, the effect of inequality may be hard to disentangle from other influences on growth at the macro level (Ravallion 1998).

Four study attributes are distinguished. They are: the spatial level of the data, the level of development, the methodology used and the ranking of the journal in which the results were published.

With respect to government consumption, we found that the likelihood that a study concluded that "big government" is detrimental for growth was less in studies of developed economies, but greater in cross-section studies. The higher probability of a negative government size and growth relationship in cross-section studies is particularly interesting. Gwartney et al. (1998) found that during the second half of the 20th century there had been a concurrent trend of an increasing government share in GDP and declining economic growth, at least among developed economies. Consequently, cross-sections of countries at different stages of development are likely to reveal an inverse correlation between government size and growth, which may be interpreted as a causal effect from government on growth. However, this causality issue cannot be addressed without panel data and the proportion of studies that accept the null hypothesis was indeed lower with the latter type of data (because it was higher than average for cross-section studies). There were no discernible effects of the use of national versus regional data. We will discuss the link with journal status later.

An extensively studied topic is the impact of defence expenditure on growth. The process of (nuclear) disarmament, the break-up of the Soviet-Union and the emerging new global order have provided a new impetus for research on the relationship between defence spending and growth. The central question is whether the end of the arms race generated a so-called *peace dividend* in the form of higher economic growth, particularly in developing countries (see also Gleditsch et al. 1996). However, the balance of the evidence of the 21 studies for which statistics are reported in Table 3 is rather inconclusive. While only one study suggested that defence spending benefits economic growth (Brumm 1997), 11 studies (52 percent) concluded that it is detrimental to growth. Table 3(viii) shows that the 95 percent confidence interval for the probability that a randomly selected study suggests a negative impact of greater defence spending is between 0.30 and 0.74.

An interesting finding with respect to studies on defence spending is that the conclusion appeared to be related to the year of publication. More recent studies were less supportive of a peace dividend than earlier ones. In contrast, the proportion of studies supporting the peace dividend was greater among studies of developed economies and in cross-section studies (in both cases 66 percent rather than 52 percent).

Over our sample period 1983-98, studies of tax effects were rather less common than studies of expenditure effects on growth (see Table 1). However, quite a lot of research has been done on the impact of state and local taxes on economic growth in the United States. Bartik (1991) surveyed more than 80 econometric studies on this topic completed since 1979. Bartik's literature survey provided the data for a meta-analysis by Phillips and Goss (1995). They found that taxes had a modest growth-reducing effect on US interstate or intermetro areas, but a much more pronounced detrimental effect within metro areas. However, most modelling differences encountered across studies did not affect the estimated tax elasticity.

Among the 10 tax studies in our sample, there were no studies that found that higher tax rates were associated with higher economic growth. Instead, there appears to be empirical support for the hypothesis that higher taxes lower growth (with an overall 60 percent probability) and inspection of the individual cases shows that this is

particularly true for studies that focus on *marginal* rather than *average* tax rates. However, the small sample size leads to a wide interval of (0.26, 0.89) for the proportion of studies supporting the null hypothesis and indicates that this conclusion must remain rather tentative. As noted earlier, this is one area where further empirical research and meta-analysis are desirable.

The next type of fiscal policy to be considered is public infrastructure. The sample included 39 observations on this topic. There are broadly two types of studies with respect to infrastructure. The first type, which is the more common, compares the productivity of the stock of public capital such as roads, dams, airports etc. with the productivity of private capital. The often-cited articles by Aschauer (1989a, 1989b and 1989c) provided a major boost to research in this area. The estimated coefficients of public capital in the production function provide then the means through which the effect of growth in public capital on growth in output can be calculated.[8] The second approach is to consider directly the impact of the flow of current government expenditures on infrastructure in growth regressions. With either approach, the evidence is relatively strongly supportive of a positive impact of public infrastructure on growth. In total, about 72 percent of the studies on the relationship between infrastructure and growth suggested a positive impact, while about one fifth was inconclusive. After research on the impact of education expenditure discussed below, this is the relatively most conclusive body of research.

However, it is also hard to make firm quantitative generalisations here. Button's (1998) meta-analysis reports a range of output elasticities of between 0.03 and 0.39. These elasticities appear to be related to the level of geographic aggregation. The output elasticity of public capital becomes less, the smaller the geographical area that acts as the unit of observation. The most obvious reason for this is that due to leakages, small regions cannot capture the full payoff to infrastructure investment. Moreover, the rest of the economy may reap any dynamic spillover effects. Indeed, we found in our sample that studies with national data were more likely than regional studies to identify benefits from infrastructure.

The importance of considering a long time span to assess the impact of infrastructure was confirmed by the statistical significance at the 10 percent level of "time span of observations" in a simple logit model for the probability that a study supported the hypothesis of a positive impact.[9] However, articles in unranked journals were much more optimistic about growth benefits from infrastructure than articles in the 71 ranked journals.

Statistics on the impact of education expenditure can be found in the top row of Table 3(viii). Initially, an attempt was made to consider also *health* expenditure. However, the impact of health expenditure on growth and productivity of the work force appears to be a rather neglected area.[10]

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[8] However, Flores de Frutos et al. (1998) argued that a dynamic multivariate framework is essential to identify the positive long-term effects of public investment on the private sector and proceeded to use a VARMA model to demonstrate that public investment had positive long-run effects in the Spanish economy.

[9] The mean time span of the time series (most recent year of observation minus earliest year plus one) is about 30 years. An estimated elasticity of 0.42 suggests that a one-year increase in the time span of the study increases the probability that a study finds significant benefits from infrastructure by 1.4 percent.

[10] Only one study in our sample, Singh and Weber (1997) considered both health and education expenditure. A recent empirical study by Webber (2002) concludes that policies to increase economic growth should favor investments in education over health.

All but one of the 12 studies included in our sample provided support for the hypothesis that education has a positive impact on growth. The only empirical study to cast doubt on the role of education in long-run growth is Levine and Renelt (1992) but, as noted earlier, their test of statistical significance may have been too strict. Nonetheless, even though most empirical research appears to confirm the theoretical prediction that human capital accumulation is central to the growth process, it is very hard to derive a *quantitative* generalisation of the impact of education. Growth studies use a wide range of statistical proxies to measure the level of education of the work force or actual educational expenditure by government (see Poot 2000 for some examples). The effect of education quality (e.g. as measured by internationally comparable test scores) is likely to be more important than school attainment per se (see Barro 2001).

Some further insights can be obtained by pooling the data on the different types of fiscal policy. Table 4 shows how "support for the conventional prior" and "inconclusiveness" are in some cases related to study characteristics. Recent studies are slightly less conclusive on the issue than earlier ones (54.4 and 56.1 percent respectively), but the difference is not statistically significant. However, the "message" does vary with the ranking of the journal. Top journals (the top two tiers) are less likely to support the conventional prior (46.3 and 59.8 percent respectively) and the difference is statistically significant if we take, given the small and heterogeneous sample of studies, a p-value of 0.2 as the cut-off for significance. An even greater difference occurs with respect to the adopted methodology: conventional growth regressions are less likely to support the hypothesis that increases in government size, defence and tax rates decrease growth, while education and infrastructure increase it. Conventional growth regressions are a less efficient means of detecting the impact of government on growth than alternative approaches (e.g. time-series, general equilibrium and micro-level studies).

TABLE 4 ABOUT HERE

However, the results do not differ much between cross-section and panel data growth regressions. Panel data appear less likely to find inconclusive effects, although the difference is not statistically significant. Finally, there is some support for the view that the absence of initial income on the right hand side of the growth regression may be a form of specification error with respect to testing the effect of fiscal policy on growth. Among the studies that exclude initial income from the specification, 35.7 percent supported the conventional prior, as compared with 52.8 percent of studies that include the variable. Since income level is correlated with government consumption (Wagner's law), the absence of the former in the growth regression would bias the coefficient on the latter.

Given the relatively small sample of observations on each type of study on fiscal policy and growth, and the qualitative nature of much of the data, there is a limit to the extent to which standard statistical techniques can be adopted. In this case, rough set analysis is an attractive alternative method of detecting patterns in the data. The next section outlines the key ideas of rough set analysis. Some findings of rough set analysis applied to our information table of 123 objects are given in Section 5.

## 4. Introduction to rough set analysis

Much of the available information in comparative research on government and growth is of a qualitative, linguistic or categorical nature, so that standard statistical techniques are less suitable for a synthesis. Besides the results discussed in the previous section, we have therefore also adopted a method for qualitative classification that is based on rough set theory. Pawlak (1982) laid the foundations for this theory. Details of theory and applications can be found in Pawlak (1992), Slowinski (1995), van den Bergh et al. (1997) and Nijkamp and Pepping (1998).

A *rough set* is a set for which it is uncertain in advance which objects belong precisely to that set, although it is in principle possible to identify all objects that may belong to the set at hand. Rough set analysis operates on a finite set of objects for which some information is available in terms of factual (qualitative or numerical) knowledge on a class of attributes (features, characteristics). Let this set of all available objects be called *U*. The information on the elements of *U* is stored in a categorical data matrix, called the *information matrix*, in which qualitative information on attributes or performance values of case studies (objects) is systematically represented in a coded form. The information matrix for our sample has the same format as Table 2, except that quantitative attributes *A*2 (year of publication), *A*4 (number of observations), *A*5 (year of earliest observation) and *A*6 (year of most recent observation) are transformed into categorical variables with a limited number of levels only. The set of all attributes will be referred to as the set *Q*.

These attributes may be used to define *equivalence* relationships for these objects, so that the researcher can classify objects into distinct equivalence classes. For any given set of attributes, objects that have the same values of *all* attributes under consideration are called *indiscernible*. Hence we can partition the information table into subsets of indiscernible objects. These are called *elementary sets*. Clearly, the more attributes we take into account, the larger the number of elementary sets. If we take *all* available attributes into account, and the elementary sets are identical to the objects (i.e. all case studies yield a unique combination of attributes), the objects are referred to as *atoms*. The classification of objects as given by the elementary sets is the most precise classification possible on the basis of the available information.

The key idea of rough set analysis is to reduce the information table to a small number of elementary sets, without losing much information. An analogy can be made with forecasting in regression analysis. In that case the objective may be to find a small subset of explanatory variables that is equally good at predicting a dependent variable as the set of all potential explanatory variables. The difference is that in regression analysis, the selection of variables depends on statistical criteria, whereas in rough set analysis no statistical model needs to be imposed.

Let a subset of attributes of *Q* be referred to as *P*. *P** denotes the family of elementary sets that results when only the attributes in *P* are considered. Also consider a subset of objects, *Y*. The *P-lower approximation of Y*, denoted by *PLY*, is the union of the subsets of *P** which contain *only* elements of *Y*. The *P-upper approximation of Y*, denoted by *PUY*, is the union of the subsets of *P** which *contain at least one* element of *Y*. The *accuracy of the approximation* is defined as the ratio of the number of elements in *PLY* over the number of elements in *PUY*.

Next, we will introduce the concept of a *reduct*. A reduct is a subset of the set of all attributes with the following characteristic: adding another attribute to a reduct does not lead to a more accurate classification of objects, while elimination of an attribute from a reduct does lead to a less accurate classification of objects. Finally, the *core* is defined as

the intersection of all reducts.[11]

If we consider a partitioning $X$ of the set of objects $U$ and a set of attributes $P$, the *quality of the approximation of classification X* by the set of attributes $P$ or, in short, the *quality of the classification* expresses the ratio of all $P$-correctly classified objects to all objects in the system. If the set of attributes $P$ is the core, we can similarly compute the *quality of the core.*

Based on the previous concepts, rough set analysis is able to specify various decision rules of an "if then" nature. For this purpose, the information table is partitioned into *condition* (background) and *decision* (response) attributes. When the equivalence classes based on certain condition attributes are modified by inclusion of decision attributes, there is ambiguity that is reflected in less than 100 percent accuracy. In our application, the decision variable is labelled $D1$ in Table 2, and measures the growth impact of fiscal policy (negative, inconclusive or positive).

A decision rule is then an implication relationship between the description of certain condition attributes and that of a decision attribute. Such a rule may be *exact* or *approximate*. A rule is exact if the combination of the values of the condition attributes in that rule implies only one single combination of the values of decision attributes. An approximate rule only states that more than one combination of values of the decision attributes corresponds to the same values of the condition attributes. The *support* is the number of objects that satisfy the rule. These objects are referred to as the *support class*. The *relative strength* is the ratio of the support over the frequency of objects leading to the decision.

One potential issue with rough set analysis is that it is concerned solely with qualitative attributes of studies. Quantitative information must be categorised into distinct classes and the proper demarcation of class boundaries requires some skill. As the results may be sensitive to the mapping used, some experimentation is often necessary.

Obersteiner and Wilk (1999) provide an example of rough set theory applied to long-run growth analysis. These authors used the panel of cross-country data on growth and socio-economic conditions compiled by Barro (1997) and Sala-i-Martin (1997). This panel covered 136 countries and the countries were classified into six categories related to the state of development (industrialised and non-industrialised) and the rate of growth (slow, medium, fast). Obersteiner and Wilk (1999) concluded that gross fixed capital formation and human capital formation (i.e. education) are the major determinants of high economic growth. In the terminology of Glass (1976), Obersteiner and Wilk's research can be referred to as an example of secondary analysis, while in the present paper we apply rough set theory in the context of tertiary (i.e. meta-) analysis.

## 5. Results from rough set analysis

Several software packages now exist to carry out rough set analysis. For our application we used the program ROSE2 (see Predki and Wilk 1999). Key results from carrying out a rough set algorithm on the information table on government and growth (Table 2) by means of the program ROSE2 are given in Table 5. A sensitivity analysis was also carried out by varying the discretisation of the qualitative attributes

[11] It can be shown that the core may be an empty set and is, in general, not a reduct.

and by varying the number of objects. In the latter case, the calculations were applied to only the first 66 observations (1983-1993) in order to test whether the results of earlier studies on government and growth differed qualitatively from more recent ones. However, the major results reported below are robust to such sensitivity analysis, which is also (with respect to publication year) the conclusion obtained earlier by means of Table 4.

TABLE 5 ABOUT HERE

Using the full sample of 123 objects, the algorithm identified 57 deterministic rules of an 'if …then…' nature. Table 5 reports only those results where the relative strength (that is, the proportion of objects of the particular type that satisfy the rule) is higher than 10 percent. There were eight such rules. Table 5 also reports the core and the quality of the classification. As noted in the previous section, the core is the set of attributes that is essential for correctly classifying objects with respect to the decision variable. In our case, the core consists of all attributes, except A3 (national or regional data). Hence we can draw the interesting conclusion that studies of the impact of fiscal policy are equally informative at the national level as at the regional level. Given that national-level studies are much more common than regional ones, this provides some support for the validity of transferring the findings of the former to the latter.[12]

Table 5 reports that the quality of the classification is about 96 percent. That is, about 96 percent of the objects can be correctly identified based on the attributes provided. Since, as noted above, A3 provides redundant information, the quality of the core is also 96 percent.[13]

The information in Table 5 reinforces what was concluded in Section 3. All but one of the reported rules (the exception is rule 8) relate to a specific type of government policy. Positive impacts are found for infrastructure policy (rules 1 to 3 and 5) and education policy (rule 4). Negative impacts are found for defence policy (rules 6 and 7). No rules relate to inconclusive impacts regarding fiscal policy.

Rule 1, the rule with highest relative strength, says that among infrastructure studies, those using time series analysis have found a positive impact of infrastructure spending on growth. Twelve observations supported this rule. As the total frequency of studies concluding a positive impact of fiscal policy was 47, the proportion is 25.5 percent (also referred to as the relative strength). This rule was particularly robust to sensitivity analysis and may therefore be considered the main finding of the rough set analysis. Rule 1 highlights that the full impact of infrastructure is not likely to be measured immediately after the investment is made. Rough set analysis reinforces here the observation made in Section 3 that the probability that a study in the sample detected a significantly positive effect of public infrastructure on growth was the greater, the longer the time span of data used in the econometric analysis. New infrastructure may lead to a dynamic process of growing trade, firm relocation, household migration, etc. It may take several years for a new steady state to be reached and studies that capture such effects require time series data. In order to capture spatial spillover effects, a multi-year panel of regional cross-sections is

[12] Note that it is not implied here that regional growth has the same determinants as national growth. Only the *partial* effects of fiscal policy on growth that were obtained from national level studies appear equally applicable at the regional level. The scope for fiscal policy at the regional level is often much more limited.

[13] If there is more than one reduct, the two percentages may not be the same.

essential.

However, rule 2 indicates that the studies that support the positive impact of public infrastructure tended to be published in unranked journals, using data primarily from the early post-war period. They also tended to be based on a relatively small number of observations (rule 3). Finally, rule 5 suggests that support for public infrastructure could also be found in studies that were based on data before the 1990s and that were published in the second-highest ranked tier of journals.

Rule 4 indicates that there was a relatively large frequency of studies of the impact of education on growth that used relatively small samples of observations (less than 100) and concluded that there was a significantly positive impact.

Rules 6 and 7 both refer to defence spending. In both cases they suggest a negative impact. As there were 32 studies concluding that the impact of fiscal policy was negative, the relative strength for both rules is 12.5 percent, as each is supported by only four objects. Rule 6 says that among studies of the impact of defence spending on growth, particularly the earlier ones (published before 1989), and at the same time using a small number of observations (less than 100), coincided with a negative impact. Hence we conclude that the older studies on the impact of defence spending, which tended to use relatively smaller samples, were more supportive of the peace dividend than other such studies. Moreover, rule 7 suggests that the idea of a peace dividend is more supported by studies on developed economies, rather than developing countries or a mixture of the two types.

The final rule relates to the conclusions from studies that did not use orthodox cross-section, time-series or pooled regression analyses. Two of these were literature surveys (Lindgren 1984 and Grobar and Porter 1989), while the other two used simulation models (van Sinderen 1993 and Berthelemy et al. 1995). These four studies used data from before the 1990s, on countries, with relatively few observations. They all concluded that the impact of government on growth was negative (with respectively the first two focussing on defence spending, the third one on taxation and the fourth one on education policy).

It is clear that rough set analysis has partly reinforced the earlier conclusions of the paper, while also detecting additional patterns in the data that - given the relatively small number of observations on each fiscal policy area - are unlikely to be obtainable from conventional statistical techniques.

## 6. Conclusions

In this paper we assessed the empirical evidence on the link between government and growth by means of a sample of 93 articles published between 1983 and 1998 in refereed journals. We considered five policy areas: general government consumption, tax rates, defence, education expenditures, and public infrastructure. The conventional belief is that increases in the former three hamper growth, while increases in the latter two boost growth. The support for this common prior was tested by meta-analysis.

Several meta-analytical techniques were applied. On balance, the evidence for the expected impact of the selected fiscal policy variables on growth is rather weak. However, the commonly identified importance of education and infrastructure was confirmed. Moreover, the results of the studies appear sensitive to several research design parameters.

Model specification, the type of data used and econometric methodology matter.

Cross-country growth regressions that exclude initial income are less likely to detect a significant impact of government policy than those that include this variable (e.g. to test for conditional convergence to the steady state, or as a proxy of available technology).

As expected, panel studies are in general more informative on the issues than cross-section studies. However, cross-section studies were more likely to suggest a detrimental effect of "big government" on growth than studies using panel data, but they were unlikely to be able to correctly identify the growth impact of infrastructure. The probability that a study detects a significantly positive effect of public infrastructure on growth appears to be greater, the longer the time span of data used in the econometric analysis. We noted that the confirmation of the positive impact of education and infrastructure on growth derived from macroeconometric research does not provide much guidance for education or infrastructure policy, and research in this area will need to be complemented by appropriate micro level studies.

Compared with other types of research methodologies, conventional growth regressions appear less informative on the issues, as a greater percentage of the cross-country growth regression models are inconclusive. Overall, however, there is little evidence that more recent studies (1994-98) have become more conclusive on the issue of fiscal policy and growth than earlier ones (1983-93). In contrast, the prestige of the journal where the results were published appears to contain some information: higher ranked journals provide less support for the conventional prior, because studies published in such journals have rejected less often the null hypothesis of a zero effect of the policy variable. Perhaps there is in such journals a reluctance to publish evidence that becomes only apparent at high significance levels.

While the literature on this topic has peaked in the late 1990s, further publications will undoubtedly appear and they are desirable. Even among growth regression models, there are still various issues that deserve more attention. An obvious issue is the endogeneity of government expenditure itself. The size of government may be related to the stage of development, the openness of the economy, the variability of output, social fragmentation, population structure and institutional and cultural aspects of society. If growth regressions continue to have policy variables on the right hand side, special efforts should be made to find suitable instrumental variables to avoid biased policy variable coefficients (as, for example, elucidated by Agell et al. 1999). A good example of state of the art methodology in this respect is provided by Levine et al. (2000), who use a generalised method of moments (GMM) dynamic panel estimator to assess the relationship between the financial system and economic growth.

Another issue is parameter stability over time, as well as the limited transferability of models across different groups of countries and levels of development (e.g. Brock and Durlauf 2001). Fiscal policies may also operate indirectly via their impact on investment behaviour, innovation, factor mobility, etc., thereby warranting a multi-equation rather than a single equation growth model.

Econometrically, most studies ignore the spatial configuration of the growth process. Regions or countries are often treated as non-spatial units of observation. While panel data analysis may control for the possibility of cross-sectional heteroscedasticity, time-wise autoregression, simultaneity and endogeneity, the possibility of spatial autocorrelation is rarely acknowledged (see also Anselin and Florax, 1995).

It is possible that more can be learnt from parameter calibration methods for micro-foundations based models than from parameter estimation of regression models with ad hoc specifications. In any case, there remain severe limitations on what can be learned for policy from highly aggregative models of endogenous growth. The empirical work remains constrained by the fact that there are many potential growth influences relative to limited observations. More multi-sectoral modelling (e.g. dynamic CGE modelling) and micro level modelling in national and regional contexts is desirable (as advocated also by, e.g., Besley 2001).

In recent years the emphasis of the research of fiscal policy on growth has shifted from the traditional fiscal policy variables studies discussed in this paper to issues of externalities, competition policy, monetary policy, R&D, property rights, institutions and law and order. Given the growing popularity of meta-analysis in economics and the growing ease by which new research findings are speedily disseminated worldwide in electronic form, meta-analysis of such topics could be a fruitful endeavour in the foreseeable future.

## Acknowledgements

The authors are grateful for research assistance provided by Katja Kleinveld and Gabriella Vindigni. We also wish to thank Henri de Groot, John Janssen and two anonymous referees for constructive comments and suggestions.

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Table 1: Sample size in relation to the estimated population of similar *EconLit* documents

| Type of policy | Keywords search criterion | Total number of records (a) | The number of eligible records (b) | Number in the sample (c) |
|---|---|---|---|---|
| Government consumption | (C) | 196 | 41 | 41 |
| Defence | (D) | 45 | 36 | 21 |
| Taxation | (T) | 127 | 24 | 10 |
| Infrastructure | (I) | 93 | 39 | 39 |
| Education | (E) | 89 | 24 | 12 |
| TOTAL | | | 164 | 123 |

Source: *EconLit*.

Notes:
(C) (“government” or “ public”) and (“size” or “share”)) or ((“government” or “public”) and “consumption”) and ((“economic” or “long-run”) and “growth”)
(D) (“defense” or “defence”) and (“expenditure” or “spending”) and ((“economic” or “long-run”) and “growth”)
(T) (“tax” or “taxation”) and (“rate” or “rates”) and ((“economic” or “long-run”) and “growth”)
(I) (“public investment” or “government investment” or “infrastructure”) and ((“economic” or “long-run”) and “growth”)
(E) (“education” or “educational” or “schooling”) and (“government” or “public”) and ((“economic” or “long-run”) and “growth”)
(a) The counts refer to 1983-1998 journal articles with published abstracts only.
(b) Eligible records are English-language articles that draw a conclusion with respect to the impact of the specific fiscal policy by means of formal empirical analysis.
(c) This is only approximately a subset of the previous column. Some articles not recorded in *EconLit*, or without an abstract, are included in the sample.

Table 2: The information table

| Objects | | A1 | A2 | A3 | A4 | A5 | A6 | A7 | A8 | A9 | D1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Authors | Observation number | Type of government policy (a) | Year of publication | Type of geographical area (b) | Number of observations | Year of earliest observation | Year of most recent observation | Level of development of the nations or regions (c) | Research methodology (d) | Ranking of journal where article was published (e) | Conclusion of the study (f) |
| Deger and Smith | 1 | 2 | 1983 | 1 | 50 | 1965 | 1973 | 1 | 1 | 1 | 1 |
| Gemmell | 2 | 1 | 1983 | 1 | 27 | 1960 | 1970 | 2 | 4 | 2 | 2 |
| Landau | 3 | 5 | 1983 | 1 | 96 | 1960 | 1977 | 2 | 1 | 2 | 3 |
| Landau | 4 | 1 | 1983 | 1 | 96 | 1960 | 1977 | 2 | 1 | 2 | 1 |
| Lim | 5 | 2 | 1983 | 1 | 54 | 1965 | 1973 | 1 | 1 | 2 | 1 |
| Ratner | 6 | 4 | 1983 | 1 | 24 | 1949 | 1973 | 3 | 2 | 3 | 3 |
| Cappelen, Gleditsch and Bjerkholt | 7 | 2 | 1984 | 1 | 85 | 1960 | 1980 | 3 | 3 | 1 | 1 |
| Faini, Annez and Taylor | 8 | 2 | 1984 | 1 | 1242 | 1952 | 1970 | 2 | 3 | 2 | 1 |
| Lindgren | 9 | 2 | 1984 | 1 | 41 | 1968 | 1984 | 3 | 4 | 1 | 1 |
| Helms | 10 | 3 | 1985 | 2 | 672 | 1965 | 1979 | 3 | 3 | 4 | 1 |
| Kormendi and Meguire | 11 | 1 | 1985 | 1 | 47 | 1950 | 1977 | 2 | 1 | 3 | 2 |
| Landau | 12 | 1 | 1985 | 1 | 384 | 1952 | 1976 | 3 | 3 | 2 | 1 |
| Landau | 13 | 4 | 1985 | 1 | 384 | 1952 | 1976 | 3 | 3 | 2 | 1 |
| Saunders | 14 | 1 | 1985 | 1 | 46 | 1960 | 1981 | 3 | 3 | 1 | 2 |
| Biswas and Ram | 15 | 2 | 1986 | 1 | 116 | 1960 | 1977 | 1 | 3 | 2 | 2 |
| Landau | 16 | 1 | 1986 | 1 | 1152 | 1960 | 1980 | 2 | 3 | 2 | 1 |
| Landau | 17 | 4 | 1986 | 1 | 1152 | 1960 | 1980 | 2 | 3 | 2 | 2 |
| Ram | 18 | 1 | 1986 | 1 | 230 | 1960 | 1980 | 2 | 3 | 4 | 3 |
| Ram | 19 | 1 | 1986 | 1 | 2300 | 1960 | 1980 | 2 | 3 | 4 | 3 |
| Canto and Webb | 20 | 3 | 1987 | 2 | 960 | 1957 | 1977 | 1 | 3 | 2 | 1 |
| da Silva Costa, Ellson and Martin | 21 | 4 | 1987 | 2 | 48 | 1972 | 1972 | 3 | 1 | 2 | 3 |
| Bairam | 22 | 1 | 1988 | 1 | 20 | 1960 | 1980 | 3 | 2 | 1 | 3 |
| Grossman | 23 | 1 | 1988 | 1 | 34 | 1949 | 1984 | 3 | 2 | 2 | 2 |
| Aschauer - a | 24 | 4 | 1989 | 1 | 133 | 1966 | 1985 | 3 | 3 | 1 | 3 |
| Aschauer - b | 25 | 4 | 1989 | 1 | 36 | 1949 | 1985 | 3 | 2 | 3 | 3 |
| Aschauer - c | 26 | 4 | 1989 | 1 | 33 | 1953 | 1986 | 3 | 2 | 3 | 3 |
| Grier and Tullock | 27 | 1 | 1989 | 1 | 500 | 1950 | 1981 | 2 | 3 | 3 | 1 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Grobar and Porter | 28 | 2 | 1989 | 1 | 29 | 1972 | 1988 | 1 | 4 | 1 | 1 |
| Gyimah-Brempong | 29 | 2 | 1989 | 1 | 328 | 1973 | 1983 | 1 | 3 | 1 | 1 |
| Koester and Kormendi | 30 | 3 | 1989 | 1 | 63 | 1970 | 1979 | 2 | 1 | 3 | 2 |
| Rao | 31 | 1 | 1989 | 1 | 230 | 1960 | 1980 | 2 | 3 | 4 | 2 |
| Rao | 32 | 1 | 1989 | 1 | 2300 | 1960 | 1980 | 2 | 3 | 4 | 2 |
| Scully | 33 | 1 | 1989 | 1 | 115 | 1960 | 1980 | 2 | 1 | 2 | 1 |
| Bairam | 34 | 1 | 1990 | 1 | 300 | 1960 | 1985 | 1 | 3 | 1 | 2 |
| Grossman | 35 | 1 | 1990 | 1 | 48 | 1970 | 1983 | 2 | 1 | 2 | 2 |
| Mullen and Williams | 36 | 4 | 1990 | 2 | 29 | 1963 | 1966 | 3 | 1 | 2 | 2 |
| Munnell - a | 37 | 4 | 1990 | 1 | 38 | 1949 | 1987 | 3 | 2 | 1 | 3 |
| Munnell - b | 38 | 4 | 1990 | 2 | 48 | 1970 | 1986 | 3 | 1 | 1 | 3 |
| Barro | 39 | 5 | 1991 | 1 | 98 | 1960 | 1985 | 2 | 1 | 4 | 3 |
| Barro | 40 | 1 | 1991 | 1 | 98 | 1960 | 1985 | 2 | 1 | 4 | 1 |
| Barro | 41 | 4 | 1991 | 1 | 98 | 1960 | 1985 | 2 | 1 | 4 | 2 |
| Chowdhury | 42 | 2 | 1991 | 1 | 1430 | 1961 | 1987 | 1 | 2 | 1 | 2 |
| Eisner | 43 | 4 | 1991 | 2 | 48 | 1970 | 1986 | 3 | 4 | 1 | 3 |
| Hulten and Schwab | 44 | 4 | 1991 | 2 | 144 | 1970 | 1986 | 3 | 3 | 2 | 2 |
| Hulten and Schwab | 45 | 4 | 1991 | 2 | 144 | 1970 | 1986 | 3 | 4 | 2 | 2 |
| Moomaw and Williams | 46 | 5 | 1991 | 2 | 47 | 1954 | 1976 | 3 | 1 | 2 | 3 |
| Moomaw and Williams | 47 | 4 | 1991 | 2 | 47 | 1954 | 1976 | 3 | 1 | 2 | 3 |
| Yu, Wallace and Nardinelli | 48 | 3 | 1991 | 2 | 336 | 1929 | 1985 | 3 | 3 | 1 | 1 |
| Levine and Renelt | 49 | 5 | 1992 | 1 | 103 | 1960 | 1989 | 2 | 1 | 4 | 2 |
| Levine and Renelt | 50 | 1 | 1992 | 1 | 103 | 1960 | 1989 | 2 | 1 | 4 | 2 |
| Lynde and Richmond | 51 | 4 | 1992 | 1 | 32 | 1958 | 1989 | 3 | 2 | 4 | 3 |
| Munnell | 52 | 4 | 1992 | 2 | 38 | 1973 | 1992 | 3 | 4 | 2 | 3 |
| Bajo-Rubio and Sosvilla-Rivero | 53 | 4 | 1993 | 1 | 25 | 1964 | 1988 | 3 | 2 | 1 | 3 |
| Binswanger, Khandker and Rosenzweig | 54 | 4 | 1993 | 2 | 85 | 1960 | 1981 | 1 | 1 | 3 | 3 |
| Durden and Elledge | 55 | 1 | 1993 | 2 | 48 | 1982 | 1993 | 3 | 1 | 1 | 1 |
| Easterly and Rebelo | 56 | 3 | 1993 | 1 | 100 | 1970 | 1988 | 2 | 1 | 3 | 2 |
| Easterly and Rebelo | 57 | 4 | 1993 | 1 | 100 | 1970 | 1988 | 2 | 1 | 3 | 3 |
| Easterly and Rebelo | 58 | 3 | 1993 | 1 | 3304 | 1870 | 1988 | 3 | 3 | 3 | 2 |
| Easterly and Rebelo | 59 | 4 | 1993 | 1 | 3304 | 1870 | 1988 | 3 | 3 | 3 | 3 |
| Lynde and Richmond | 60 | 4 | 1993 | 1 | 32 | 1958 | 1989 | 3 | 2 | 4 | 3 |
| Mohammed | 61 | 2 | 1993 | 1 | 390 | 1973 | 1983 | 1 | 4 | 1 | 2 |
| Park | 62 | 2 | 1993 | 1 | 25 | 1963 | 1987 | 1 | 2 | 1 | 2 |
| Sattar | 63 | 1 | 1993 | 1 | 560 | 1950 | 1985 | 1 | 3 | 1 | 3 |
| Sattar | 64 | 1 | 1993 | 1 | 280 | 1950 | 1985 | 3 | 3 | 1 | 2 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sheehey | 65 | 1 | 1993 | 1 | 102 | 1960 | 1980 | 2 | 1 | 1 | 2 |
| van Sinderen | 66 | 3 | 1993 | 1 | 1 | 1985 | 1985 | 3 | 4 | 1 | 1 |
| Assane and Pourgerami | 67 | 1 | 1994 | 1 | 46 | 1970 | 1990 | 1 | 3 | 1 | 1 |
| Evans and Karras | 68 | 5 | 1994 | 2 | 768 | 1970 | 1986 | 3 | 3 | 4 | 3 |
| Evans and Karras | 69 | 1 | 1994 | 2 | 768 | 1970 | 1986 | 3 | 3 | 4 | 2 |
| Evans and Karras | 70 | 4 | 1994 | 2 | 768 | 1970 | 1986 | 3 | 3 | 4 | 1 |
| Hansen - a | 71 | 1 | 1994 | 1 | 242 | 1966 | 1988 | 3 | 3 | 1 | 2 |
| Hansen - b | 72 | 1 | 1994 | 1 | 23 | 1968 | 1991 | 3 | 2 | 1 | 2 |
| Hansson and Henrekson | 73 | 5 | 1994 | 1 | 153 | 1970 | 1987 | 3 | 1 | 2 | 3 |
| Hansson and Henrekson | 74 | 1 | 1994 | 1 | 153 | 1970 | 1987 | 3 | 1 | 2 | 1 |
| Hansson and Henrekson | 75 | 4 | 1994 | 1 | 153 | 1970 | 1987 | 3 | 1 | 2 | 2 |
| Holtz-Eakin | 76 | 4 | 1994 | 2 | 816 | 1969 | 1986 | 3 | 3 | 4 | 2 |
| Hsieh and Lai | 77 | 1 | 1994 | 1 | 714 | 1885 | 1987 | 3 | 2 | 1 | 2 |
| Kusi | 78 | 2 | 1994 | 1 | 1386 | 1971 | 1989 | 1 | 2 | 1 | 2 |
| Lee and Lin | 79 | 1 | 1994 | 1 | 114 | 1960 | 1985 | 2 | 1 | 1 | 2 |
| Lin | 80 | 1 | 1994 | 1 | 20 | 1960 | 1985 | 3 | 1 | 1 | 2 |
| Lin | 81 | 1 | 1994 | 1 | 42 | 1960 | 1985 | 1 | 1 | 1 | 2 |
| Sala-i-Martin | 82 | 1 | 1994 | 1 | 12 | 1986 | 1993 | 2 | 4 | 3 | 2 |
| Sala-i-Martin | 83 | 5 | 1994 | 1 | 12 | 1986 | 1993 | 2 | 4 | 3 | 3 |
| Andrews and Swanson | 84 | 4 | 1995 | 2 | 768 | 1970 | 1986 | 3 | 3 | 1 | 3 |
| Berthelemy, Herrera and Sen | 85 | 2 | 1995 | 1 | 2 | 1972 | 1972 | 1 | 4 | 1 | 1 |
| Chletsos and Kollias | 86 | 2 | 1995 | 1 | 17 | 1974 | 1990 | 3 | 2 | 1 | 2 |
| Garrison and Lee | 87 | 1 | 1995 | 1 | 67 | 1960 | 1987 | 2 | 1 | 1 | 2 |
| Garrison and Lee | 88 | 3 | 1995 | 1 | 67 | 1960 | 1987 | 2 | 1 | 1 | 1 |
| Holtz-Eakin and Schwartz | 89 | 4 | 1995 | 2 | 720 | 1971 | 1986 | 3 | 3 | 1 | 2 |
| Karikari | 90 | 1 | 1995 | 1 | 21 | 1963 | 1984 | 1 | 2 | 1 | 1 |
| Macnair, Murdoch, Pi and Sandler | 91 | 2 | 1995 | 1 | 370 | 1951 | 1988 | 3 | 3 | 2 | 1 |
| Macnair, Murdoch, Pi and Sandler | 92 | 1 | 1995 | 1 | 370 | 1951 | 1988 | 3 | 3 | 2 | 3 |
| Andres, Domenech and Molinas | 93 | 1 | 1996 | 1 | 720 | 1960 | 1990 | 3 | 3 | 3 | 2 |
| Devarajan, Swaroop and Zou | 94 | 1 | 1996 | 1 | 860 | 1970 | 1990 | 1 | 3 | 3 | 3 |
| Devarajan, Swaroop and Zou | 95 | 4 | 1996 | 1 | 860 | 1970 | 1990 | 1 | 3 | 3 | 1 |
| Dunne | 96 | 2 | 1996 | 1 | 54 | 1973 | 1996 | 1 | 4 | 1 | 2 |
| Harmatuck | 97 | 4 | 1996 | 1 | 36 | 1949 | 1985 | 3 | 2 | 1 | 3 |
| Kocherlakota and Yi | 98 | 3 | 1996 | 1 | 71 | 1917 | 1988 | 3 | 2 | 4 | 2 |
| Kocherlakota and Yi | 99 | 2 | 1996 | 1 | 71 | 1917 | 1988 | 3 | 2 | 4 | 2 |
| Kocherlakota and Yi | 100 | 4 | 1996 | 1 | 71 | 1917 | 1988 | 3 | 2 | 4 | 3 |
| Morrison and Schwartz | 101 | 4 | 1996 | 2 | 816 | 1970 | 1987 | 3 | 3 | 4 | 3 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Roux | 102 | 2 | 1996 | 1 | 30 | 1960 | 1990 | 3 | 2 | 1 | 1 |
| Wylie | 103 | 4 | 1996 | 1 | 45 | 1946 | 1991 | 3 | 2 | 3 | 3 |
| Ansari and Singh | 104 | 5 | 1997 | 1 | 36 | 1951 | 1987 | 1 | 2 | 1 | 3 |
| Barro | 105 | 5 | 1997 | 1 | 3000 | 1960 | 1990 | 2 | 3 | 1 | 3 |
| Barro | 106 | 1 | 1997 | 1 | 3000 | 1960 | 1990 | 2 | 3 | 1 | 1 |
| Brumm | 107 | 2 | 1997 | 1 | 88 | 1974 | 1989 | 2 | 1 | 1 | 3 |
| Glomm and Ravikumar | 108 | 5 | 1997 | 1 | 31 | 1983 | 1994 | 2 | 4 | 1 | 3 |
| Glomm and Ravikumar | 109 | 4 | 1997 | 1 | 31 | 1983 | 1994 | 2 | 4 | 1 | 3 |
| Guseh | 110 | 1 | 1997 | 1 | 1475 | 1960 | 1985 | 1 | 3 | 1 | 1 |
| Kocherlakota and Yi | 111 | 3 | 1997 | 1 | 320 | 1831 | 1991 | 3 | 2 | 3 | 1 |
| Kocherlakota and Yi | 112 | 4 | 1997 | 1 | 320 | 1831 | 1991 | 3 | 2 | 3 | 3 |
| Kollias and Makrydakis | 113 | 2 | 1997 | 1 | 39 | 1954 | 1993 | 1 | 2 | 1 | 2 |
| Lau and Sin | 114 | 4 | 1997 | 1 | 64 | 1925 | 1989 | 3 | 2 | 2 | 3 |
| Odedokun | 115 | 4 | 1997 | 1 | 960 | 1970 | 1990 | 1 | 3 | 1 | 3 |
| Singh and Weber | 116 | 5 | 1997 | 1 | 44 | 1950 | 1994 | 3 | 2 | 1 | 3 |
| Baffes and Shah | 117 | 2 | 1998 | 1 | 420 | 1965 | 1984 | 1 | 3 | 2 | 1 |
| Baffes and Shah | 118 | 5 | 1998 | 1 | 420 | 1965 | 1984 | 1 | 3 | 2 | 3 |
| Button | 119 | 4 | 1998 | 2 | 28 | 1973 | 1994 | 3 | 4 | 1 | 3 |
| Cronovich | 120 | 1 | 1998 | 1 | 30 | 1970 | 1990 | 2 | 1 | 2 | 3 |
| Sanchez-Robles | 121 | 4 | 1998 | 1 | 57 | 1970 | 1992 | 2 | 1 | 1 | 3 |
| Sanchez-Robles | 122 | 4 | 1998 | 1 | 19 | 1970 | 1985 | 1 | 1 | 1 | 3 |
| Zhang and Zou | 123 | 1 | 1998 | 2 | 420 | 1978 | 1992 | 1 | 3 | 3 | 2 |

Notes:

(a) Type of government policy: “1” refers to government “size” or consumption; “2” refers to defence expenditure; “3” refers to average or marginal tax rates; “4” refers to public infrastructure; “5” refers to public expenditure on education.

(b) Type of geographical area: “1” refers to countries; “2” refers to regions.

(c) Level of development of the nations or regions: “1” refers to less developed countries; “2” refers to a mixture of developed and less developed countries; “3” refers to developed countries.

(d) Research methodology: “1” refers to regression models with cross-sectional data; “2” refers to models using techniques for time series analysis; “3” refers to regression models with panel data; “4” refers to other methods.

(e) Ranking of the journal where the article was published. The classification of Towe and Wright (1995) was adopted. “1” refers to unranked journals; “2” refers to the third tier of journals; “3” refers to the second tier of journals; “4” refers to the top tier of journals.

(f) Conclusion of the study: “1” refers to a negative impact of the policy on economic growth; “2” refers to an inconclusive impact of the policy on economic growth; “3” refers to a positive impact of the policy on economic growth.

Table 3: Descriptive statistics on the sample of "government and growth" studies (n=123)

| | | | | | Percentage of studies |
|---|---|---|---|---|---|
| *(i) Type of fiscal policy* | | | | | |
| Government size or consumption | | | | | 33.3 |
| Defence expenditure | | | | | 17.1 |
| Average or marginal tax rates | | | | | 8.1 |
| Public infrastructure | | | | | 31.7 |
| Public expenditure on education | | | | | 9.8 |
| *(ii) Research methodology* | | | | | |
| Regression models with cross-sectional data | | | | | 28.5 |
| Regression models with panel data | | | | | 37.4 |
| Conventional growth regressions among the above two categories (a) | | | | 52.0 | |
| of which | | | | | |
| control for initial income (test of conditional convergence): | | | 56.3 | | |
| control for population or labour force growth: | | | 93.8 | | |
| control for the rate of investment or savings: | | | 81.3 | | |
| Models using techniques for time series analysis | | | | | 22.8 |
| Other methods | | | | | 11.4 |

*(iii) Observations available for each study*

| | Mean | Stand. Dev. | Min | Max |
|---|---|---|---|---|
| Number | 389.2 | 667 | 1 | 3304 |
| First Year | 1957.6 | 24.4 | 1831 | 1986 |
| Time Span | 28.3 | 25.3 | 1 | 161 |

| | |
|---|---|
| *(iv) Level of development of the nations or regions* | |
| Less developed countries | 22.8 |
| A mixture of developed and less developed countries | 28.5 |
| Developed countries | 48.8 |
| *(v) Ranking of the journal where the article was published, using the Towe and Wright (1995) classification* (b) | |
| Unranked journals | 42.3 |
| The third tier of journals | 24.4 |
| The second tier of journals | 16.3 |
| The top tier of journals | 17.1 |
| *(vi) Type of geographical area* | |
| Countries | 82.1 |
| Regions | 17.9 |
| *(vii) Support for conventional prior beliefs (General government consumption or size, taxation or defence harms growth; government investment in education and infrastructure benefits growth)* | |
| The conventional prior is supported | 55.3 |
| The study is inconclusive | 35.8 |
| The conventional prior is rejected | 8.9 |

*(viii) Cross-tabulation of type of fiscal policy and study conclusion*

| Type of fiscal policy | Number of studies | Proportion concluding positive impact | Proportion concluding negative impact | Proportion with inconclusive impact | Conventional prior belief regarding the impact | 95% confidence interval for the proportion of studies supporting the conventional prior belief (c) |
|---|---|---|---|---|---|---|
| Education | 12 | 0.92 | 0.00 | 0.08 | + | (0.57,0.99) |
| Infrastructure | 39 | 0.72 | 0.08 | 0.20 | + | (0.58,0.86) |
| Taxation | 10 | 0.00 | 0.60 | 0.40 | - | (0.26,0.89) |
| Defence | 21 | 0.05 | 0.52 | 0.43 | - | (0.30,0.74) |
| Government consumption or "size" | 41 | 0.17 | 0.29 | 0.54 | - | (0.15,0.43) |
| All types | 123 | 0.38 | 0.26 | 0.36 | as above | (0.46,0.64) |

Notes:

(a) Conventional growth regressions are linear regression models with the growth in real national output or income as the dependent variable.

(b) The Towe and Wright (1995) classification is as follows. The top tier of journals consists of *Am Econ Rev, Econometrica, Econ J, Int Econ Rev, J Econ Theory, J Fin; J Fin Econ, J Pol Econ, Quarterly J Econ, Rand J Econ, Rev Econ Stat, Rev Econ Stud*. The second tier consists of *Am Econ Rev P&P, Brookings P Econ Act, Canad J Econ, Econ Inquiry, Economica, Econ Let, Eur Econ Rev, J Am Stat Ass, J Bus, J Dev Econ, J Econometrics, J Econ Lit, J Hum Res, J Int Econ, J Labor Econ, J Law Econ, J Math Econ, J Mon Econ, J Mon Cred Banking, J Pub Econ, J Royal Stat Soc, Oxford Econ Pap, Scand J Econ*. The third tier consists of *Am J of Agric Econ, Aus Econ Pap, Cambridge J Econ, Carnegie-Roch C.S. Pub Pol, Econometric Rev, Econometric Theory, Econ Develop Cult Ch, Econ His Rev, Econ Rec, Expl Econ Hist, Hist Pol Econ, Ind Lab Rel Rev, Int J of Ind Org, IMF Staff Pap, J of Bus Econ Stat, J of Comp Econ, J of Econ Behav & Org, J of Econ Hist, J of Econ Persp, J of Fin Interm, J of Health Econ, J of Indus Econ, J of Int Money and Fin, J of Post Keynesian Econ, J of Reg Sc, J of Urban Econ, Kyklos, Land Econ, Manchester School, Nat Tax J, Oxford Bull Econ Stat, Pub Choice, Rev Inc Wealth, Scot J of Pol Econ, South Econ J, Weltwirts Archiv*. All other *EconLit* journals are in the remaining category.

(c) Using a normal approximation for I, D and C; and exact binomial confidence intervals for E and T from Clopper and Pearson (1934).

Table 4: Effects of selected study characteristics on conclusions

| Effect of: | Number of studies | Percentage of studies supporting the conventional prior | Pearson Chi-square test of independence of classifications (b) | Percentage of studies that is inconclusive | Pearson Chi-square test of independence of classifications (b) |
|---|---|---|---|---|---|
| *Year of publication* | | | | | |
| Early studies (1983-1993) | 66 | 56.1 | | 36.4 | |
| More recent studies (1994-1998) | 57 | 54.4 | 0.035 (0.852) | 35.1 | 0.022 (0.883) |
| *Ranking of journal* (a) | | | | | |
| Top two tiers | 41 | 46.3 | | 41.5 | |
| Other journals | 82 | 59.8 | 1.990 (0.158) | 32.9 | 0.867 (0.352) |
| *Methodology* | | | | | |
| Conventional growth regression | 64 | 45.3 | | 39.1 | |
| Other types of studies | 59 | 66.1 | 5.367 (0.021) | 32.2 | 0.629 (0.428) |
| *Within conventional growth regressions* | | | | | |
| (i) By type of data used | | | | | |
| Cross-section studies | 28 | 46.4 | | 46.4 | |
| Panel data studies | 36 | 44.4 | 0.025 (0.874) | 33.3 | 1.135 (0.287) |
| (ii) By test of conditional convergence | | | | | |
| Includes initial income | 36 | 52.8 | | 38.9 | |
| Does not include initial income | 28 | 35.7 | 1.851 (0.174) | 39.3 | 0.001 (0.974) |

Notes:
(a) See note (b) of Table 3.
(b) Significance levels in parentheses.

Table 5: Results from rough set analysis

*Discretisation of continuous attributes*
Year of publication: 3 intervals: (−∞, 1988.5) [1988.5,1993.5) [1993.5,+∞)
Number of observations: 4 intervals: (−∞, 99.5) [99.5,500.5) [500.5,1000.5) [1000.5,+∞)
Year of earliest observation: 3 intervals: (−∞, 1939.5) [1939.5,1970.5) [1970.5,+∞)
Year of most recent observation: 2 intervals: (−∞, 1989.5) [1989.5,+∞)

*Quality of the classification:* 0.9593 (a)
*Quality of the core:* 0.9593
*Core variables:* All, except the type of geographical area.

*Deterministic rules ranked by relative strength; minimum relative strength=10%:*

(1) "In studies on public infrastructure, using techniques for time series analysis, the impact of infrastructure policy on growth is significantly positive."
Supporting observations: {6,25,26,37,51,53,60,97,100,103,112,114}; Relative strength = 25.5%

(2) "In studies on public infrastructure, with the data primarily from the early post Word War II period, published in unranked journals, the impact of infrastructure policy on growth is significantly positive."
Supporting observations: {24,37,38,43,53,84,97,115,121,122}; Relative strength = 21.3%

(3) "In studies on public infrastructure, using less than 100 observations, published in unranked journals, the impact of infrastructure policy on growth is significantly positive."
Supporting observations: {37,38,43,53,97,109,119,121,122}; Relative strength = 19.2%

(4) "In studies considering public expenditure on education, using less than 100 observations, the impact of education policy on growth is significantly positive."
Supporting observations: {3,39,46,83,104,108,116}; Relative strength = 14.9%

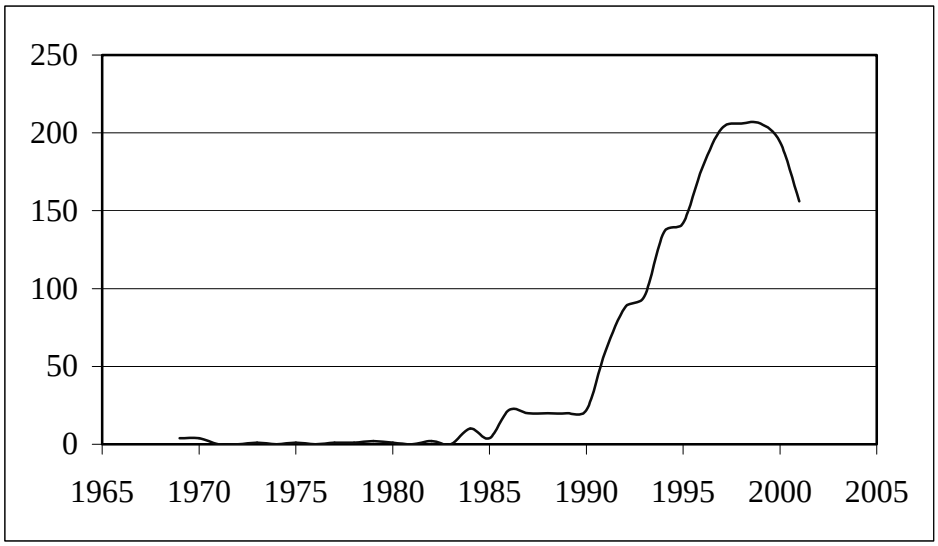
(5) "In studies on public infrastructure, using data before 1990, published in the second-highest tier of journals, the impact of infrastructure policy on growth is significantly positive."
Supporting observations: {6,25,26,54,57,59}; Relative strength = 12.8%

(6) "In studies on defence expenditure, published before 1989, using less than 100 observations, the impact of defence expenditure on growth is significantly negative."
Supporting observations: {1,5,7,9}; Relative strength = 12.5%

(7) "In studies on defence expenditure, with the data primarily from the early post Word War II period, and using observations from developed economies only, the impact of defence expenditure on growth is significantly negative."
Supporting observations: {7,9,91,102}; Relative strength = 12.5%

(8) "In studies using country data, using less than 100 observations and data before 1990 and methods other than regression models, the impact of fiscal policy on growth is significantly negative."
Supporting observations: {9,28,66,85}; Relative strength = 12.5%

Note:
(a) Definitions of the various measures are given in Section 5.




Source: *EconLit*
Note: The keywords search criterion is: ((“economic growth” or “long-run growth”) and ((“fiscal” or “government”) and “policy”), n = 1799

Fig. 1. Estimated number of documents in *EconLit* on the relationship between fiscal policy and economic growth, 1969-2001