Welfare state generosity and student performance: Evidence from international student tests

Falch, Torberg and Fischer, Justina AV

Department of Economics, Norwegian University of Science and Technology (NTNU), World Trade Institute, University of Bern

7 December 2011

Welfare state generosity and student performance: Evidence from international student tests

Torberg Falch[*]
Department of Economics, Norwegian University of Science and Technology

Justina AV Fischer[+]
World Trade Institute, University of Bern

Version: November 2011

Abstract
Student achievement has been identified as important contributor to economic growth. This paper investigates the relationship between redistributive government activities and investment in human capital measured by student performance in international comparative tests in Mathematics and Science during the period 1980 to 2003. In fixed effects panel models, government consumption, government social expenditures, and the progressivity of the income tax system have negative effects on student achievement. The results are robust to a variety of model specifications, including models that condition on educational expenditures. Our best estimate indicates that increased government size by 10 percent reduces student achievement by 0.1 standard deviations.

Keywords: Student achievement; welfare state; government size; tax system; panel data; international tests
JEL codes: H2; I2; C33

Acknowledgement
We thank Fredrik Carlsen, Urs Fischbacher, Stefan Hupfeld, Thomas Lange, Bjarne Strøm, Ludger Wößmann, and conference and seminar participants at the CESifo Area Conference on Employment and Social Protection, International Institute of Public Finance in Maastricht, and Economics Departments at the University of Konstanz and the Norwegian University of Science and Technology for helpful comments and suggestions. Justina Fischer acknowledges Marie Curie experienced researcher fellowship (RTN ENABLE) and a COFIT fellowship.

[*] Torberg Falch, Department of Economics, Norwegian University of Science and Technology, Dragvoll, N-7491 Trondheim, Norway, e-mail: Torberg.Falch@svt.ntnu.no, tel. +47 73596757.
[+] World Trade Institute, University of Bern, Hallerstrasse 6, CH-3012 Bern, e-mail: Justina.fischer@wti.org or Justina.Fischer@gmx.de

1. Introduction

The equity-efficiency quandary of the welfare state is usually attributed to perverse incentive effects in the labor market. The welfare state includes 'unproductive' government spending which reduces the return to work and is financed by distortionary taxes. Apparently, little evidence exists on the effect of welfare state arrangements on investment in human capital.

The welfare state can be seen as a social insurance mechanism, see for example Sinn (1995). When the insurance terms for the insured improve, her incentives to invest in order to avoid capture are weakened. In a macroeconomic context, this moral hazard problem may have detrimental effects on investment in human capital, saving, and, ultimately, economic growth.[1] Indeed, welfare state arrangements may also be seen as interventions in imperfect markets, working in the opposite direction. The evidence on public sector size and economic growth in empirical cross-country studies, however, indicates a negative relationship.[2] Ehrlich and Zhong (1998) and Ehrlich and Kim (2007) look directly on investment in human capital, and find a negative effect of old-age pension benefits on secondary school enrolment rates, in particular for for developed countries.[3] Using German data, Fossen and Glocker (2011) find that university enrollment is positively related to expected return to tertiary education.

To our best knowledge, we are among the first to empirically investigate to what extent government redistribution activities affect individual investment in human capital. In this study, we approximate the former through three, partly overlapping measures of welfare state generosity: government consumption, social expenditures, and the progressivity of the tax system. We use achievement on international student tests, adjusted to facilitate comparability across countries and time, as measure of investment in human capital. Most of the existing empirical analyses on economic growth employ as a proxy of human capital some measure of *quantity* of education in the population. This is obviously a crude measure, and we follow Wössmann (2003) who argues that the number of *quality*-education-years varies across countries stronger than the mere duration of education, with which it might even be uncorrelated. Indeed, Hanushek and Kimko (2000) find that average student achievement in compulsory schooling is a much more sizable determinant of economic growth than years of

[1] In addition, Bjørnskov, Dreher and Fischer (2007) find that higher government consumption spending is related to less subjective well-being, perhaps through misallocation of resources or the inefficiencies generated through modern taxation schemes.

[2] For example Fölster and Henrekson (2001), Romero-Avila and Strauch (2008) and Bergh and Karlsson (2010) find negative effects on growth of various measures of government size. Kneller, Bleaney and Gemmell (1999) distinguish between different types of taxes and spending categories, and find that distortionary taxation reduces growth whilst productive government expenditure enhances growth, a result in accordance with Romero-Avila and Strauch (2008). Agell, Ohlsson and Thoursie (2006) argue that the estimated relationships are not causal.

[3] Zhang and Zhang (2004) find the opposite relationship. Ehrlich and Kim (2007) report that - not unsurprisingly in a growth context - the estimates are sensitive to whether the models condition on initial GDP or not.

education in the population. The strong effect of student achievement is confirmed by Jamison, Jamison and Hanushek (2007) and Hanushek and Wössmann (2009).

We construct an unbalanced country panel that utilizes data on comparative international tests in Mathematics and Science for the age group 13-15 years and includes eight tests in the period 1980-2003 for a maximum of 79 countries. This panel allows the application of panel data estimation methods, while existing studies utilizing cross-country variation in student achievement are almost exclusively based either on one single cross-section of individual student performances in the same test of a single year or on a cross-section of country aggregates in test performance averaged over several years, as in, e.g., Hanushek and Kimko (2000), Jamison et al. (2007), and Hanushek and Wössmann (2009).[4] In contrast, this paper exploits the panel structure in the test score data and estimates fixed effects models that account for unobserved heterogeneity across countries and common time-specific macroeconomic developments around the world. Our differences-in-differences approach suggests that more government redistribution activities exert an investment-lowering effect on students – be it either through the provision of goods (e.g. hospitals), but also through direct financial transfers to households (e.g. pension spending and active labor market policies), or when measured indirectly through the progressivity of the income tax schedule. The results are robust to a variety of model specifications, including models that condition on educational expenditures and the teacher-student ratio. The negative effect of welfare state generosity seems not to be mediated by resource use in education,

The empirical analysis is preceded by a simple theoretical model that relates the size and the scope of the welfare state to human capital investment in terms of student effort. The insurance aspect of the welfare state manifests in a system that both reduces the risk related to future income and that redistributes from high income individuals to low income individuals. In traditional human capital models (Becker, 1964), where educational outcomes are determined by rational individuals weighting costs and benefits, increased redistribution of income is predicted to weaken the incentive to invest in education. The prediction of the effect of reduced idiosyncratic risk in future income is more complicated and ambiguous.

This paper is related to the literature on educational effects of cash transfer programs in developing countries, which typically transfer money to poor families conditional on their investments in human capital. These evaluations provide clear evidence of positive effects on student enrollment and reduced dropout rates (see, e.g., the review by Rawlings and Rubio, 2005). However, such programs are not representative for the main portion of public expenditures because they include direct incentives for schooling. In addition, the recent

[4] The only exception seems to be Barro and Lee (2001a), who employ a panel of countries participating in international tests up to 1990 to estimate the effect of school inputs on student achievement.

evidence indicates that the cash transfer programs have no effect on student achievement (Ponce and Bedi, 2010; Behrman et al., 2009).

The paper proceeds as follows. The next section presents the theoretical considerations on the investment effects of government redistributive activities and derives the testable hypothesis. Section 3 describes the international student tests data and our measure of adjusted average student performance, and introduces our three measures of welfare state generosity. Section 4 presents the empirical model. Section 5 provides the main empirical findings and presents robustness tests related to potential omitted variables and results for subsamples. Section 6 offers some concluding comments.

2. Theoretical considerations

Numerous papers have analyzed the relationship between taxation, uncertainty, and education incentives, including Levhari and Weiss (1974), Eaton and Rosen (1980), Hamilton (1987), Glomm and Ravikumar (1992), Andersson and Konrad (2003), Konrad and Spadaro (2006), and Poutvaara (2007). To clarify relevant mechanisms in a simple framework, without discussing optimal tax and welfare policy, we present a partial two-period model where students' incentives in schools depends on exogenous redistribution of income and income uncertainty. At the outset we consider a model with one decision-maker - the student - but below we discuss its real-world applicability where other agents such as parents and teachers have an additional influence on student effort.

Consider a life-time utility maximizing individual living in two periods. In period one, she invests in her human capital. The investment is modeled as the time devoted to education, Z, instead of leisure L, where Z + L is normalized to unity. Effort at school has opportunity costs in terms of foregone leisure, but is an investment in future income. In period two, she consumes her return to education. Assuming separability over time, the life-time utility in expectational terms is

$$\mathrm{E}\{\mathrm{V}\} = \mathrm{u}(1-\mathrm{Z}) + \mathrm{rE}\{\mathrm{U(C)}\} \tag{1}$$

where r is the discount rate, C is consumption, and utility functions u and U are concave.

The welfare state is an institution that, in period two, transfers a fraction τ of the income from high income earners to individuals with low income, and thus reduces the consumption inequality in society. The uncertainty of the representative agent's future income is captured

by the stochastic return of her education investment (ε), where E(ε) = 0 and $\mathrm{Var}(\varepsilon)=\sigma^2$. We write consumption in period two as

$$C=(1-\tau)\,y(Z)(1+\varepsilon)+\tau\bar{y} \tag{2}$$

where the right hand side is the representative individual's expected income after redistribution. The deterministic part of the income is the productivity that depends on effort in school, y(Z), with diminishing returns ($y'(Z)>0,\ y''(Z)<0$). Because of income redistribution only a fraction (1–τ) of the consumption is related to own productivity, y, while the fraction τ is related to the average productivity in society, $\bar{y}$. This formulation implies that transfer-related income component can be written as $\tau\left(\bar{y}-y(Z)(1+\varepsilon)\right)$, and that individuals with the stochastic productivity y(1+ε) below (above) the societal mean productivity $\bar{y}$ will have a positive (negative) transfer. Thus, the redistribution factor τ is an indicator of the generosity of the welfare state – which we capture later in the empirical analysis by three different, partly overlapping measures of redistributive government activity. For simplicity, the implicit taxation and transfer rules are not written down in the model.

The individual maximizes equation (1) with respect to effort Z subject to constraint (2). The first order condition is

$$u'(1-Z)=(1-\tau)\,y'(Z)\,rE\left\{U'(C)(1+\varepsilon)\right\}. \tag{3}$$

In optimum, the marginal cost of effort is equal to the expected marginal return to effort. To keep the analysis simple, we assume the quadratic utility function $U_2(C)=\alpha C-\beta C^2/2$. Then the first order condition (3) can be written as $u'(1-Z)=(1-\tau)\,y'(Z)\,r\left[\alpha-\beta\left((1-\tau)\left(1+\sigma^2\right)y(Z)+\tau\bar{y}\right)\right]$. Calculation of the partial derivates is straightforward. Regarding the redistribution parameter τ, we have

$$\frac{dZ}{d\tau}=-\frac{1}{D}\left[\frac{u'(1-Z)}{1-\tau}+\beta(1-\tau)\,y'(Z)\,r\left(\bar{y}-\left(1+\sigma^2\right)y(Z)\right)\right] \tag{4}$$

where $D=\beta(1-\tau)^2\,r\left(1+\sigma^2\right)\left(y'(Z)\right)^2-u''(1-Z)-y''(Z)u'(1-Z)/y'(Z)>0$. The first term in the square bracket of equation (4) reflects that the incentive to invest in education is reduced when the extent of government redistribution, τ, rises and the return to education, r, declines. The sign of the second term depends on the relative income position ($\bar{y}$ - y) For

individuals with income below the mean $\bar{y}$, more redistribution increases income and decreases the marginal utility of consumption, which partially lowers investment in education. For rich people, however, income decreases and thus the marginal utility of consumption increases, partially working in the direction of higher investment. In principle, this indirect effect of income redistribution may be so strong that its total effect on education investment is positive. However, for a representative individual with income close to mean income,[5] the effect of redistribution on her optimal effort level is negative.

Regarding uncertainty, it follows that

$$\frac{dZ}{d\sigma^2} = -\frac{\beta(1-\tau)^2 r y'(Z) y(Z)}{D} < 0 \tag{5}$$

Increased uncertainty in the return to education, σ^2 , decreases investment in education. For example, the model of Levhari and Weiss (1974) predicts a similar relationship because individuals prefer less risky investments, all else equal.

The result that volatility in the return to education reduces education investment is, however, not universally true, but depends on theoretical assumptions. While our model considers the investment in effort at school as an asset, education investment may also have similarities with real options. In a model where education investment is the time devoted to non-compulsory education, and assuming that, after having left education for the labor market, the individual cannot return to education, Hogan and Walker (2007) show that investment is positively related to the uncertainty in the labor market: If a bad state of the labor market occurs, the individual can continue at school, but if a good state occurs, she can always switch to the labor market. As increased variability of the state of the labor market increases the upside payoff more than the downside payoff, the expected return to education investment rises. Jacobs (2007) reaches the same conclusion in a somewhat different model, in which he assumes that one can always leave the labor market again for education. Then increased variability in the return to education increases the probability that education investment is profitable at one point in time.

In this model, termination of education is not regarded as a choice variable, as we analyze determinants of education outcome at the compulsory level of schooling. For this reason, the mechanisms described by Hogan and Walker (2007) and Jacobs (2007), which rely on duration of education as an individual choice variable, are not directly applicable. However,

[5] Since mean income seems to be higher than median income in all income distributions, it is more reasonable to assume that the representative individual has income below the mean than above the mean.

the probabilities of enrolling in post-compulsory education and of being able to choose among a large range of higher education institutions are typically related to preceding school performance at the compulsory level. Thus, low effort in compulsory schooling reduces the probability of attaining the real option inherent in higher education.

So far, this model assumes that investment decisions are made by the student in isolation. In real life, however, parents and teachers influence their children's and students' effort levels through instructing and bargaining. This is an important aspect because parents and teachers are concerned about student effort at school, which may come about by altruistic, dynastic preferences of parents, and a mission or wage maximization of teachers. For reasons of simplicity, our model abstracts from these additional influences. In principle, however, the optimal effort level from the viewpoint of parents and teachers may be derived in the same way as the optimal student effort above, albeit some parameters of the model may be different. For example, children are likely to be more short-sighted than adults. In our model, their discount rate r may be lower, perhaps because of more pronounced hyperbolic discounting (see for example Laibson, 1997, or O'Donoghue and Rabin, 1999). Then it follows from equation (3) that the optimal effort level is higher for parents and teachers than for students, which results in attempts of the first to positively influence effort of the latter. In addition, it follows from equation (4) that the response to the welfare state is positively related to r, making the optimal effort level from the parents' and teachers' point of view more responsive to income redistribution than the optimal effort level from the student's point of view. Finally, the general comprehension in society of the importance of skills and knowledge, and the societal degree of risk aversion, also affect the parameters of the objective function. Thus, the actually observed student effort is likely to be a result of not only students' behavior, but also parental and teacher behavior, and country-specific factors such as culture and population risk aversion.

In our econometric analysis, we do not aim at determining specific parameters of the model above; dominating values and attitudes in a society are features which we account for by country fixed effects. Clearly, how changed macro-incentives are transmitted through schools, teachers, parents and students, cannot be revealed by the empirical strategy in this paper. Instead, the contribution of this paper is to make an attempt to empirically identify mechanisms through which governments' welfare and redistributive policies may affect aggregated student achievement.

From our model, the implicit function of education investment is

$$Z = f\left(\tau, \sigma_1^2, \bar{y}\right) = Z\left(g, \bar{y}\right) \tag{6}$$

where $g = g\left(\tau, \sigma_1^2\right)$ captures the common effects of the welfare state. The investment Z decreases in $\bar{y}$ because the utility function is concave, while the effect of the welfare state g is in general ambiguous. However, we regard redistribution of income, τ, as the dominating aspect of the welfare state, which has a negative effect on Z.

Our *testable hypothesis* is that a more generous welfare state lowers individuals' educational investments.

3. Data

3.1. International measures of student achievement

We rely on comparative international tests of student achievement conducted by different international organizations. The International Association for the Evaluation of Educational Achievement (IEA) has been responsible for the largest number of such tests, among them the TIMSS tests, but also the OECD has developed a Programme for International Student Assessment (PISA).

We construct a synthetic panel data set of the national averages of international tests on student performance covering a period of almost 25 years (1980 – 2003). Individual level data is not available for the tests prior to 1994/95, and the gain of exploiting micro-variation is limited in our setting because measures of government activities only vary at the national level. The tests cover the core subjects Reading, Mathematics and Natural Science separately, but we restrict our attention to student assessments in Mathematics and Science for several reasons. First, these two subjects have more similarities with each other than with Reading and are thus more suitable for constructing a synthetic panel. Second, reading skills are tested less regularly internationally, and even within the same test and year, potentially differ considerably by language. Third, performance in Mathematics and Natural Science are more likely to determine a country's innovativeness in an economic growth context, as empirically tested in Hanushek and Wössmann (2008). Comparability of test results is also given in the age dimension, as all tests included are conducted on middle-aged students (13-15 years).

Choosing this age group has also the advantage that compulsory schooling still applies, mitigating selection out of education issues. The tests we utilize are described in Table 1.[6]

Insert Table 1 about here

Recently, it has become common to report national averages based on Items Response Theory which weights the different questions by their difficulty ("Warm estimates", Warm, 1989), and standardizes the scores such that the average across all students across all countries participating is 500 with standard deviation of 100. Particularly the PISA studies employ this methodology. With this approach, the average score of a particular country will depend on the achievement of the students in the other participating countries. Thus, the test scores for a particular country are not comparable over time since the composition of participating countries changes. More importantly, for the tests prior to 1991, "Warm estimates" were not calculated, so we have to rely on the share of correct answers for these tests.[7]

To make the scores on the different international tests comparable on a common metric, we have re-scaled the average scores for each international test by the following procedure. First we calculate the average of the Mathematics and Science tests when both subjects are tested. Second, we standardize the average score for each test to have mean zero and standard deviation equal to unity for a "core" group of 15 countries. The "core" is defined as the countries that have participated in at least six out of the eight international tests reported in Table 1, namely Australia, Canada, Hong Kong, Hungary, Israel, Italy, Japan, Korea, Netherlands, New Zealand, Russia, Sweden, Thailand, UK, and USA.[8] Third, we re-scale the scores for each of the remaining countries using the same parameters as for the "core"

[6] Even though all tests are in the fields 'Mathematics' and 'Science', they do not necessarily test the same cognitive skill: The IEA tests are related to common elements of school curricula across countries while IAEP is geared towards the curriculum in USA building on the national testing procedures developed by the National Assessment of Education Progress NAEP. The OECD PISA test has a more real-world approach and claims to assess the skills that are considered to be essential for full participation in the society. The high correlation coefficient between the (adjusted) test results among various test types suggests that these differences are not important with respect to measured student performance. For the 18 countries participating both in TIMSS 2003 and PISA 2003, the correlation is 0.94, while the correlation between the average Science and Mathematics score in TIMSS-repeat 1999 and PISA 2000 is 0.87, and the corresponding number for IAEP 1991 and TIMSS 1995 is 0.80. Interestingly, as can be seen from Figure 2 below, USA had its poorest performance in the IAEP test that was based on the US curriculum.

[7] We have compared the Warm estimates and percent correct answers for the IEA tests in 1994-95 and 1998-99 for which both measures are available. The correlation coefficients for Mathematics are 0.997 and 0.982, respectively, and for Science 0.994 and 0.977, respectively. Thus, the differences across countries do not seem to be influenced in any important way by the choice of scale.

[8] More precisely, we standardize the score for those of the "core" countries that participated in the particular test. Out of the 15 "core" countries used to standardize the test scores, the data sources reports results for 11 countries in 1980-81, 12 in 1983-84, 8 in 1990-91, 15 in 1994-1995, 14 in 1998-99, 15 in OECD 2000, 13 in TIMSS 2003 and 13 in OECD 2003. Only USA has test scores for all tests.

countries. Finally, since some countries participated in two parallel tests in 2003 (TIMSS and PISA), we calculate the average of both tests in 2003.

Making the results from different tests comparable across time has been a challenge also for previous empirical studies. For example, Hanushek and Kimko (2000) calculate a measure of labor-force quality based on the percent of correct answers in international student achievement tests for the period 1965-1991. They adjust the mean for each test, but not the variance (except the linear scaling that follows from the adjustment of the mean). Adjusting the means across tests is crucial in their analysis because they subsequently calculate an aggregated 30-year average quality measure for each country. More recently, Hanushek and Wössmann (2009) utilize for their cross-section of national student performance tests from TIMSS, PISA and the IEA up to 2003 and, in addition to adjusting the means, they correct the dispersion of each single test in a similar way as ours.[9]

Figure 1a shows that the density of our measure of student achievement across the 15 "core" countries observations is close to the normal distribution. The density for all observations presented in Figure 1b has a long left tail, illustrating that some countries, mostly developing countries that participate less frequently in international tests, have low student achievement.

Insert Figures 1a and 1b about here

In a model with country-specific fixed effects, identification is only based on within-country variation. Figure 2 shows the development of test averages over time for the "core" countries. The figure indicates that there are some systematic changes. For example, the relative achievement in the more neo-liberal Western economies USA, Canada, and UK increased during the 1990s, while the achievement declined in Israel and in the transition countries Russia and Hungary. Some countries perform consistently better than others. For example, Italy performs below average and Netherlands performs above average in each test. However, Figure 3 shows that there is quite some variation in the *change* in student achievement, although the variation is lower than that for the distribution in *levels* of achievement.[10]

Insert Figures 2 and 3 about here

---

[9] Hanushek and Wössmann (2009) use as their "core" countries 13 OECD countries with "stable education systems", but they do not report which countries.

[10] In Figure 3, only observations with at most eight years interval are utilized.

Appendix Table A1 presents the 72 countries participation in the relevant international tests. 16 countries have only conducted one test, and will thus not contribute to the identification in models with fixed country effects. The table shows that the test score typically is low in developing countries, and that the within-country variation is relatively high.[11]

3.2. Independent variables: welfare state generosity and controls

Our focal determinant of student performance in this analysis is the generosity of the welfare state which is made operational in three ways: Firstly, we employ general government consumption spending (in percentage of GDP), obtained from the WDI (2007) database of the World Bank, a widely used measure of government production of goods and services that has been employed in various cross-country growth studies (Fölster and Henrekson, 2001, Agell et al., 2006) and happiness studies (Bjørnskov, Dreher, and Fischer, 2007 and 2008). Government consumption excludes financial transfers to single households, but includes the government production of goods and services, which are mostly financed by taxes. For example, government consumption spending includes expenses for hospitals, infrastructure, public transport, and culture – state expenses which all relax the income constraint on private households' consumption now and in the future. In addition, given that most publicly provided goods are financed through progressive tax systems, they entail a consumption redistribution aspect. Following the traditional public finance literature, we will refer to this measure as 'government consumption'.

Secondly, we use public sector social expenditures (in percentage of GDP) that are obtained from OECD *Social Expenditure database* (SOCX) and include aggregated public expenditures of all government tiers.[12] This measure captures direct transfers from government institutions to single households, including "benefits to, and financial contributions targeted at, households and individuals in order to provide support during circumstances which adversely affect their welfare, provided that the provision of the benefits and financial contributions constitutes neither a direct payment for a particular good or service nor an individual contract or transfer" (OECD, 2007, p. 7). OECD defines expenditures as 'social' if they satisfy two criteria: first, they have to intend a social purpose, and, second, these programs must be based on either inter-personal redistribution or compulsory participation (OECD, 2007, p. 8). They take the form of "cash benefits (e.g. pensions, income support during maternity leave, and social assistance payments), social services (e.g.

[11] The within-country variation tends to be high in countries with declining test scores such as Bulgaria and Hungary. Singapore had an exceptionally high score in TIMSS 1995.

[12] The OECD defines expenditures as 'public' (as opposed to being 'private') when institutions of the 'General Government' control the relevant financial flows. The 'General Government' in this context includes different levels of government and social security funds. This definition of 'public' includes, often by tradition, transfers by compulsory social insurances and social assistance schemes (see also OECD 2007, p.8-10).

childcare, care for the elderly and disabled) and tax breaks with a social purpose (e.g. tax expenditures towards families with children, or favorable tax treatment of contributions to private health plans)" (ibidem, p. 7), excluding the administrative costs of executing them.

By employing separate components of public social expenditure, we are able to differentiate government transfers by social policy area; pension payments, unemployment benefits, active labor market policy spending, family allowances, health care (service) spending, housing subsidies, and 'other spending'. Table 2 provides an overview of spending components. The major population is, in principle, entitled to all those spending programs so that each may exert an independent effect of its own. The correlation coefficient between government consumption spending and total social spending is equal to 0.67 in our sample.

Figure 4 presents within-country variation in total social expenditures as a share of GDP for the "core" countries. There is a tendency of increased social expenditures during the period of investigation. The average share of social expenditures in Figure 4 increases from 0.17 in 1980 to 0.19 in 2003.[13] The Netherlands is the only country which reduced social expenditures, while Japan has the largest growth. Notice that social expenditures as a share of GDP serve as automatic stabilizers and, thus, typically shrink in a boom and expand in a recession. Thus, it is important to include GDP in the empirical model in order to avoid identification on variation in national income.

Insert Figure 4 about here

Table 3 presents some descriptive statistics on government consumption in the world sample, and total social expenditures for OECD countries, including its single components. The variance in social expenditures is slightly higher than that for government consumption, both overall and within countries. The within country variation, for which we identify the effects on student achievement, constitutes 7-8 percent of the overall variance. Pension spending is the largest component of social expenditures, followed by public health spending.

Insert Tables 2 and 3 about here

---

[13] For all 29 OECD countries included in the empirical analyses, social expenditures increase from 17 percent of GDP in 1980 to 21 percent in 2003.

The third measure of the generosity of the welfare state that we employ is an index of income tax rate progressivity developed by the *Fraser Institute* (Gwartney and Lawson, 2002). The index constitutes an income-bracket adjusted marginal tax rate levied in the highest income bracket in one country, adjusted for the lowest income threshold for this income bracket. The redistributive impact of a given tax rate depends on the financial threshold the rate applies on. Since the index is adjusted for threshold effects it facilitates comparability of the marginal top income tax rate across countries and time. Progressive taxes are redistributive as they relax the financial constraint on poor households relative to richer households, but also since they finance provision of goods and services that equalize consumption patterns between the rich and the poor. The index of income tax progressivity ranges from 0 to 10, with higher values representing a higher top tax rate, and, thus, more redistribution of income. Between 1970 and 2000, data have been collected every five years, and annually from 2000. We have linearly interpolated missing values to maximize the number of observations in our regressions.

The regression-sample within-country variation for our three measures of welfare state generosity is presented in Appendix Table A1. For countries with relatively large variation in one or two variables, the variation of the third variable is often similar to the average. For example, during the 1990s Korea increased rapidly both social expenditures and the progressivity of the tax system, but without changing government consumption. On the other hand, in Ireland and the UK government consumption and tax progressivity declined markedly in the 1990s without much change in social expenditures. Thus, the subsample of countries that contribute most to the within-country variation in the empirical analysis will differ across the three measures.

Annual GDP and population data are taken from the WDI 2007 database. Adult education attainment is taken from Barro and Lee (2001b), which are available on a quinquennial basis up to the year 2000; missing values prior to 2000 have been linearly interpolated. We use the 3-years lag of the percentage of the population over age 25 with secondary school attained in order to include also the international tests after the year 2000 in the empirical analysis. In some robustness tests, we also use current data on primary school educational expenditures (% GDP) and pupil-teacher ratios from the World Bank. Again, we linearly interpolate the variables when there are missing values for at most five years.[14]

[14] From 1990 on, these data have roughly been collected on an annual basis.

4. Model specification and identification

We estimate the following model for student achievement Z of country i in year t

$$Z_{it} = \beta_1 g_{it} + \beta_2 \log(GDP/POP)_{it} + \beta_3 \log(POP)_{it} + \beta_4 EDU_{it} + \phi_i + \varphi_t + \varepsilon_{it} \quad (7)$$

where g_{it} is the measure of the welfare state generosity, while GDP per capita (GDP/POP) is the proxy for mean income $\bar{y}$, both derived from equation (6) in section 2. Family characteristics as parental income and education have strong effects in micro studies of student achievement, which is why we also include the share of adult population with at least some secondary education (EDU). Since we measure GDP in per capita terms, we also employ population size (POP). The time fixed effects φ_t account for macro-developments common to all countries, e.g. financial market crises and global recessions, but also for the fact that most of the independent variables have positive trends.[15] Country-specific fixed effects ϕ_i account for time-invariant differences between countries.

In our theoretical model, it is assumed that it is the *expected* welfare state arrangements in the future that affect educational investment decisions today. We argue that the contemporaneous level of government redistribution activities might be the best proxy for the expectations in our framework. The average spending level over time that may persist due to country's institutions is captured by the country fixed effects. However, it is the short-term within-country changes, conditional on GDP and population size, that drive the results in the difference-in-difference model. As educational production is cumulative, expectations of students and parents at earlier grades in the past are important for observed achievement today at the age of 13-15 years. Thus, contemporaneous levels of government redistribution are to some extent a leaded measure for the real decisions. However, we will also investigate the robustness of the results by using five-years moving averages in the independent variables in some model specifications.

Including country fixed effects in the model, which amounts to a difference-in-differences specification, is essential in order to interpret the estimated relationships. The school systems vary greatly across countries, for example with respect to school starting age and early tracking of students. In addition there might be differences across countries in culture for learning, risk aversion, and labor market institutions that are important for students'

[15] Notice that including time-specific effects may influence the interpretation of the results, as we discuss later. The scaling of the test scores makes the scores comparable over time so that, by including time fixed effects, the model in essence draws inference on which other countries that participated on the different test and year. Thus, we also report results where the time-specific effects are replaced by a simple trend.

investment decisions. However, all these characteristics change slowly at the national level, and are thus to a major extent captured by the country fixed effects.

One must, of course, nevertheless be careful in interpreting the estimated relationship between welfare state generosity and student performance as causal. As always for the difference-in-differences approach, the main source of concern is that important variables that vary over time in a way that is correlated with the variable of interest are missing from the analysis. We investigate the robustness of our results in several ways. First, we employ different measures of welfare state generosity which have different within-country variation. Second, we investigate whether omitted variables are likely to drive the results by expanding some models to include educational spending, unemployment, and the age composition of the population. Third, we estimate separate models for OECD countries that arguable are more homogenous that the world sample. All the independent variables are of course measured with some error, which in the standard case will bias the estimated effects towards zero.

Finally, there might in principle be reverse causality; public policy might respond on dissatisfactory school performance. However, even if welfare reforms often are related to poor economic performance and problems in the labor market, unsatisfactory performance of schools is to our knowledge not used as an argument for reduced generosity of welfare state arrangements.

5. Empirical Results

5.1. Government consumption

Table 4 presents results for government consumption spending including up to 72 countries and 232 observations. The first column simply presents the correlation between student achievement and government consumption spending as share of GDP. There is no unconditional correlation. Column (2) includes the control variables GDP per capita, adult educational attainment w.r.t. secondary education, population size, and time-specific fixed effects. The number of observations drops due to missing observations for adult education for some countries. As expected, we find strong positive effects of GDP per capita and adult education. The positive income effect mirrors Hanushek and Kimko (2000) who report a positive effect of student achievement on economic growth, and is in accordance with micro evidence on the effect of parental income on student performance. However, the result for GDP is not in accordance with our theoretical model where the utility function is concave. The positive effect of adult educational attainment mirrors results from previous micro-econometric studies.

The conditional effect of government consumption spending in column (2) is negative, as expected, appears sizeable and is significant at the 1 percent level. Thus, conditional on income, a small public sector is favorable as it increases student performance, and conditional on public sector size, students in rich and well-educated countries perform better than those living in poor and low-educated countries. When the share of government consumption increases by 0.1 log-points (approximately 10 percent) student achievement declines by 0.15 "core" country standard deviations.

Insert Table 4 about here

Columns (3) to (5) of Table 4 present models with country fixed effects that mitigate a potential omitted variable problem.[16] However, including country fixed effects in addition to year effects in column (3) does not change the point estimates of GDP and adult education attainment much compared to column (2), although the standard errors are twice as large as in the model with only time fixed effects (column (2)). On the other hand, the estimate of government consumption is small and insignificant.

In these fixed effects models, our variable of interest becomes sometimes insignificant so that identification of its effects needs to be discussed. The relative large standard errors in the models with country fixed effects in columns (3) to (5) may indicate that the within-country variations in student achievement and government consumption are too small for statistical identification. Notably, the OLS R^2 is as high as 0.94. However, it may equally be that it is the time-specific effects that complicate identification, e.g. in column (3). The purpose of the scaling of the test scores described above is to make the scores comparable over time. In consequence, with time-specific fixed effects, the model in essence draws inference on the change in composition of participating countries in a particular test and year. Our motivation for including year effects is that, on average, all the independent variables have positive trends. Indeed, while the p-value of joint significance of the time-specific fixed effects is 0.02 in the model in column (3) in Table 4, the p-value is only 0.13 when a simple trend is added. For this reason, we replace in column (4) the time fixed effects with such a time trend. The coefficient of the trend variable is negative, indicating a positive trend in the other independent determinants, as expected. The OLS R^2 appears only marginally lowered, while the within-R^2 is clearly reduced. Interestingly, the effect of government consumption spending is significantly negative in this specification. We conclude that it is not unobservable, time-

[16] The number of observations is reduced in the fixed effects models because only countries with at least two observations can contribute to the identification.

invariant country-specific factors that let the effect of government size appear insignificant in column (3), but the handling of the variation over time.

What kind of within-country variation in student achievement and government consumption is driving the results? Is it country-specific trends, or fluctuations around the trends? Figure 2 above suggests that some countries exhibit a trend-like development in student achievement. To investigate this question, column (5) in Table 4 expands the model with country-specific time trends. Then the effect of government consumption increases to about the same magnitude as in the model without country-specific fixed effects in column (2), and becomes highly significant again. Thus, it seems like it is the variation around country-specific trends that accounts for the association between government consumption and student achievement. This result is independent of whether the model includes time-specific fixed effects or not, and the increase in significance from the model in column (3) to the one in column (5) is not related to the fact that the number of countries that contribute to identification is necessarily smaller in the latter model.

In columns (6) through (8) of Table 4 we estimate the same models restricting our sample to OECD countries, to ease comparison with Table 5 below. We define the subsample of OECD countries by membership in the year 2000, but test later the robustness of our results for post-communist period effects (see section 5.5.). In the OECD sample, the effect of government consumption is significant in the model without country fixed effects (column (6)), with its coefficient size appearing independent of whether country fixed effects and country-specific trends are included in the model or not (columns (7) and (8)). The effect of -1 is remarkably similar to that in column (4) - the preferred model for the whole world sample. In columns (7) and (8), however the standard errors are relatively large. Nevertheless, the variation that drives these results appears to differ between OECD countries and non-OECD countries. While the variation across country-specific trends aids identifying a strong effect for the whole sample, inclusion of trends in the OECD sample does not influence the effect of government size.

In sum, we identify a negative impact of government consumption spending on student achievement. This evidence is in accordance with our hypothesis that a more generous welfare system generates disincentives for educational investment. The result indicates that when government consumption spending increases by 0.1 log-points, student achievement is reduced by about 0.1 “core” country standard deviations.

5.2. Social expenditures

Table 5 presents results for government total social expenditures, measured as share of GDP, available for 29 OECD countries, resulting in a sample of 124 observations. Column (1) shows that the unconditional correlation between welfare transfers to households and student achievement is negative and significant at 5 percent level. Inclusion of co-variates even increases the effect of social expenditures both in terms of magnitude and statistical significance (column (2)).[17] Also within OECD countries, there are positive impacts of GDP and adult education attainment. When country fixed effects are included (column (3)), the coefficient of social expenditures is still significant at 5 percent level, but larger in magnitude. Interestingly, it is of similar size as the point estimate of government consumption spending in Table 4. Column (4) shows that the results are not sensitive to whether the model includes time-specific fixed effects or a common time trend.

Insert Table 5 about here

However, when including country-specific time trends, the attainment-lowering impact of social expenditures completely disappears (column (5) of Table 5). We conclude that it is country-specific trends that drive the results, which indicates that in the OECD sample there are some systematic medium-term changes in government policy that students and parents react on.

In the last part of Table 5 we distinguish between different components of social expenditures relating to specific social policy areas such as health, family care, labor market, pension system, etc. In column (6) we replace total social expenditures with all its various components. All components have a negative sign as expected, except for 'health care spending', 'other spending', and 'family allowances'. Notably, the spending category 'other spending' is of a rather 'kitchen-sink' nature so that its estimate is not easy to interpret. The positive effect of family allowances is in fact significant at 10 percent level, which may indicate that relaxing parents' budget constraints in the poorest families may have an attainment-increasing effect on their children.

The positive correlations among the different social expenditure components may contribute to their heterogeneous and mainly insignificant effects in column (6). Thus, we have run regressions including each of the components separately. In all cases, the effects are negative, except for family allowances. Columns (7) and (8) in Table 5 report the two single cases of a

[17] The sample is smaller in column (2) than in column (1) of Table 5 because adult educational attainment is not available for Luxembourg.

minum statistical significance at the 10 percent level. .Both payments on active labor market policies and pension spending lower students' test scores, each with significance at 1 percent. Since the former constitutes only a small part of total social expenditures, the negative effect of social expenditures in columns (1) to (4) seems to a large part to be driven by pension spending.[18]

Taken all together, Table 5 shows that the effect of social spending in OECD countries is in accordance with the hypothesis that government redistribution activities create disincentives to human capital investment. Among the different types of welfare transfers, it is pension benefits that contribute most to this effect. Possibly, because of path dependency in policy-making, current changes in spending on pensions may have a strong predictive power on governments' future pension system policies, which are strongly redistributive in nature: in most developed countries, on the one hand, pensions systems guarantee an income-independent minimum rent to every contributor, while, on the other hand, they place a cap on the maximum rent, equalizing rent incomes in the non-active elderly population.

5.3. Tax progressivity

Table 6 uses the same model specifications as Table 4, but replaces the government consumption variable with a 10-point scale index of the top marginal income tax rate, adjusted for the income bracket, a measure of progressivity of the income tax system. For this welfare state generosity measure, there is a negative correlation with student achievement for the whole sample (column (1)), but the effect disappears when we include the control variables national income, population size and educational attainment in the population (column (2)). However, in the models with country-specific fixed effects in columns (3) and (4), the tax progressivity coefficient is significant at five and 10 percent levels, respectively. Column (5) suggests that the development of tax income progression over time is not captured by country-specific time trends, as the coefficient estimate as similar to those in columns (3) and (4), which exclude such country-specific trends. When the index of income tax progressivity increases by one standard deviation, which is about 2.5 points, student achievement is reduced by 0.21 adjusted "core" country standard deviations.

Insert Table 6 about here

---

[18] We are unable to exclude the possibility that more public expenditures on pension may equally proxy for a large body of civil servants. In this case, the prospects of becoming a civil servant with high job security and generous retirement options may equally lower effort in mandatory schooling.

How the effect of the variable of interest changes when we alter the model specification varies greatly between the government spending, social transfers and tax progressivity models (Tables 4-6), which indicates that the variables have very different features.[19] Nevertheless, the main result for all measures of welfare state generosity is that they tend to reduce student achievement. The quantitative effects of the adjusted top tax rate are difficult to compare to the other variables since using an index variable makes quantitative predictions difficult.

Regarding OECD countries, there is a strong negative effect of tax progressivity (column (6)) when the model does not include country fixed effects, but the effect disappears when country fixed effects are added. This finding is similar to the pattern observed for government consumption spending in the OECD countries (columns (6) to (8) of Table 4). In Table 6, it most possibly suggests that the conditional within-country variation of tax progressivity is too small to identify a statistically significant effect. Overall, using a measure of tax progressivity, we find convincing support for our hypothesis that student learning efforts decrease as the redistributive activities of the government expand.

5.4. Generosity of the welfare system

The sizes of government consumption and social spending, expressed in percentage of GDP, are commonly viewed as proxies for the generosity of redistributive activities by the government. However, in principle, generosity of social transfers can be more directly assessed when values per recipient of social benefits in place of per capita numbers are employed. However, precise information on number of recipients is not easily available. Thus, we analyze the effects of welfare state generosity by estimating models with those selected components of social expenditures for which appropriate population shares serving as proxies for number of recipients are available. We employ either the share of elderly in the population or the share of unemployed in the active population. Indeed, omission of beneficiary measures might have biased our previous results as the spending estimates might capture population composition effects: simple correlations of the spending measures with the number of their specific beneficiaries are large.[20]

In Table 7 we present results for models with measures of the number of recipients included. Taken all together, the results are not sensitive to inclusion of proxies for the number of beneficiaries. Pension spending and active labor market policy spending still exert a student performance lowering impact when the share of elderly and the unemployment rate,

[19] The correlation coefficient between government consumption spending (log) and the top marginal tax rate index is -0.44, and for the social spending (log) in OECD countries -0.30. Please note that financing of government activities also occurs through corporate taxation and indirect taxes on e.g. consumption goods.

[20] The correlation coefficients between unemployment spending and unemployment rate is 0.51 and between pension spending and the share of the population above the age of 60 is 0.86. The correlation between active labor market policy spending and the unemployment rate is only 0.17.

respectively, are included in the model (columns (1) and (2)), while the effects of unemployment and health care spending remain insignificant (columns (3) and (4)). The similarity of the coefficients on the spending variables with the original models reported in Table 5 suggests that the bias from using spending measured per GDP (conditional on population size) in place of per recipient is rather small. Regarding pension spending in column (1), the significance level is reduced to 5 percent when the share of elderly is included. While the share of the population above 60 years of age is insignificant, the test of joint significance clearly suggests that both variables are jointly related to student achievement. The effect of active labor market policies spending is equally lowered in significance (now at 5 percent level) when the unemployment rate is included (column (2)), while this time the test of joint significance clearly suggests that only one of the variables is related to student achievement.

Insert Table 7 about here

5.5. Robustness analyses

The student test scores from the 1980s are not average results for jointly conducted Mathematics and Science tests as those achievement tests in the post-1990 period, but separate tests on the two subjects. Another reason for restricting the sample to the post-1990 period is that many argue that test designs and test procedures have improved over time. Therefore, the dependent variable may incorporate a larger measurement error in the 1980s than in later periods. Table 8 presents results for regressions on the subsample for the 1990-2003 period. Columns (1)–(3) in the table show that the coefficients of all three measures of welfare state - government consumption spending, social transfers, and income tax progressivity - are in fact larger in this subsample compared to the full sample that includes the pre-1990 tests, although the effect of government consumption spending is still insignificant in the model with time-specific fixed effects.

Insert Table 8 about here

It might also be argued that government spending and social spending are proxies for educational expenditures. Notice, however, that the typical finding in the literature, both from studies using single country data and international data, is that educational expenditures and teacher-student ratios have at most a minor effect on student performance (e.g. Hanushek and Luque 2003). If, still, educational expenditures or education quality have a positive effect on

student achievement, their exclusion will bias the effect of welfare state size in our previous models since these variables are likely to be positively correlated. Thus, our previous coefficient estimates in Tables 4 to 6 may rather be biased downwards in absolute terms, providing a lower bound of welfare state effect. In columns (4) to (9) of Table 8 we add to our model educational expenditures per pupil in primary schools as a percentage of GDP and pupil–teacher ratios in primary schools from the World Bank education database.[21] The effects of educational expenditures and pupil–teacher ratio appear insignificant in all but one specification. Most important, the effects of government consumption, social expenditures, and the progressivity of the income tax system remain qualitatively unchanged when these measures of resource use and school quality in primary education are accounted for. Overall, we find no indication that the generosity of the welfare system and government public goods' creation proxies previously unobserved educational expenses or school quality.

Lastly, we investigate whether the choice of functional form of the empirical model is important. One may argue that it is not short-term fluctuations in the independent variables that are important, but the development in the medium or long term. We have carried out identical regressions as reported in Tables 4-6 using 5-year moving averages of the independent variable in place of using current values. The findings for government consumption spending appear partly sensitive to the choice of time window, although a robust and large performance lowering effect at the 1 percent level remains if country-specific time trends are included. The effect of social spending appears insignificant throughout, albeit their coefficients prevail in size and direction. In contrast, the student performance lowering impact of active labor market policies spending and pension benefit spending is strongly supported.[22] Estimation of 5-year moving averages corroborates the results for progressivity of the tax system for OECD countries (analogously to Table 6), while the coefficients for the full country sample are now smaller and insignificant, albeit all with negative signs.[23] Overall, the results for welfare state generosity appear insensitive to changes in model specification and sample selection.

[21] For secondary education, the number of observations was insufficient. The correlation coefficients of per pupil spending in primary education with our government consumption and social spending exceed well 0.5, while those with pupil-teacher ratio in primary education are -0.76 and -0.29, respectively.

[22] Significant at least at the 5 percent level. In addition, housing subsidies appear now conducive to student performance, (at the 5 percent level) in a similar manner as family allowances in the current value model.

[23] We have also investigated the sensitivity to the assumed functional form in logs. The analogous results for government consumption in Table 4 are similar and show, again, the importance of country-specific time trends to identify the effect of size of welfare state in the world sample. In contrast, the coefficients for social spending in the OECD become insignificant, suggesting a model misspecification. Results for single social spending components are, however, comparable to the results in Table 5.

6. Conclusion

The recent publications of international comparative student achievement tests such as PISA and TIMSS have spurred the debate on quality of public education in many countries. While most of the discussion has been centered around educational resource use and school organization, analyses of macro incentives implicit in government's economic policies are limited.

This paper studies the relationship between welfare state generosity and individuals' investment in human capital during compulsory education. We estimate differences-in-differences models accounting for unobserved country heterogeneity for the period 1980-2003 using international test scores in mathematics and science made comparable across testing institutions and test years. The results clearly suggest that the generosity of the welfare state has a deteriorating impact on student performance. Both the effect of government consumption spending per capita, the degree of progressivity of the income tax system, and, for OECD countries, the size of direct social transfers to households have a significant negative effect on student achievement. For the monetary measures of government activity we find that an increase by 10 percent reduces student achievement by about 0.1 standard deviations.

However, one needs to be cautious when drawing policy implications from our empirical results: the fact that findings in form of econometric 'point estimates' always must be interpreted as marginal, 'local' changes. Furthermore, our findings are for high- and middle-high income countries only – whether similar results can be found in other contexts remains an open question.

References

Agell, J., H. Ohlsson and P. S. Thoursie (2006): ”Growth effects of government expenditure and taxation in rich countries: A comment”. *European Economic Review* 50, 211-218.

Andersson, F. and K. A. Konrad (2003): “Human capital investment and globalization in extortionary states”. *Journal of Public Economics* 87, 1539-1555.

Barro, R. J., and J.-W. Lee (2001a): “Schooling quality in a cross-section of countries.” *Economica* 68, 465-488.

Barro, R. J., and J.-W. Lee (2001b): “International data on educational attainment: updates and implications.” *Oxford Economic Papers* 53, 541-563.

Becker, G.S. (1964). *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. Chicago, University of Chicago Press.

Behrman, J. R., S. W. Parker, and P. E. Todd (2009): “Medium-term impact of the Oportunidades conditional cash transfer program on rural youth in Mexico”. in S. Klasen and F. Nowak-Lehmann (eds), *Poverty, Inequality and Policy in Latin America,* Cambridge , MA: MIT Press.

Bergh, A., and M Karlsson (2010): “Government size and growth: Accounting for economic freedom and globalization”. *Public Choice* 142, 195-213.

Bjørnskov, C., Dreher, A. and Fischer, JAV (2007): "The bigger the better? Evidence of the effect of government size on life satisfaction around the world". *Public Choice* 127(3), 267-292.

Bjørnskov, C., Dreher, A. and Fischer, JAV, (2008). "Cross-country determinants of life satisfaction: exploring different determinants across groups in society". *Social Choice and Welfare* 30(1), 119-173.

Eaton, J. and H. Rosen (1980): "Taxation, human capital and uncertainty," *American Economic Review* 70, 705-715.

Ehrlich, I., and J. Kim (2007): "Social security and demographic trends: Theory and evidence from the international experience", *Review of Economic Dynamics* 10, 55-77.

Ehrlich, I. and J. G. Zhong (1998): "Social security and the real economy: An inquiry into some neglected issues". *American Economic Review* 88, 151-157.

Fossen, F. M. and D. Glocker (2011): "Expected future earnings, taxation, and university enrollment". *International Tax and Public Finance* 16, 688-723.

Fölster, S. and M. Henrekson (2001): "Growth effects of government expenditure and taxation in rich countries". *European Economic Review* 45, 1501-1520.

Glomm, G., and B. Ravikumar (1992): "Public versus private investment in human capital: Endogenous growth and income inequality". *Journal of Political Economy* 100, 818-834.

Gwartney, J. and R. Lawson. (2002), *Economic Freedom of the World: 2002 Annual Report*. Vancouver: Fraser Institute.

Hamilton, J. H. (1987): "Optimal wage and income taxation with wage uncertainty". *International Economic Review* 28, 373-388.

Hanushek, E. A. and D. D. Kimko (2000): "Schooling, labor-force quality, and the growth of nations". *American Economic Review* 90, 1184-1208.

Hanushek, E. A. and J. A. Luque (2003): "Efficiency and equity in schools around the world". *Economics of Education Review* 22, 481-502.

Hanushek, E. A. and L. Wössmann (2008): "The role of school improvement in economic development". *Journal of Economic Literature* 46, 607-668.

Hanushek, E. A. and L. Wössmann (2009): "Do better schools lead to more growth? Cognitive skills, economic outcomes, and causation". NBER Working Paper 14633.

Hogan, V. and I. Walker (2007): "Education choice under uncertainty: Implications for public policy". *Labour Economics* 14, 894-912.

Jacobs, B. (2007): "Real options and human capital investment". *Labour Economics* 14, 913-925.

Jamison, E. A., D. T. Jamison and E. A. Hanushek (2007): "The effects of education quality on income growth and mortality decline". *Economics of Education Review* 26, 771-788.

Kneller, R., M. Bleaney and N. Gemmell (1999): “Fiscal policy and growth: Evidence from OECD countries”: *Journal of Public Economics*, 74, 171-190.

Konrad, K. A. and A. Spadaro (2006): “Education, redistribution taxation and confidence”. *Journal of Public Economics* 90, 171-188.

Laibson, D. (1997): “Golden eggs and hyperbolic discounting”. *Quarterly Journal of Economics* 112, 443-477.

Lee, J.-W., and R. J. Barro (1997): “Schooling Quality in a Cross-Section of Countries” *Economica* 68, 465-488. Data on http://www.nber.org/pub/barro.lee/

Levhari, D. and Y. Weiss (1974): "The effect of risk on investment in human capital". *American Economic Review* 64, 950-963.

O’Donoghue, T., and M. Rabin (1999): “Doing it now or later”. *American Economic Review* 89, 103-124.

OECD (2007): “$ocial €xpenditure 1980-2003: Interpretative Guide of SOCX”, Paris: OECD 2007.

Ponce, J., and A. S. Bedi (2010): “The impact of a cash transfer program on cognitive achievement: The Bono de Desarrolle Humano of Equador”. *Economics of Education Review* 29, 116-125.

Postlethwaite, T. N., and D. E. Wiley (1992): “The IEA study of science II: Science achievement in twenty-three countries”. Pegamon Press, New York

Poutvaara, P. (2007): “Social security incentives, human capital investment and mobility of labor”. *Journal of Public Economics* 91, 1299-1325.

Rawlings, L. B., and G. M. Rubio (2005): “Evaluating the impact of conditional cash transfer programs”. *The World Bank Research Observer* 20, 29-55.

Romero-Avila, D., and R. Strauch (2008): “Public finances and long-term growth in Europe: Evidence from a panel analysis”. *European Journal of Political Economy* 24, 172-191.

Sinn, H.-W. (1995): “A Theory of the Welfare State”. *Scandinavian Journal of Economics* 97, 495- 526.

Travers, K. J., and I. Westbury, eds. (1989): "The IEA Study of Mathematics I: Analysis of Mathematics Curricula". Pergamon Press, New York.

Warm, T.A. (1989). "Weighted Maximum Likelihood Estimation of Ability in Item Response Theory". *Psychometrika*, 54, 427-450.

Wössmann, L. (2003): "Schooling Resources, Educational Institutions and Student Performance: the International Evidence". *Oxford Bulletin of Economics & Statistics* 65, 117-170.

Zhang, J. and J. Zhang (2004): "How does social security affect economic growth? Evidence from cross-country data". *Journal of Population Economics* 17, 473-500.

Table 1. Data sources description

Year	Test organization	Acronym	Test subjects	Test age or grade	Countries	Data source
1980-81	IEA	SIMS	Mathematics	13 years	3 in 1980 14 in 1981	Lee and Barro (1997) Travers and Westbury (1989)
1983-85	IEA	SISS	Science	14 years	11 in 1983 11 in 1984 1 in 1985	Postlethwaite and Wiley (1992)
1990-91	IAEP	IAEP	Mathematics and Science	13 years	2 in 1990 17 in 1991	Lee and Barro (1997)
1994-95	IEA	TIMSS	Mathematics and Science	Grade 8	4 in 1994 36 in 1995	timss.bc.edu/
1998-99	IEA	TIMSS-repeat	Mathematics and Science	Grade 8	6 in 1998 31 in 1999	timss.bc.edu/
2000-02	OECD	PISA 2000	Mathematics and Science	15 years	32 in 2000 9 in 2002	www.pisa.oecd.org
2002-03	IEA	TIMSS 2003	Mathematics and Science	Grade 8	7 in 2002 38 in 2003	timss.bc.edu/
2003	OECD	PISA 2003	Mathematics and Science	15 years	40 in 2003	www.pisa.oecd.org

Note. For some countries separate scores are reported for different parts of the country. We have calculated mean country averages by using population as weight. IEA (except the 1983/84 test) and IAEP tests are conducted in the fall in the southern hemisphere and in the spring in the northern hemisphere. PISA 2000 originally only included five non-OECD countries, but nine additionally non-OECD countries conducted the same test in 2002.

Table 2. Types of social expenditures in OECD countries

Policy area	Programs
Old-age	Pensions, early retirement pensions, home-help, residential services for the elderly.
Survivors	Pensions and funeral payments.
Incapacity-related	Care services, disability benefits, benefits accruing from occupational injury and accident legislation, employee sickness payments.
Health	Spending on in- and out-patient care, medical goods, prevention.
Family	Child allowances and credits, childcare support, income support during leave, sole parent payments.
Active labour market policies	Employment services, training youth measures subsidised employment, employment measures for the disabled.
Unemployment	Unemployment compensation, severance pay, early retirement for labour market reasons.
Housing	Housing allowances and rent subsidies.
Other social policy areas	Non-categorical cash benefits to low-income households, other social services; i.e. support programmes such as, food subsidies, which are prevalent in some non-OECD countries.

Note. Source is Social Expenditure 1980-2003, OECD 2007, p.8.

Table 3. Descriptive statistics of government consumption and social expenditures

	Obser-vations	Mean	Standard deviation overall	Standard deviation within countries	Minimum value	Maximum value
General government consumption spending, percent of GDP	232 (All)	17.65	5.39	1.46	5.69	41.47
General government consumption spending, percent of GDP	124 (OECD)	18.90	4.22	1.05	10.08	29.62
Public sector social expenditures, percent of GDP	124 (OECD)	19.62	5.61	1.62	2.8	32.5
Active labor market policy spending, share of GDP	120 (OECD)	0.61	0.44	0.20	0	2.2
Public health spending, share of GDP	124 (OECD)	5.56	1.28	0.55	1.4	8.3
Family allowance spending, share of GDP	124 (OECD)	1.90	1.08	0.31	0	4.1
Unemployment benefit spending, share of GDP	120 (OECD)	1.17	0.90	0.44	0	4.4
Pension spending, share of GDP	124 (OECD)	6.38	2.76	0.76	0.6	12.8
Housing spending, share of GDP	102 (OECD)	0.42	0.39	0.17	0	1.8
Other social spending, share of GDP	99 (OECD)	4.00	1.38	0.64	1.50	8.90

Table 4. The effect of government consumption on student achievement

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Gov. consumption spending, percent of GDP (log)	0.107	-1.462**	-0.650	-1.021*	-1.596**	-1.100**	-1.060	-1.086
	(0.414)	(0.378)	(0.509)	(0.486)	(0.558)	(0.377)	(0.945)	(1.551)
GDP per capita (log)	-	1.502**	1.234*	1.123*	2.056**	0.483	1.451	3.735*
		(0.213)	(0.485)	(0.475)	(0.748)	(0.292)	(0.698)	(1.473)
Percentage secondary school attained among adults (log)	-	0.763**	0.510	0.736*	2.238**	1.268**	0.424	1.454
		(0.292)	(0.409)	(0.371)	(0.836)	(0.271)	(0.639)	(1.052)
Population size (log)	-	0.040	2.279*	1.515	-8.492	-0.048	5.221*	-11.04
		(0.77)	(1.046)	(0.978)	(6.758)	(0.62)	(2.241)	(8.728)
Trend	-	-	-	-0.041**	-	-	-	-
				(0.014)				
Country fixed effects	No	No	Yes	Yes	Yes	No	Yes	Yes
Time fixed effects	No	Yes	Yes	No	Yes	Yes	Yes	Yes
County specific trends	No	No	No	No	Yes	No	No	Yes
Observations	232	208	197	197	187	128	128	124
No of countries	72	59	48	48	43	28	28	26
Sample	All	All	All	All	All	OECD	OECD	OECD
R^2	0.0003	0.455	0.943	0.937	0.982	0.301	0.851	0.932
R^2 (within)	-	-	0.222	0.133	0.740	-	0.298	0.679

Note. Absolute standard errors in parentheses, +, * and ** denote significance at 10, 5 and 1 percent level, respectively.

Table 5. The effect of social expenditures on student achievement

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Gov. social expenditures, percent of GDP (log)	-0.488** (0.223)	-0.670** (0.230)	-0.997* (0.464)	-0.899+ (0.457)	0.505 (1.070)	-	-	-
GDP per capita (log)	-	0.717* (0.315)	0.523 (0.895)	1.508+ (0.863)	6.500** (2.355)	-0.686 (1.262)	0.546 (0.872)	-0.008 (1.000)
Percentage secondary school attained among adults (log)	-	1.225** (0.275)	0.548 (0.627)	0.433 (0.604)	0.572 (1.167)	-0.026 (1.255)	0.671 (0.6216	0.444 (0.704)
Population size (log)	-	-0.028 (0.61)	4.448+ (2.398)	2.865 (2.371)	-11.63 (9.178)	-2.474 (4.845)	3.653 (2.323)	4.268 (3.132)
Trend	-	-	-	-0.031 (0.022)	-	-	-	-
Pension spending (log)	-	-	-	-	-	- 2.470* (1.033)	- 0.986** (0.333)	-
Active labor market policy spending (log)	-	-	-	-	-	-0.392 (0.298)	-	- 0.576** (0.191)
Unemployment spending (log)	-	-	-	-	-	-0.317 (0.210)	-	-
Family allowances (log)	-	-	-	-	-	0.824+ (0.422)	-	-
Health care spending (log)	-	-	-	-	-	0.208 (0.814)	-	-
Housing spending (log)	-	-	-	-	-	-0.042 (0.198)	-	-
Other spending (log)	-	-	-	-	-	0.912 (0.667)	-	-
Country fixed effects	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Country-specific trends	No	No	No	No	Yes	No	No	No
Observations	124	121	121	121	118	80	121	113
No of countries	29	28	28	28	26	19	28	28
R^2	0.038	0.339	0.861	0.835	0.932	0.825	0.868	0.863
R^2 (within)	-	-	0.258	0.118	0.665	0.571	0.293	0.376

Note. Absolute standard errors in parentheses, +, * and ** denote significance at 10, 5 and 1 percent level, respectively.

Table 6. The effect of tax progressivity on student achievement

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Income tax rate progressivity	-0.141*	-0.009	-0.086*	-0.074+	-0.074	-0.133**	-0.025	0.018
	(0.058)	(0.059)	(0.042)	(0.039)	(0.057)	(0.046)	(0.050)	(0.066)
GDP per capita (log)	-	1.297**	1.113*	1.031+	2.118+	0.001	1.399+	4.794**
		(0.226)	(0.558)	(0.523)	(1.197)	(0.258)	(0.772)	(1.534)
Percentage secondary school attained among adults (log)	-	0.945**	-0.601	-0.51	1.013	1.403**	-0.067	0.637
		(0.336)	(0.496)	(0.449)	(1.043)	(0.285)	(0.671)	(1.258)
Population size (log)	-	0.109	0.654	-0.632	0.857	0.005	4.553	-1.245
		(0.085)	(1.245)	(1.178)	(10.023)	(0.061)	(2.789)	(10.999)
trend	-	-	-	-0.006	-	-	-	-
				(0.017)				
Country fixed effects	No	No	Yes	Yes	Yes	No	Yes	Yes
Time fixed effects	No	Yes	Yes	No	Yes	Yes	Yes	Yes
County specific trends	No	No	No	No	Yes	No	No	Yes
Observations	206	180	180	180	180	116	116	116
No of countries	64	56	56	56	56	28	28	28
Sample	All	All	All	All	All	OECD	OECD	OECD
R^2	0.029	0.387	0.958	0.952	0.983	0.280	0.855	0.939
R^2 (within)	-	-	0.188	0.066	0.674	-	0.290	0.700

Note. Absolute standard errors in parentheses, +, * and ** denote significance at 10, 5 and 1 percent level, respectively.

Table 7. Generosity of the welfare state: OECD countries

	(1)	(2)	(3)	(4)
GDP per capita (log)	0.766	-0.156	0.975	1.029
	(0.919)	(1.340)	(1.211)	(0.963)
Percentage secondary school attained among adults (log)	0.707	0.747	1.578+	0.357
	(0.658)	(0.832)	(0.846)	(0.668)
Population size (log)	2.969	2.919	5.581+	2.619
	(2.437)	(3.523)	(2.885)	(2.518)
Pension spending (log)	-1.057*	-	-	-
	(0.502)			
Active labor market policy spending (log)	-	-0.544*	-	-
		(0.209)		
Unemployment spending (log)	-	-	-0.112	-
			(0.182)	
Health care spending (log)	-	-	-	0.104
				(0.590)
Share of elderly (log)	-0.783	-	-	-2.048*
	(0.964)			(0.868)
Unemployment rates	-	-0.027	0.000	-
		(0.032)	(0.037)	
Country fixed effects	yes	yes	yes	Yes
Time fixed effects	yes	yes	yes	Yes
Observations	110	110	113	110
Countries	27	28	27	27
R^2	0.8632	0.8687	0.8479	0.8544
R^2 (within)	0.3328	0.3995	0.3079	0.2902
F-test of joint significance	5.5078	3.458	0.2524	3.1086
(p-value)	0.006	0.0372	0.7776	0.051

Note. Absolute t-values in parentheses, +, * and ** denote significance at 10, 5 and 1 percent level, respectively.

Table 8. Post-1990 period and school quality measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Gov. consumption expenditures, percent of GDP (log)	-0.856 (0.569)	-	-	-0.924 (0.637)	-	-	-0.587 (0.550)	-	-
Gov. social expenditures, percent of GDP (log)	-	-1.360* (0.537)	-	-	-1.496** (0.563)	-	-	-1.394** (0.511)	-
Income tax rate progressivity	-	-	-0.093+ (0.054)	-	-	-0.116* (0.046)	-	-	-0.132** (0.049)
GDP per capita (log)	0.554 (0.577)	0.659 (1.008)	0.412 (0.676)	1.579* (0.616)	0.152 (1.024)	2.005** (0.697)	1.347* (0.542)	1.216 (1.030)	0.901 (0.618)
Percentage secondary school attained among adults (log)	-0.498 (0.717)	0.658 (1.077)	-1.039 (0.878)	-1.168+ (0.646)	-0.168 (0.868)	-1.426+ (0.768)	1.154* (0.533)	0.571 (0.794)	-0.166 (0.725)
Population size (log)	2.836+ (1.557)	4.303 (4.117)	1.579 (1.771)	1.178 (1.516)	6.258 (4.087)	0.906 (1.466)	1.647 (1.190)	2.266 (3.189)	0.628 (1.363)
Primary education expenditures per pupil, percent of GDP (log)	-	-	-	0.412 (0.295)	0.433 (0.341)	0.579* (0.287)	-	-	-
Pupil-teacher ratio in primary education	-	-	-	-	-	-	-0.005 (0.032)	0.048 (0.031)	-0.003 (0.033)
Sample	All	OECD	All	All	OECD	All	All	OECD	All
Time period 1990 - 2003	yes	yes	yes	no	no	no	no	no	no
Country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	177	102	163	166	104	152	185	103	160
Countries	58	28	56	52	27	50	58	27	55
R^2	0.9617	0.8791	0.9626	0.9558	0.8740	0.9609	0.9484	0.8833	0.9645
R^2 (within)	0.2251	0.3290	0.1744	0.2377	0.3010	0.3161	0.2462	0.3398	0.2094
F-test (social spending, school quality)				1.5582	3.749	4.3742	0.5928	5.2155	3.9535
(p-value)				0.2156	0.029	0.0155	0.5545	0.0081	0.0226

Note. Absolute t-values in parentheses, + * and ** denote significance at 10, 5 and 1 percent level, respectively.

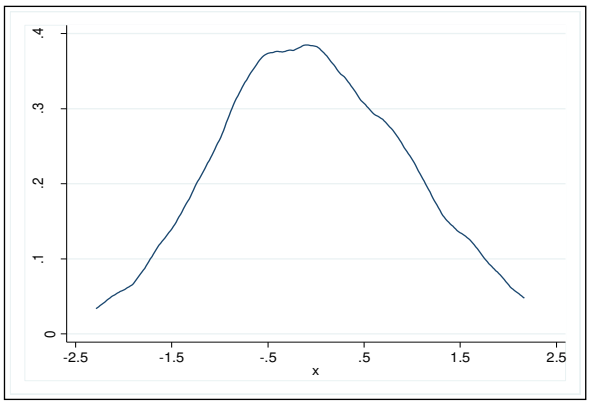
Appendix Table A1. Participating countries and within-country variation

	Number of relevant international tests	Mean value dependent variable	Difference between maximum and minimum values observed in the regression sample			
			Dependent variable	Log(government consumption)	Log(Social expenditures)	Income tax progressivity
Albania	1	-3.17	0	0	-	-
Argentina	1	-2.86	0	0	-	0
Armenia	1	-2.02	0	0	-	-
Australia	6	0.13	0.89	0.08	0.34	2
Austria	3	0.18	0.57	0.10	0.05	0
Bahrain	1	-3.81	0	0	-	0
Belgium	4	0.12	0.57	0.10	0.05	1
Botswana	1	-5.74	0	0	-	0
Brazil	3	-4.45	1.93	0.01	-	0
Bulgaria	4	-0.77	2.35	0.22	-	5
Canada	7	0.11	1.05	0.24	0.34	2
Chile	2	-4.07	0.87	0.11	-	0.4
China	3	1.19	1.14	0.02	-	1.6
Colombia	1	-5.46	0	0	-	0
Cyprus	3	-2.37	1.01	0.04	-	3
Czech Republic	4	0.47	1.36	0.11	0.15	2
Denmark	3	-0.84	1.57	0.05	0.11	1
Egypt,	1	-4.03	0	0	-	0
Estonia	1	0.55	0	0	-	0
Finland	5	0.36	1.31	0.16	0.20	1.6
France	5	-0.09	1.29	0.08	0.27	2.4
Germany	3	-0.44	0.49	0.03	0.04	2
Ghana	1	-9.32	0	0	-	0
Greece	3	-1.51	0.49	0.14	0.10	0
Hong Kong	6	0.52	2.38	0.42	-	0
Hungary	7	0.57	2.49	0.12	0.10	5
Iceland	3	-0.71	1.73	0.16	0.20	2
Indonesia	3	-3.39	0.68	0.21	-	1.2
Iran	3	-3.19	0.72	0.28	-	5.6
Ireland	4	-0.49	1.27	0.22	0.18	2
Israel	6	-1.04	1.49	0.37	-	3.4
Italy	6	-1.00	1.60	0.12	0.20	5.8
Japan	6	1.49	1.00	0.25	0.54	3
Jordan	3	-3.21	1.67	0.43	-	0
Korea	6	1.24	1.94	0.18	0.81	4.2
Kuwait	1	-4.95	0	0	-	-
Latvia	4	-1.05	1.32	0.16	-	2
Lebanon	1	-4.05	0	0	-	-
Lithuania	3	-1.37	1.82	0.18	-	0
Luxembourg	3	-1.35	1.26	0.17	0.22	0
Macedonia	3	-2.68	0.82	0.08	-	-

Malaysia	2	-0.57	0.07	0.35	-	0.4
Mexico	2	-2.88	0.68	0.11	0.16	0
Moldova	2	-1.99	0.32	0.64	-	-
Morocco	2	-5.41	1.19	0.09	-	0.2
Mozambique	1	-8.79	0	0	-	-
Netherlands	6	0.79	0.83	0.12	0.27	2.6
New Zealand	6	-0.28	1.39	0.17	0.15	1.8
Nigeria	1	-2.58	0	0	-	0
Norway	4	-0.60	1.09	0.18	0.12	2.2
Peru	1	-4.77	0	0	-	0
Philippines	3	-4.91	1.68	0.62	-	0
Poland	3	-0.39	0.77	0.04	0.08	0
Portugal	4	-2.03	1.47	0.15	0.47	1
Romania	3	-1.86	0.50	0.88	-	4
Russian Federation	5	-0.16	1.65	0.27	-	2
Saudi Arabia	1	-5.76	0	0	-	-
Serbia and Montenegro	2	-1.44	1.11	0	-	-
Singapore	4	1.71	4.40	0.39	-	1
Slovak Republic	3	0.12	0.71	0.06	0.09	1
Slovenia	3	0.04	1.23	0.04	-	0
South Africa	3	-8.56	2.00	0.08	-	1.4
Spain	4	-1.03	0.78	0.05	0.06	4
Swaziland	1	-2.50	0	0	-	-
Sweden	5	-0.30	1.17	0.12	0.13	5.6
Switzerland	4	0.38	1.15	0.07	0.35	1
Thailand	6	-1.37	1.76	0.29	-	1
Tunisia	2	-3.33	1.44	0.01	-	0
Turkey	2	-2.59	0.54	0.11	0	0.4
United Kingdom	7	-0.28	1.35	0.19	0.13	6.2
U.S.A.	7	-0.73	1.15	0.18	0.20	4.2
Uruguay	1	-2.33	0	0	-	0

Figure 1. Kernel density of student achievement

a) "Core" country observations



b) All observations

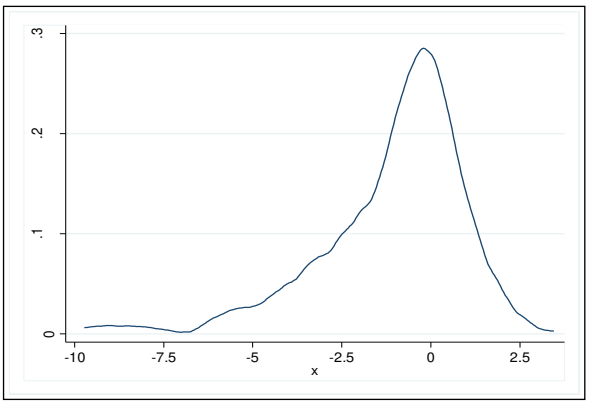
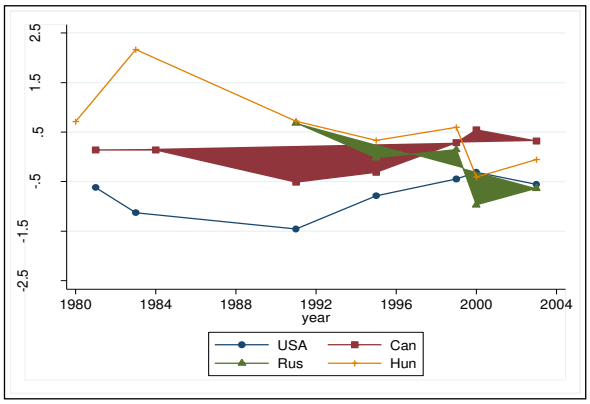
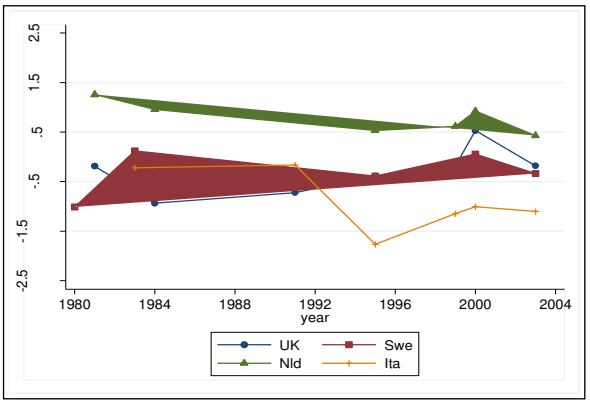
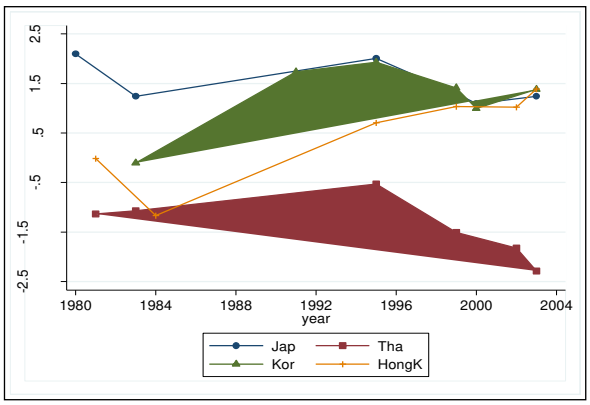


Figure 2. Country-specific development in relative student achievement.







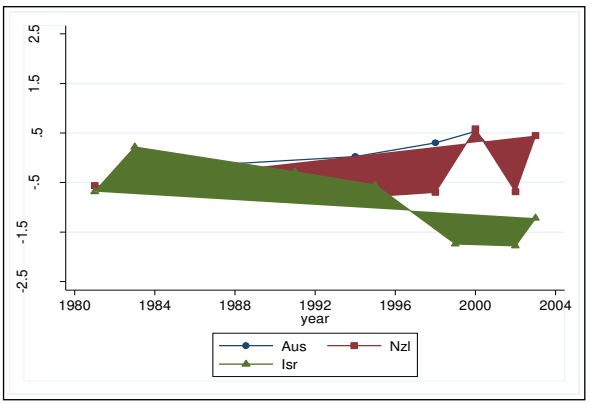


Figure 3. Kernel density of change in student achievement

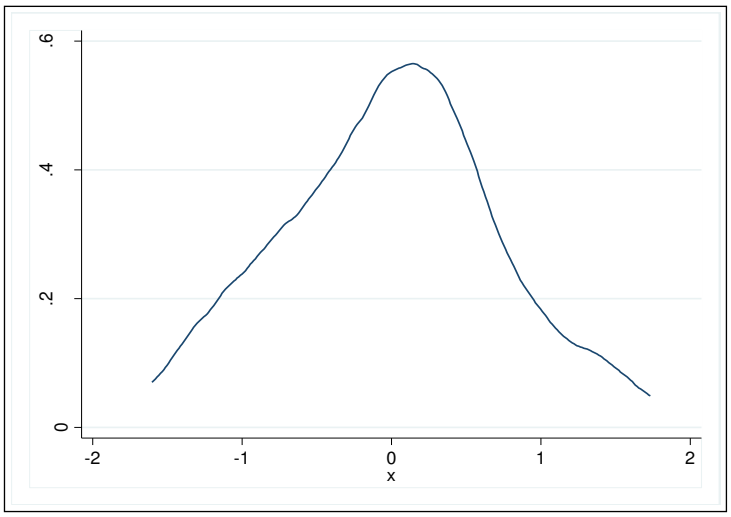


Figure 4. Country-specific development in social expenditures as share of GDP