TECHNISCHE UNIVERSITÄT DRESDEN
Fakultät Wirtschaftswissenschaften

# PUBLIC EDUCATION SPENDING IN THE GERMAN LÄNDER: ADJUSTMENT TO DEMOGRAPHIC SHOCKS, POLITICS, AND COST EFFICIENCY

Dissertation zur Erlangung des akademischen Grades
Dr. rer. pol.

vorgelegt von

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Tag der Verteidigung
18. Dezember 2009

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Meinen Eltern und Geschwistern

# ACKNOWLEDGEMENTS

First and foremost, I sincerely thank my supervisor, Helmut Seitz, who died in April 2009, shortly after I had submitted this dissertation. Professor Seitz provided support and motivation within a nice and inspiring working atmosphere. He freely shared his expertise in public finance, econometrics and institutional settings in Germany. I miss his presence.

I am grateful to Marcel Thum and Alexander Kemnitz for stepping in to act as referees and for chairing the lunch-time seminars at TU Dresden. These seminars, along with summer school courses and several conferences, helped very much to improve my work. I acknowledge the encouragement and remarks from fellow participants in summer courses and conferences, especially Frank Neffke and Elvire Guillaud.

Much of Chapter 4 was written while I was a guest of the Department of Economics at the Norwegian University of Science and Technology in Trondheim from February through June 2008. I will remember the department's warm reception, hospitality and helpful comments. Special thanks go to Torberg Falch, Bjarne Strøm, Linn Renée Naper, Per Tovmo and Wenting Chen.

I also thank Christian von Hirschhausen, Astrid Cullmann and Borge Hess for their doctoral courses on efficiency analysis, which laid the groundwork for Chapter 5.

Over the years I have shared in economic, and not so economic, discussions over coffee and other breaks with my colleagues and fellow doctoral students at Technische Universität Dresden: Dirk Freigang, Borge Hess, Michael Hofmann, Sören Högel, Susann Kühn, Carsten Pohl, Gunther Markwardt, Anne Neumann and Diana Zdravkovic among many others.

I have benefitted from financial support of the German Research Foundation (DFG) under the Priority Programme, "Institutional Design of Federal Systems – Theory and Empirical Evidence" (SPP 1142, Project: SE 540/2-2). Thank you very much.

Frankfurt am Main, January 2010 Gerhard Kempkes

# 1 INTRODUCTION

*"Friede in Sicht! Im dreißigjährigen Schulkrieg zeichnen sich Lösungen ab"* [1]
(Spiewak, 2008, 39).

Ideological discussions about the design of Germany's education system have shaped the public debate about education since the implementation of the first comprehensive schools in the early 1970s. However, Spiewak (2008) notes a widespread perception that these discussions are currently losing strength. As international assessments of student performance, such as the Programme for International Student Assessment (PISA) become popular throughout the industrialised world, the education policies of Germany's leading political parties appear to converge, becoming more evidence-based. The broadly discussed PISA results increase transparency and accountability of education systems around the world; cross-country comparisons have revealed their effectiveness and efficiency. At the same time, education and the creation of human capital are increasingly considered of crucial importance for securing high living standards. The German education system, strongly dominated by the public sector, faces tight public budgets and pronounced demographic shifts. Taken together, these factors increase the pressure on public authorities to improve the current education system, while at the same time diminishing the ideological debate.

Against this background, I take a closer look at the German education system. I first examine several historical issues – the ideological conflicts in the West German education system – and issues that already reflect the future challenges of public education – by analysing the effects of the strong demographic changes on public education in the East German Länder. Education policy at the primary, secondary and higher education levels is also considered.

In particular, I analyse the effects of strong *demographic shifts* by considering how the East German Länder responded to the rather dramatic decline in the number of students in primary schools (Chapter 3). The demographic shock is a consequence of collapsing birth rates after German Reunification. Previous results from the literature, which rely

[1] "Peace in sight! A solution to the Thirty Year's School-War is near".

on data from rather stable demographic periods, suggest that public resources are incompletely adjusted to shrinking cohort size such that large reductions in the student population translate into important increases in spending per student and not in significant reductions of public resources allocated to education. My empirical analysis suggests, however, that resource adjustments have been considerable, especially in the years when student cohorts were actually decreasing. Adjustments have been less tight in the period when student numbers stagnated such that the 50% decrease in cohort size has translated into a 25% increase in the teacher/student-ratio.

A major topic in German lower secondary education is *tracking students according to their ability*. Thus, Chapter 4 tests whether partisan theory can help to explain the practise of ability-tracking in West Germany over the last three decades. The analysis starts from the empirical observation that in the German education system – where tracking is practised very early compared to other OECD countries – the correlation of parent's education or income with their children's track choices is very strong. In short, students whose parents have a high-education background have significantly higher probabilities of attending a high-ability track. Partisan theory states that political parties – when in office – pursue the interests of their members and electoral constituencies. Political parties representing highly educated households should therefore support the practise of ability-tracking and advocate higher education spending on the tracks for good students. My findings suggest that German political parties support tracking if they represent high-education households and oppose tracking if they represent lower educated households. The results for the distribution of public resources across tracks are weaker but still support partisan theory.

Research-oriented higher education in Germany is almost exclusively provided by the public sector, which highlights the importance of measuring university cost efficiency, because market exit and entry – which ensure efficient resource use in the private sector – virtually do not exist (see e.g., Hanushek, 2002, 2068). Chapter 5 provides evidence about the *factors that benefit efficient resource use* in the German higher education landscape. I analyse whether relatively liberal university regulation improves the cost efficiency of public universities as suggested in the literature (see Aghion et al., 2008). The results show that liberal university regulation indeed contributes to more efficient use of resources. Moreover, I find that there are cost-reducing effects from a prosperous

private economic environment. In particular, high regional GDP per capita seems to reduce university costs.

The thesis is organised as follows. Chapter 2 provides background on the German education and political systems. Chapter 3 analyses how the East German Länder responded to strongly decreasing student cohort size. Chapter 4 tests whether the practise of ability-tracking in the West German Länder may be explained using partisan theory and Chapter 5 provides an analysis of the determinants of German university cost structures and cost efficiency. Chapter 6 offers some concluding remarks.

# 2 GERMANY'S EDUCATION AND POLITICAL SYSTEMS: AN OVERVIEW

This chapter gives a brief overview of the institutional settings and stylised facts of Germany's education and political systems necessary for understanding the ensuing chapters. In particular, Section 2.1 provides evidence on (1) the involvement of the public sector in education in Germany, (2) the division of tasks between the federal (Bund), state (Länder) and local (Gemeinden) governments in education and (3) some details of student curricula and the ability-tracking system. Section 2.2 reports evidence of the link between students' track choice and parental background while Section 2.3 outlines the demographics of student cohorts. Section 2.4 describes the various political parties, the socioeconomic characteristics of their party members and electoral constituencies as well as what the party manifestos tell us about education policy.

## 2.1 The German education system

As in most OECD countries, the German education system is dominated by the public sector. In primary, lower secondary and upper secondary education about 97%, 92% and 91% of students attend public schools, respectively (see Table 2.1). The German Constitution (Art. 7 Grundgesetz für die Bundesrepublik Deutschland) guarantees the right to establish and operate private schools, most of which are affiliated with a religion. Private schools operate, however, under Länder regulation and receive subsidies from Länder governments, which amount to about 90% of spending on teachers (Leschinsky and Cortina, 2003 and Leschinksy, 2003). Thus, private education cannot be looked upon as "independent", but rather should be considered as government-dependent private education (see also OECD, 2008a, 346). Higher education, type A, which is defined as "largely theory-based" and providing "sufficient qualifications for entry to advanced research programmes" (OECD, 2008b) denotes the classical universities in Germany. Here, the public sector assumes a significant role. The few private universities often concentrate on specific interests, e.g., medical schools, business schools, etc. Higher education, type B, denotes the universities of applied science (Fachhochschulen), which provide "practical, technical or occupational skills for direct entry into the labour market, although some theoretical foundations may be

covered in the respective programmes" (OECD, 2008c). Due to the applied character of type B universities, the private sector plays a more important role than in the research-oriented higher education. Note that the German division between public and private institutions is not so different from the OECD mean, albeit the public sector is somewhat more important on average (see Table 2.1).

Table 2.1 Share of students enroled in public institutions (OECD countries, 2006)

| | Primary education | Lower secondary education | Upper secondary education | Higher education (Type B) | Higher education (Type A) |
|---|---|---|---|---|---|
| Germany | 96.7 | 92.1 | 91.4 | 62.6 | 95.9 |
| France | 85.0 | 78.6 | 69.6 | 72.1 | 87.1 |
| UK | 94.7 | 93.7 | 52.2 | - | - |
| Sweden | 93.5 | 92.4 | 91.2 | 61.7 | 93.8 |
| **EU19 mean** | **89.9** | **87.4** | **83.3** | **68.3** | **81.5** |
| Norway | 97.7 | 97.2 | 91.4 | 56.4 | 86.7 |
| USA | 90.2 | 91.6 | 92.0 | 84.3 | 71.9 |
| Japan | 99.0 | 93.3 | 69.2 | 7.1 | 24.1 |
| **OECD mean** | **91.1** | **87.4** | **83.3** | **65.5** | **78.5** |

Data source: OECD (2008a). In the UK, 100% of institutions in higher education (Types A and B) are classified as "government-dependent private". Type A higher education denotes programmes that are "largely theory-based and are designed to provide sufficient qualifications for entry to advanced research programmes…" (OECD, 2008b). Type B higher education denotes programmes that are "typically shorter than those of tertiary-type A and focus on practical, technical or occupational skills for direct entry into the labour market, although some theoretical foundations may be covered in the respective programmes" (OECD, 2008c).

Education is a major responsibility of the Länder governments as fixed in the German Constitution (Art. 30 Grundgesetz für die Bundesrepublik Deutschland). Thus, some background information on political federalism in Germany and especially on the role of the Länder in the education system is useful.

The former West Germany consisted of 11 Länder. After reunification, the Federal Republic of Germany now consists of 16 Länder (see Table 2.2). Berlin was divided, and has thus been part of West and East Germany. It is helpful to distinguish between "city states" (Stadtstaaten) and "non-city states" (Flächenländer). City states consist of one large city or metropolitan area (Berlin, Hamburg and Bremen) and Flächenländer are area-based, comprising many local governments (Gemeinden), which have an independent status but receive considerable funding from the Länder governments. City states also assume the responsibilities of the local governments because there are no independent local governments. Table 2.2 shows that the Länder are quite

heterogeneous with respect to their population size. The largest Land, North-Rhine Westphalia, has about 18 bn. inhabitants, while Bremen, the smallest Land, has about 660 000 inhabitants.

Table 2.2 The German Länder (2007)

| Abbrev. | Land | West/East | City/ Area | Population (bn.) |
|---|---|---|---|---|
| BW | Baden-Württemberg | West | Area | 10.7 |
| BY | Bavaria | West | Area | 12.5 |
| HB | Bremen | West | City | 0.7 |
| HH | Hamburg | West | City | 1.8 |
| HE | Hesse | West | Area | 6.1 |
| NI | Lower Saxony | West | Area | 8.0 |
| NW | North-Rhine Westphalia | West | Area | 18.0 |
| RP | Rhineland-Palatinate | West | Area | 4.0 |
| SL | Saarland | West | Area | 1.0 |
| SH | Schleswig-Holstein | West | Area | 2.8 |
| BE | Berlin | East & West | City | 3.4 |
| BB | Brandenburg | East | Area | 2.5 |
| MV | Mecklenburg-Vorpomerania | East | Area | 1.7 |
| SN | Saxony | East | Area | 4.2 |
| ST | Saxony-Anhalt | East | Area | 2.4 |
| TH | Thuringia | East | Area | 2.3 |

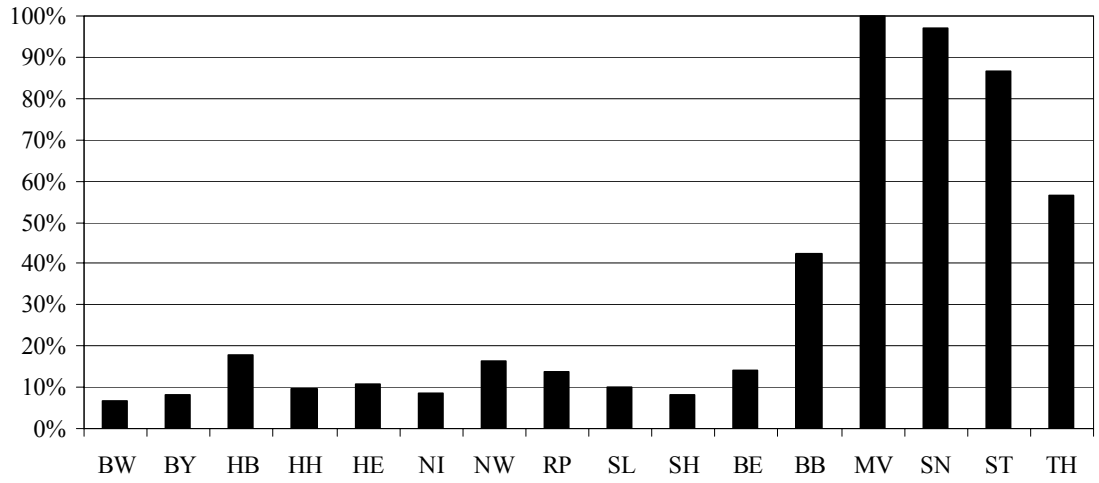
Data source: Federal Statistical Office of Germany. Population size as of December 31, 2007.

In *primary and secondary education*, Länder governments share responsibility with the local level. About 80% of primary and secondary education expenditures accrue to the Länder and 20% are borne by the local governments.[2] Länder are also in charge of teaching staff, but the local governments provide school infrastructure and pay for non-teaching staff (see also Leschinsky, 2003, 174).[3] This represents a significant component of total public expenditure, both at the Länder and local level. On average, primary and secondary education spending make up 36% of the total wage bill at the Länder level (excluding city states) and 14% of total capital spending at the local level.[4] Figure 2.1 shows that in the East German Länder the majority of teachers are employed as regular public sector employees, whereas in the West German Länder most teachers receive the status of civil servants (more attractive for teachers in terms of net wage, job

[2] Although local governments are involved in providing primary and secondary education, the Länder assume the general power of decision.
[3] In some (larger) Bavarian cities, teachers are employed by local governments.
[4] However, local governments receive a considerable amount of grants from the Länder to finance school expenditures. Expenditure data refers to 2004.

protection and pension plans). However, there are marked differences across the East German Länder. In particular, Brandenburg and Thuringia offer a significant amount of civil servant positions. For the abbreviations of Länder names see Table 2.2.

Figure 2.1 Share of teachers employed as regular public sector employees (and not as public servants) (16 German Länder, 2004)




Data source: Federal Statistical Office of Germany.

The Länder are also responsible for *higher education* where they finance current spending on universities, which accounts for about 8% of total expenditures at the Länder level. The Länder share the responsibility for new construction of university buildings with the federal government (50%). The federal government also finances financial aid for students (Bundesausbildungsförderungsgesetz). Furthermore, since 1976 the federal government sets the Framework Act for Higher Education (Hochschulrahmengesetz), which originally defined university tasks and regulated university structure and organisation (Leschinsky, 2003). The Framework Act has been liberalised via several amendments since 1985. Currently, the German Parliament is considering outright abolishment. Education policies are coordinated across the Länder within the Standing Conference of German Länder Education Ministers (Kultusministerkonferenz, KMK) while the Joint Science Conference (Gemeinsame Wissenschaftskonferenz, GWK) is the forum for co-operation between the federal government and the Länder.[5]

[5] Until the end of 2007, the federal government and the Länder cooperated within the Bund-Länder Commission for Educational Planning and Research Promotion (Bund-Länder Kommission für Bildungsplanung und Forschungsförderung, BLK).

Länder responsibility results in marked differences in education institutions across the 16 Länder. Nevertheless, there are several common features (see also Leschinky and Cortina, 2003 and Federal Ministry for Education and Research, 2007a). Students enter primary schools at the age of six and leave the joint primary education after the fourth grade (at the age of ten).[6] In lower secondary education, students are grouped into three types of schools according to their ability ("ability-tracking"). High-performing students attend "Gymnasium" (comparable to grammar school in the UK and high school in the U.S.), medium-performing students attend "Realschule" (intermediate school) and lower-performing students attend "Hauptschule" (secondary general school).[7] Teachers give a recommendation regarding student's track choice at the end of primary school. Generally, about 75% of track choices match the teacher recommendations (Cortina and Trommer, 2003, 357). However, depending on Länder, if the student's parents disagree with the teacher recommendation, the final decision may either be made by the parents or by the school administration: in 11 out of 16 Länder the parents make the final decision.[8] Mobility between educational tracks is possible and actually increased in the past fifty years. At the end of the 1960s, the (cumulative) share of pupils in one cohort who changed tracks was far below 10% (Blossfeld, 1990), but by 2000 the share increased to about 14%. However, about 75% was downward mobility (Cortina and Trommer, 2003, 375; Bellenberg, 2005 and the literature cited therein).[9]

In 2006, about 36% of all students in lower secondary education attended a Gymnasium with some variation across the Länder (see Figure 2.2). Since 1981, the percentage increased from about 30%. Due to several key differences in Länder education systems (described below), information on the relative importance of the other two types of

[6] Students stay in primary schools for six years in Berlin and Brandenburg. Consequently, in these two Länder, students are tracked after the sixth grade. Currently, Hamburg is implementing six-year primary education as of summer 2010.

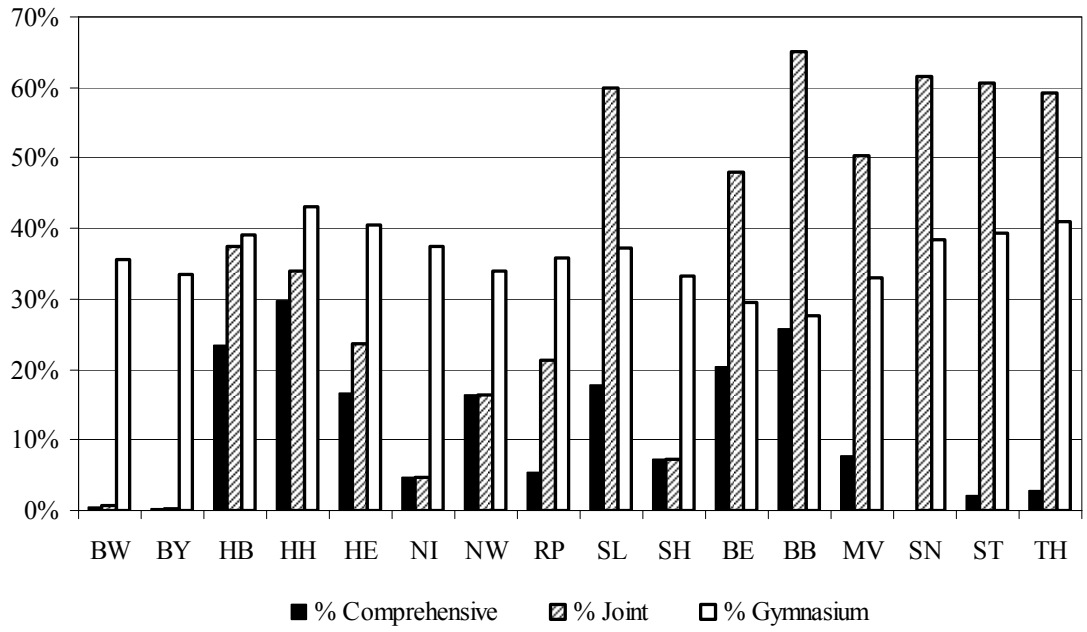
[7] Some schools in a minority of Länder have a so-called orientation stage for two years ("Orientierungsstufe") following primary school. Students are then tracked after the sixth grade.

[8] As an example, in North-Rhine Westphalia, the largest Land, the decision concerning the choice of school track is usually assumed by the parents provided they roughly follow the primary school teacher's advice. If parents' request and teacher's advice is not even roughly in accord, then the decision is made by the school administration after test lectures (Schulgesetz für das Land Nordrhein-Westfalen, §11 and Ausbildungsordnung Grundschule, §8). For an extensive overview of the transition regulation from primary schools to lower secondary schools in all German Länder see Standing Conference of German Education Ministers (2006a).

[9] From an international perspective, ability-tracking in Germany starts very early. Across OECD countries only Austria tracks students as early as Germany (OECD, 2005). The present system has a long history and its origins date to the 19th century. Directly after the WWII tracking was replaced by a comprehensive system by the Allied occupation. In the postwar period, however, tracking was reestablished again (Baumert, Cortina and Leschinsky, 2003, 54).

schools is not easy to find, e.g., the share of students enroled in Hauptschule was reported to be about 20% at the end of the 1990s (Solga and Wagner, 2000, 2).

Figure 2.2 Share of students enroled in comprehensive schools, joint schooling and Gymnasium (16 German Länder, 2006)




Data source: Standing Conference of German Länder Education Ministers.

Some Länder provide *comprehensive schools* ("integrierte Gesamtschulen"), which generally comprise all three tracks in lower secondary education. Students are educated in one organisational unit and share common instruction for all performance levels in some subjects, whereas in other subjects students are grouped according to their ability. This is also a common practise in the U.S. ("streaming of students"). Mobility between these "streams" is much higher in the comprehensive schools than in the traditional system. As Köller (2003, 458) points out, the model of the comprehensive school, introduced for the first time in 1968 in West-Berlin and from the early 1970s in other Länder, and accompanied by unprecedented ideological, political and pedagogical discussion, originally was designed to replace the tracked education system, not as a complement. This leaves today's comprehensive schools at a strategic disadvantage in the competition for gifted students. Thus, the composition of students in comprehensive schools is biased towards middle and low-performance students (Köller, 2003, 468). Compared with the total population students in comprehensive schools less than proportionately graduate with Abitur (A-level) degrees, which permit unrestricted access to higher education (Köller, 2003, 479).

Some Länder also provide a school type that consolidates the two lower educational tracks, Haupt- and Realschule, into one school ("Schulen mit mehreren Bildungsgängen", Standing Conference of German Länder Education Ministers, 2006b, 7). In these schools, there is joint and tracked education in varying proportions across the Länder. Furthermore, some Länder also provide the school type "Orientierungsstufe" (orientation stage), which is only available to students in grades 5 and 6, and which offers instruction similar to comprehensive schools. The basic concept is to allow for higher mobility between tracks during grades 5 and 6, the two first years of tracking.

Aggregating the students enroled in (1) comprehensive schools, (2) Schulen mit mehreren Bildungsgängen and (3) Orientierungsstufe gives us the total number of students who are educated in some type of cooperative education, labelled as students enroled in *joint schooling* in the following. Both the share of students enroled in comprehensive schools and the share enroled in joint schooling may be interpreted as measures of the degree of comprehensive schooling in lower secondary education. Figure 2.2 reports the share in lower secondary education enroled in comprehensive/joint schools across the Länder in 2006. It is obvious that there is considerable variation in the adoption of comprehensive education. While some Länder offer virtually no comprehensive education (Bavaria, Baden-Württemberg) others provide significant fractions of lower secondary education in the form of comprehensive instruction (Saarland, Hamburg), such that up to 60% of students in lower secondary education are educated in schools which comprise at least two tracks (see Köller, 2003, 465).

Compulsory education ends at the end of lower secondary education, after the ninth or tenth grade. Students then opt for additional higher secondary education, which may be some type of vocational training (in-company training in combination with part-time vocational schooling is the most important type), or two additional years in Gymnasium if the student has been educated in Gymnasium, or in Realschule (under certain conditions) in lower secondary education. Students generally leave the education system after 12 years of schooling at the age of 18-19 with a vocational degree or with the Abitur degree (A-level-examinations, high school diploma).

Länder responsibility tends to complicate the availability of data. For instance, comparable expenditure data or appropriate test score data for primary and secondary education is simply not available.[10] However, the Standing Conference of German Länder Education Ministers annually publishes data on physical resource indicators, i.e. number of teachers, classes and teaching hours, which are comparable across Länder. Such data is used extensively in the following chapters (see e.g., the current issue: Standing Conference of German Länder Education Ministers, 2007). Note that the number of teachers is reported in full-time equivalents (fte), which takes into account that some teachers only work part-time. Thus, the number of full-time equivalent teachers is a calculative number and may differ from the number of (physical) teachers employed in a Land. Physical resource indicators are used in Chapters 3 and 4. In particular, the teacher/student-ratio (T/St) is considered an excellent resource indicator (Standing Conference of German Länder Education Ministers, 2002, 96). For higher education, comparable expenditure data at the level of universities is published by the Federal Statistical Office of Germany, which is used in Chapter 5.

[10] At the end of the 1990s, the Federal Statistical Office started to publish expenditures per student for single levels of schooling such as primary education. However, a change in the accounting design makes it impossible to compare pre- and post-2002 years.

## 2.2 Relevant facts on the link between parental background and track choice

In Germany, even more than in most other OECD countries, there is a strong correlation between parents' educational background, income and profession and the educational achievements of their offspring. This applies to students' educational achievements in general (see e.g., Wößmann, 2004) but more importantly for this study, also to *track choice* in the transition from primary school to lower secondary school (Cortina and Trommer, 2003, 358). Baumert and Schümer (2001, 462) report that the share of students from a blue-collar parental background in Hauptschule and Schulen mit mehreren Bildungsgängen is about 63%, about 51% in comprehensive schools, 43% in Realschule and 22% in Gymnasium. The share of students from households with university degree varies from 62% in Gymnasium to 13% in Hauptschule. There is also evidence for important differences in the probability of attending a Gymnasium between blue-collar parents' offspring and those of civil servants, the self-employed and white-collar workers (Max-Planck-Institut für Bildungsforschung, 2002, 20). Across all Länder, the latter three have a three times higher probability of sending their children to a Gymnasium compared to blue-collar workers.[11] In some Länder (Bavaria, Schleswig-Holstein), this differential is even six-fold. Interestingly, the socioeconomic status of students in comprehensive schools as measured by father's profession is considerably below that of students enroled in Gymnasium (Köller, 2003, 481; Baumert and Schümer, 2001). Corroborating these results, Schimpl-Neimanns (2000), Schnabel et al. (2002) and Dustmann (2004) consistently report that the correlation is still significant, although the correlation of parental background with track choice and educational achievement has somewhat weakened over the last 50 years. The link holds for parental background in terms of education, profession and income. Evidence from Contini, Scagni and Riehl (2007) suggests that the correlation of parental background with track choice is more important in Germany than in other countries, such as the Netherlands or Italy.

Moreover, evidence presented by Schnepf (2002) suggests that parental socioeconomic background also dominates the negative effect of being an immigrant. Her finding is

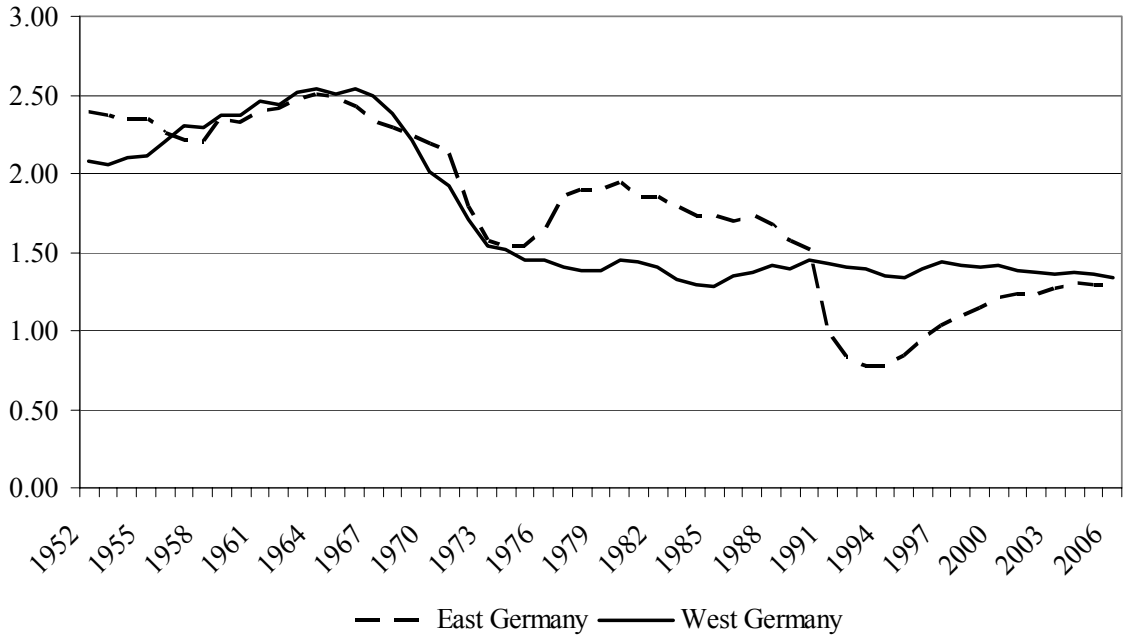
[11] Similar correlations also hold for the transition from lower secondary to higher secondary education (see Federal Ministry of Education and Research, 2007b) and with respect to the question whether children obtain higher education or not (see OECD, 2007, 116).

confirmed by a recent study which analyses the socioeconomic background of students who participated in a scholarship programme that was intended to grant scholarships to gifted students with a migrant parental background ("START" programme financed by the Hertie foundation, see Bommes, Grünheid and Wilmes, 2008). The results suggest that educated parents (1) impart to their children a positive attitude towards education and knowledge, and (2) can give their children guidance on choosing school/track, and (3) can advise their children to apply for scholarships in the first place – virtually irrespective of whether they are natives or migrants and whether the parents' educational degrees were formally approved within the German education system.

## 2.3 Demographics of the school- and university-relevant populations

This chapter presents the variations in student cohort size, which is of special importance in Chapter 3. Figure 2.3 shows the birth rate for East and West Germany as the most important determinant of the size of student cohorts. As a matter of course, immigration and outmigration also have some importance for the demographics of student cohorts, which is accounted for in Figures 2.3 and 2.4, which present student numbers or cohort sizes of the school- and university-relevant populations (including immigrants).

Figure 2.3 Birth rate in East and West Germany (1952-2006)

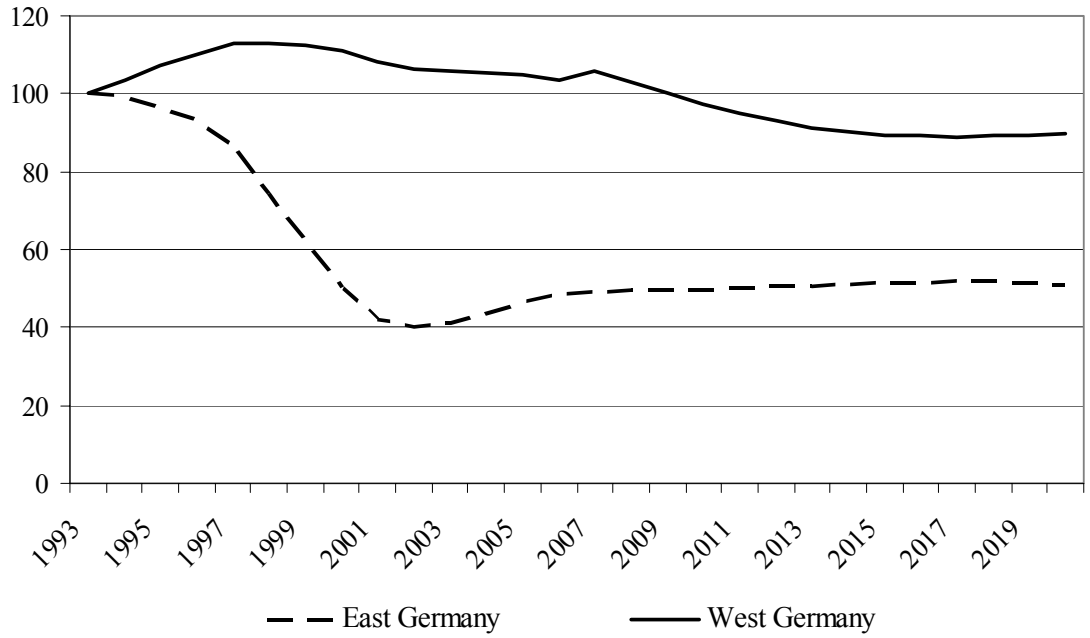



Data source: Federal Statistical Office of Germany. Note: Total fertility rate, births per woman.

In Figure 2.3 we observe that the general trend in the birth rate in East and West Germany has not greatly differed. However, there are two marked differences. In East Germany there was a significant rise in the birth rate starting at the end of the 1970s ("Honecker-Buckel"). Over several years, there was a 0.5-child differential in the births per woman between East and West Germany. This differential decreased steadily in the 1980s and resulted in a collapsing birth rate after German Reunification. The East German birth rate decreased from 1.5 in 1990 to about 0.77 in 1993 and recovered

slowly over the following years.[12] Consequently, student enrolment in East German primary schools decreased by about 60% from 1993 to 2002 (see Figure 2.4). Although the number of pupils began to pick up in 2003 and increased slightly until 2007, in the long-run, student cohorts in primary schools will reach about 50% of the 1993 level. In contrast, student enrolment in West German primary schools will stay fairly constant and is forecasted to decrease smoothly to about 90% until 2020. The demographic shock in East Germany is explored in Chapter 3, which studies the response of the public sector to changes in the size of the student cohorts.

Figure 2.4 Student enrolment in primary schools in East and West Germany (1993-2020). Normalised time series (1993=100)



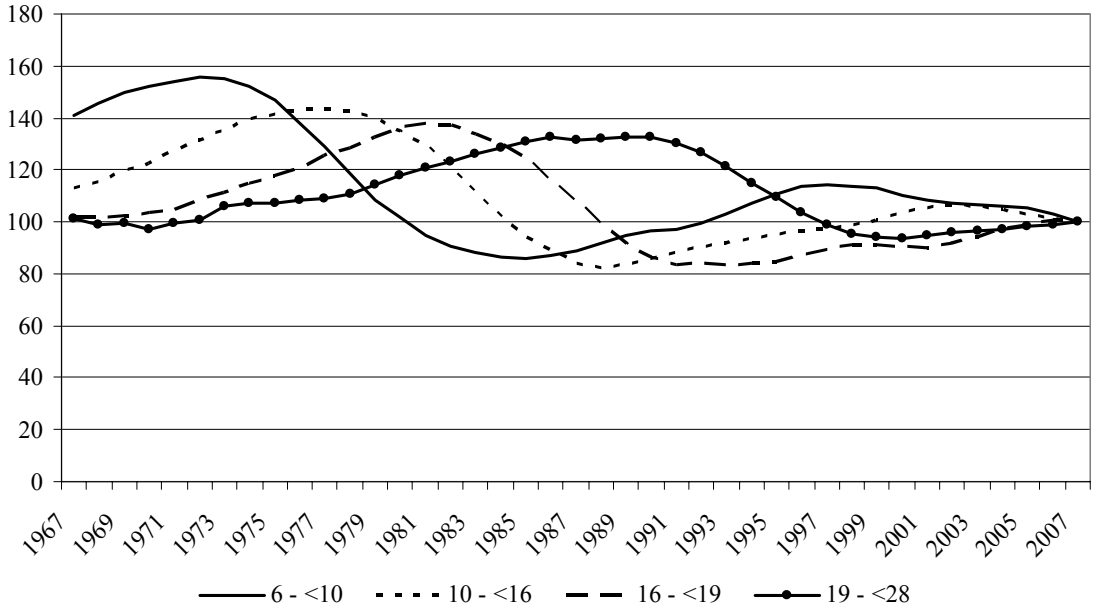

Data source: Standing Conference of German Länder Education Ministers. Note: Historical data from 1993 through 2006. Forecast from 2007 through 2020 taken from Standing Conference of German Länder Education Ministers (2005).

Figure 2.5 plots the size of the school- and university-relevant age cohorts for primary schools (6-10), lower secondary schools (10-16), upper secondary schools and for higher education (19-28) in West Germany from 1967 to 2007, relative to the respective cohort size in 2007. The figure shows that the large cohorts of the baby boomers finished primary schools and entered lower secondary schools at the end of 1960/early 1970s. The large cohorts stayed in lower secondary education until the mid-1980s,

[12] In addition, due to the poor economic performance of the East German economy there are rather strong east-west migration flows. Hence, the East German population declined by 8% from 1991 to 2005 whereas the population size in West Germany increased by approximately 5% in the same period (excluding Berlin).

suggesting that it may be of some importance to control for student cohort size when analysing education spending in West Germany over the 1979-2006 period (see Chapter 4). Figure 2.5 also suggests that demographic variation of the university-relevant population (19-28 years) is limited in the rather short time period, 1998-2003, used in Chapter 5.

Figure 2.5 Size of school- and university-relevant age cohorts (West Germany, 1967-2007). Normalised time series (2007=100)




Data source: Federal Statistical Office of Germany.

## 2.4 Political parties, platforms and manifestos

In Germany, traditionally, two parties predominate. The Social Democrats (SPD) and the Christian Democrats/Conservative Party (CDU) have always formed the governments both at the federal and Länder levels – alone or in coalition governments with smaller parties. The most important smaller parties are the Liberal Democrats (FDP) and an environmentalist party, the Green Party. Typically, the Green Party has formed coalition governments with the SPD, and the FDP has formed coalition governments with both the SPD and the CDU. Recently, a fifth party has achieved some notice, the Socialist party, "Die Linke". This party arose out of the Socialist Unity Party in the former German Democratic Republic. Although it has achieved some government participation in the East German Länder, so far it has lacked importance in the West German Länder over the sample period, and therefore is omitted from this dissertation.

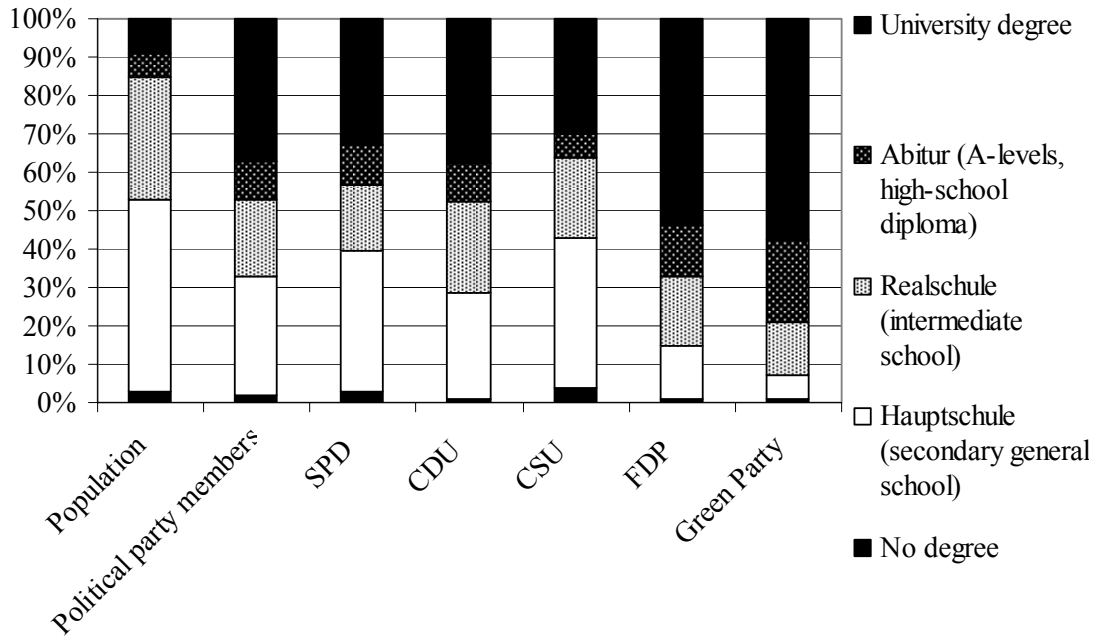
In analysing the electoral manifestos of CDU, SPD, FDP and the Green Party that were valid in the 1990s, Stern (2000) finds a range of priorities for education. While the CDU manifesto explicitly mentions maintaining the tracked education system (Gymnasium, Realschule, Hauptschule) and promoting gifted students, the SPD prioritises comprehensive schools, which should also provide full-time instruction and a closer connection of the country's education system to working life. The FDP does not take a clear position, but instead prefers "diversity" in the provision of public schools and advocates promoting gifted students. The Green Party manifesto focuses on providing comprehensive schools in lower secondary education (up to class 10).

The following data on the composition of German political parties' members and electoral constituencies by profession, social status and educational degree is especially relevant for Chapter 4. Figure 2.6 shows that SPD and CDU party members do not differ much in terms of university education, although CDU members hold somewhat more university degrees. However, a significant difference appears at the lower end of education. While about 40% of SPD members do not hold an educational degree higher than Hauptschule, the figure is less than 30% for CDU party members.[13] Another difference is between party members of CDU/SPD, the liberal FDP and the Green Party. Generally, FDP and more so, Green Party members, have a higher probability of

[13] Note, however, that party members of the Bavarian CDU, "CSU", have a structure similar to the SPD.

holding a university degree and a lower probability of having completed only Hauptschule.

Figure 2.6 Political party members' education in Germany (2002)




Data source: Heinrich, Lübker and Biehl (2002)

We can observe a similar pattern in survey data for the 2005 federal election. Generally, the FDP and especially the Green Party are overrepresented among voters holding a university degree or Abitur (see Table 2.3). Differences between the SPD and CDU/CSU voters are less pronounced. Both parties are underrepresented among highly educated voters, although the CDU/CSU shows a somewhat better result among university graduates. The differences between SPD and CDU/CSU are stronger for the professional status of the electorates (Table 2.4 and Appendix A.2.4). While blue-collar workers seem to vote more frequently for the SPD, support for the CDU/CSU is more pronounced among the self-employed and farmers (and civil servants). Note that SPD election results among blue-collar workers have been much better in past decades and that the 2005 election result marks a particularly weak result compared to previous decades (see Mertens, 2009) Self-employed and civil servants are highly overrepresented in the electorates of the Green Party and FDP.

Table 2.3 Electorates of the political parties with respect to their education in the 2005 federal election

| | SPD | CDU/CSU | Green Party | FDP | Die Linke |
|---|---|---|---|---|---|
| Hauptschule (secondary general school) | 38% | 38% | 5% | 8% | 7% |
| Realschule (intermediate school) | 33% | 35% | 7% | 10% | 10% |
| Abitur (A-levels, high school diploma) | 34% | 31% | 13% | 11% | 9% |
| University degree | 29% | 33% | 15% | 12% | 10% |
| ELECTION | 34.2% | 35.2% | 8.1% | 9.8% | 8.7% |

Data source: Neu (2006)

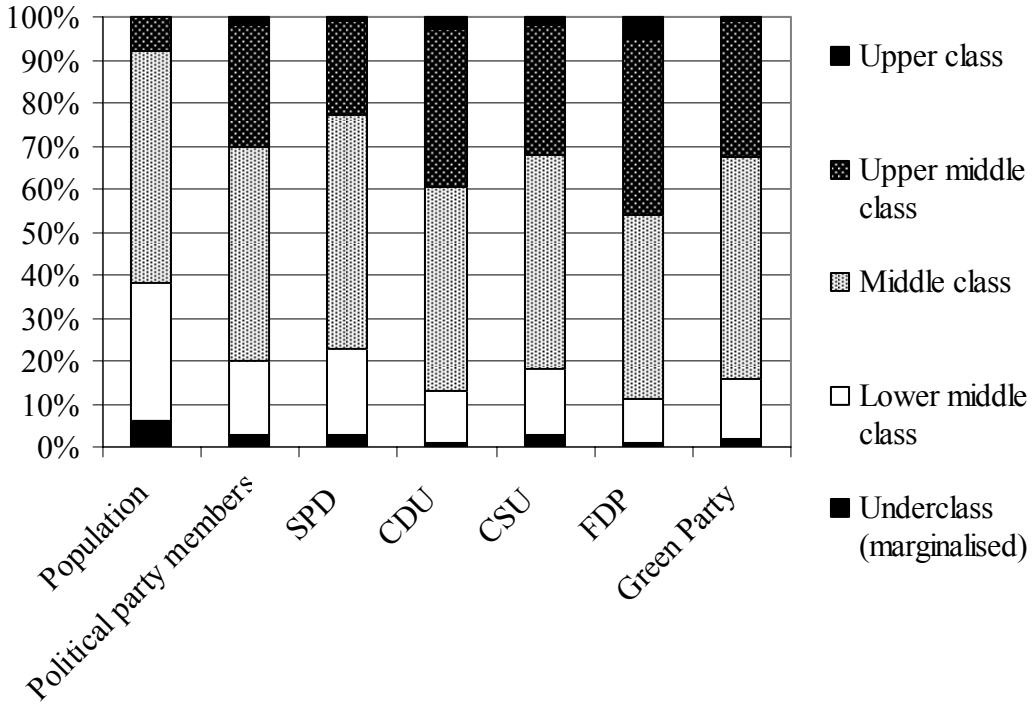
Table 2.4 Electorates of the political parties with respect to their profession in the 2005 federal election

| | SPD | CDU/CSU | Green Party | FDP | Die Linke |
|---|---|---|---|---|---|
| Blue-collar worker | 37% | 32% | 5% | 8% | 12% |
| White-collar worker | 35 % | 35% | 9% | 9% | 9% |
| Civil servants | 33% | 38% | 11% | 10% | 5% |
| Farmer | 13% | 65% | 2% | 9% | 6% |
| Self-employed | 22% | 41% | 10% | 20% | 5% |
| ELECTION | 34.2% | 35.2% | 8.1% | 9.8% | 8.7% |

Data source: Neu (2006)

A useful complement to these rather mechanical measures of party positions is the self-assessment of party members, who were asked to identify their social class as perceived by themselves (see Figure 2.7; Heinrich, Lübker and Biehl, 2002, 10f.). We observe that the self-perceptions clearly differ across the two largest political parties, SPD and CDU. CDU members identify more frequently as upper middle class, whereas SPD members see themselves more frequently as working class, reaffirming the findings presented above.

Figure 2.7 Political party members self-assessment by social class in Germany




Data source: Heinrich, Lübker and Biehl (2002)

# 3 PRIMARY EDUCATION: ADJUSTMENT TO DEMOGRAPHIC SHOCKS IN THE EAST GERMAN LÄNDER

## 3.1 Introduction

It is a well known fact that many industrialised nations will face unprecedented demographic shifts in the course of the 21st century. This applies especially to Japan and the European countries while the U.S. will undergo a somewhat less intense ageing process. A broad literature has examined the consequences of these demographic changes for public finances and labour markets – both theoretically and empirically (see for example Creedy and Disney, 1989; Verbon, 1990; Zimmermann, 1991; Cutler, Elmendorf and Zeckhauser, 1993; von Weizsäcker, 1995; Gruber and Wise, 2001 or Disney, 2007). Historically, the pension systems and public health insurance have been at the heart of economic research on the impact of ageing on public finances, but recent theoretical and empirical work has begun to consider the effects of demographic shifts on the provision of public education (see for example Gradstein and Kaganovich, 2004 for a theoretical paper, and Poterba, 1997 or Boldrin and Montes, 2009 for empirical research).

A fundamental problem encountered in the empirical work, however, is that the data does not yet reflect the magnitude and the rapidity of the upcoming demographic changes. Interpretations and (implicit) projections of future public expenditures, tax rates or public deficits have therefore always been subject to the assumption that the public choice of fiscal decisions during severe demographic shifts does not differ substantially from demographically stable periods. Regarding public education, there is evidence for several countries that (total) education spending is virtually independent of the size of their student cohorts (see e.g., Poterba, 1997 for the U.S. or Baum and Seitz, 2003 for West Germany). However, as argued above, these studies examined data sets with rather modest demographic changes. The question arises whether these results also hold under conditions of rapid demographic change. Poterba (1997, 59) puts it more generally and urges: *"further analysis of the link between cohort size and per-pupil spending, perhaps using changes in enrollment that result from exogenous shocks…"*.

This chapter uses East Germany to study the impact of strong demographic shifts on education spending.

As discussed in Chapter 2, German Reunification in 1990 induced a demographic shock in East Germany: the fertility rate hit an all-time low of 0.77 children per woman in the early 1990s. At the end of the decade, East Germany still had the lowest fertility rate in the EU-15 along with the northern regions of Spain and northern Italy. In addition, a significant share of families with school-age children migrated to the western part of the nation. As a consequence, student enrolment in East German primary schools decreased sharply in the middle of the 1990s and by 2002 the number of pupils was below 50% of the 1993 level. Recent population forecasts suggest that this is not a transitory situation. Student enrolment in primary education in the East German Länder will stay fairly constant at about 50% of the 1993 level. East Germany is therefore ideally suited to be used as a natural laboratory to study the impact of strong and rapid demographic changes on the provision of education resources.

Given the empirical evidence from the literature, which suggests highly inelastic education expenditures, one may expect rather sluggish adjustment of total education spending in the case of strongly decreasing student cohort size in East Germany. In fact, education spending per student is likely to rise during the adjustment period. What will additional education expenditures per student finance? Rising education expenditures per student could be due to smaller classes, fewer working hours per teacher, more teaching time per class, etc. Each of these adjustment options may have quite different effects on students' learning environment. To account for the changes in students' learning environment, I decompose education expenditures into physical input variables, such as class size or teaching time per class.

The chapter is organised as follows: Section 3.2 reviews international evidence on the link between cohort size and public education spending, discusses the decomposition of education spending into physical resource inputs and evaluates these inputs from the viewpoint of educational effectiveness. Section 3.3 introduces the data set and reports summary statistics. Section 3.4 presents some descriptive empirical evidence of resource adjustments in East Germany, and discusses the empirical strategy and the results. Panel data for the five East German Länder over the 1993-2006 period suggests

that resource adjustments have been considerable, especially in the years when student cohorts actually decreased (1993-2002). In this period, resource adjustment was significantly different from public policy in demographically more stable periods. After 2000-2001, adjustments have been less stringent, such that over the 1993-2006 period, the 50%-decrease in cohort size has translated into a 25% increase in the teacher/student-ratio (~27% increase in education spending per student), which is no longer significantly different from the elasticity obtained from West German data for the same period. However, due to limitations of the econometric model, it cannot be claimed that the estimated elasticities are net of possible common shifts in the demand for public education following the publication of the PISA test in autumn 2001. With respect to the composition of the adjustment package, increased spending per student most likely contains an important share of productive spending but also some demographic costs.

## 3.2 Background: resource adjustments and the composition of education spending

### 3.2.1 Existing empirical evidence

A substantial body of empirical work has investigated the determinants of education spending. Among the classics are the contributions by Denzau (1975), Ladd (1975), Lovell (1978) and Rubinfeld and Shapiro (1989). Although these studies are closely related to my work, I confine my literature review to a specific subgroup, focusing on the studies examining the impact of varying sizes of student cohorts on education expenditures.

Based on panel data for the U.S. states from 1960 to 1990 Poterba (1997 and 1998) shows that an increasing share of school-age population leads to lower education expenditures per student. Precisely, his estimate of an elasticity of -1 of education spending per student with respect to varying sizes of the student cohort suggests that total education expenditures are not adjusted at all to changes in the size of student-age cohorts.[14] This result is confirmed for the state level by several studies and is robust to alternative model specifications (Fernandez and Rogerson, 2001; Harris, Evans and Schwab, 2001; Ladd and Murray, 2001). However, studies based on county and school district data find elasticities that tend to be smaller than those obtained from state level data. Ladd and Murray (2001) investigate county level data and estimate an elasticity of about -0.4, which is robust over different sub-samples of their data set. Harris, Evans and Schwab (2001) present estimates that are within a range of -0.3 to -0.5 for the school district level.

Interestingly, the link between the demographic structure and education resources has been explored to a smaller extent for Europe, although the upcoming demographic changes will be more intense and more rapid in Europe. An exception is the work by Baum and Seitz (2003). Their results from a panel of West German Länder over the 1975-1999 period are largely consistent with the U.S. results. Alternative specifications of the expenditure (endogenous) variable are tested: the Länder level estimates range

[14] The polar cases of the elasticity of education spending per student to changes in student cohort size are -1 if total education expenditures are not adjusted and 0 if total education expenditures are adjusted proportionately to changes in student cohort size.

from -0.75 (staff expenditures) to -0.82 (other expenditures). The estimates for the local level in West Germany show somewhat greater variation and are often not significantly different from zero. However, the elasticity for current expenditures (without staff expenditures) is in line with the U.S. results (-0.4).[15]

Evidence for the Swiss Cantons is presented by Grob and Wolter (2007). They derive an elasticity of about -0.6 of school spending per pupil in Swiss primary schools to variations in enrolment. Borge and Rattsø (1995) confirm these findings for Norwegian local governments. Although declining age groups consume less total expenditures, local governments' adjustment is rather slow. This leads to increasing education expenditures per pupil as age cohorts decrease, which is broadly consistent with the results from U.S. counties, German local governments and Swiss Cantons.

International evidence presented by Schultz (1988) based on a wide panel of 89 countries from 1960 to 1980 also suggests that total education spending is not adjusted in response to varying sizes of student cohorts. More precisely, he finds that total education spending per student in primary education is reduced by 1.12% in response to a 1% increase in the size of the student cohort. The estimated elasticity for the teacher/student-ratio is -0.46. At the secondary school level, Schultz finds a rather high elasticity of -1.68 for total education spending per student and -0.81 for the teacher/student-ratio.

In short, existing empirical evidence suggests that there is a strong negative relationship between student cohort size and education spending per student. This implies that total education spending is adjusted rather sluggishly to varying student numbers. This finding applies especially to higher levels of government like the Länder/state level. The negative effect of student numbers on education spending per student tends to be lower at the local government level. However, all empirical evidence presented in the literature is derived from countries with rather modest changes in the age composition of the population. One exception is the work by Schultz (1988), but in his broad cross-section of countries, which includes developing countries, growing student cohorts prevail. The dramatic decline in the East German student cohort after the fall of the Iron

[15] Recall that at the local level the bulk of expenditures accrue to non-wage spending (see Chapter 2).

Curtain makes it possible to study resource adjustment in education under a quite unique demographic scenario.

### 3.2.2 A decomposition of education spending

Incomplete adjustment of total education resources implies that resources per student increase. From the view of educational effectiveness, there is the question about the allocation of increased spending per student in terms of physical education resources: what exactly does increased spending per student buy? This issue has not been addressed in the literature reviewed above because these papers focus on a pure public finance perspective. Higher per student expenditures can be directed to smaller classes, more teaching time per class or less teaching time per fte teacher (see Chapter 2 for details on the number of full-time equivalent teachers, fte). Thus, additional education expenditures per student can be due to various sources and do not necessarily benefit students' learning environment.

Decomposing education expenditures allows us to assess the changes in students' learning environment that may occur during the (non)-adjustment of resources. Different types of decompositions of education spending have been conducted in the literature. Although often pursuing other goals compared to my work, the decompositions commonly used can serve as a starting point for my analysis. Schultz (1988) decomposes public education expenditures per capita into the enrolment ratio, the teacher/student-ratio, current expenditures per teacher and an index of physical capital intensity, in order to disentangle quantity (enrolment) and quality elements of school spending (e.g., teacher/student-ratio). This decomposition already allows for an evaluation of students' learning conditions (e.g., teacher/student-ratio or capital intensity). However, the work by Schultz (1988) is tailored to an analysis of a broad cross-section of countries, including developing countries. The enrolment ratio, which is a key element in his framework, is of no relevance in the present study because enrolment in primary schools is virtually 100% and does not show changes over time in OECD countries. Hanushek and Rivkin (1997) add several elements to the analysis by dividing education spending components into three groups: quantity, input cost and intensity. By quantity, they capture changes in the enrolment rate, changes in the division of pupils between private and public schools as well as changes in the size of the age cohort. Input costs capture changes in the salaries of teachers while intensity

refers to the length of the school year or the teacher/student-ratio. Another approach has been used by Falch and Rattsø (1996, 1997 and 1999) who decompose education expenditures per capita into wage and non-wage spending per teacher, teacher input per class, (inverted) class size and the student share of the population.

This paper uses an alternative spending decomposition, designed to examine responses to a strong decrease in the number of students, and which pays special attention to the use of teaching capacity. With respect to teaching capacity, Länder governments – explicitly or implicitly – respond by:

- reducing the number of teachers, likewise, reducing teaching time per fte teacher with a corresponding reduction in teacher wage: "compulsory part-time"
- reducing teaching time per fte teacher *without* reducing fte teacher wage
- reducing class size
- increasing teaching time per class or reducing loss of instructional time by increasing the availability of substitute teachers

These measures can be combined to form different "adjustment bundles". To display all possible government action, the spending decomposition must account for class size, teaching input per class and teaching time per fte teacher and the institutional settings at the primary education level in Germany. The enrolment ratio, as mentioned, is of no relevance. Since there are virtually no private primary schools in East Germany, the division of pupils between private and public schools can also be disregarded. Consequently, an adequate decomposition of education spending per student (E/ST) is obtained by modifying Falch and Rattsø's approach (1997, 301):

$$(3.1) \qquad \left(\frac{E}{St}\right) = \left(\frac{W}{T} + \frac{NW}{T}\right) \cdot \left(\frac{T}{Tt}\right) \cdot \left(\frac{Tt}{Cl}\right) \cdot \left(\frac{Cl}{St}\right)$$

where E denotes total education spending, St is the number of students, W denotes the total wage bill of primary school teachers while NW denotes total non-wage spending for primary schools, T (Tt) is the number of teachers (total instructional time) and Cl denotes the number of classes in primary schools. Thus, W/T denotes wage spending per fte teacher while NW/T represents non-wage spending per fte teacher. T/Tt is the number of fte teachers divided by total teaching hours and expresses the fraction of an

fte teacher needed for the provision of one teaching hour. Tt/Cl is the teaching time per class and Cl/St denotes inverted class size and expresses the fragment of a class that is provided for one student. Non-wage spending per fte teacher (NW/T) is approximated by the number of school locations per fte teacher. Although this approximation is enforced by the lack of comparable expenditure data, it is not unrealistic in the context of primary education: apart from school buildings, little additional equipment is used in the education of 6-10 year old pupils compared to the laboratory- and computer-intensive equipment of older students.

### 3.2.3 Educational effectiveness

The decomposition in Equation (3.1) identifies the forces that drive per student expenditures, thereby allowing for an assessment of the effects from increasing resource endowments per pupil on learning conditions. Based on the results of educational production economics, the spending elements on the right side of Equation (3.1) can be assessed with respect to educational effectiveness. Rather than offering a broad discussion of the literature, I focus here on presenting an outline of the current state of research.

The effects of *class size* (St/Cl) on student performance have been intensively investigated in recent years (Hanushek, 1986, 1999, 2003; Card and Krueger, 1992, 1996; Weiß, 1997; Hoxby, 2000; Krueger, 2003; Rivkin, Hanushek and Kain, 2005; Wößmann, 2005 or Wößmann and West, 2006). This discussion has not come to a generally accepted conclusion, but the prevailing opinion appears to be that smaller class size does not per se lead to higher student performance.

Less evidence is available on the effect of *teaching time* per class (Tt/Cl) or per student on educational achievement. Yet, most existing empirical studies suggest that there is no simple mechanism that associates more instructional time with much higher student achievement (for recent surveys see Millot and Lane, 2002 or Baker et al., 2004). Millot and Lane (2002) argue that reorganisation of existing time input might yield more educational revenue than simple increases of teaching time (see also Reimers, 1993). Eren and Millimet (2007) find that the effects of additional teaching input on achievement strongly depend on individual student performance. High-performance students benefit from other settings than low-performance students. However, most

studies find at least small beneficial effects of more teaching time on educational outcomes (see also Kiesling, 1984). This is true especially when more teaching time is combined with reduced class size (Coates, 2003). Some recent papers investigate the effect of *cancellation of instructional time* and teacher absence on student achievement. Marcotte and Hemelt (2007) report evidence from school districts in Maryland that losing instructional time due to unscheduled school closings significantly and negatively affects student performance. The effect is greater for students in lower grades such as primary education. However, evidence presented by Clotfelter, Ladd and Vigdor (2007) and Miller, Murnane and Willett (2007) suggests that there is a negative effect of teacher absence on student achievement even when classes are covered by substitute teachers.

Even less evidence is available on the effect of decreasing *teaching time per teacher* (Tt/T). To my knowledge, no study exists that shows a beneficial/harmful effect on student performance. Teaching obligations for teachers in German primary schools are roughly equal to the OECD country mean (about 2.6% below the OECD mean: see OECD, 2004, 407). Given that teaching obligations and teacher salaries in primary education are well within the framework given by the OECD countries, there are no a priori reasons to suspect a beneficial/harmful effect of decreasing teaching obligations per teacher.[16]

The proxy variable of *non-wage spending per teacher* (NW/T), namely the number of school locations per teacher, closely links to *school size* and *way to school.* There is a considerable literature on the effects of school size on student achievement; especially in the U.S. there has been lengthy and controversial debate. While from the 1950s to the 1970s opinion prevailed that school consolidation was an important element for improving the effectiveness of public schools, currently "small schools have become the next big thing in education" (Berry, 2004, 56). Kuziemko (2006), Foreman-Peck and Foreman-Peck (2006), as well as Jones, Toma and Zimmer (2008) consistently find that students in smaller schools skip school lessons less frequently and achieve higher test scores. However, one should bear in mind that in this chapter the number of schools is merely used as a *proxy* for non-wage spending at the Länder level. Recall that school

[16] Wages in German primary education for teachers with minimum training are from 26% to 60% above the OECD country mean when measured in PPP U.S. dollars (according to their years of service, OECD, 2004, 390).

infrastructure in Germany is a responsibility of the local government level and this chapter intends to measure the *Länder*-level response.

In summary, the literature reviewed above suggests that decreasing class size and additional teaching time per class can have (small) beneficial effects on student achievement, especially in combination with each other. Also the availability of substitute teachers and thus refraining from cancelling instructional time may be considered a (limited) investment in human capital. No such effect can be assumed for decreasing teaching time per teacher.

## 3.3 Data and summary statistics

The data set comprises information on primary education (grades one to four) because primary schooling is compulsory and thus, there are no changes in participation rates which can influence the provision of public resources. Moreover, data on primary education already fully reflects the demographic shock. The data derives from two sources. Information about teachers (T), students (St), classes (Cl) and teaching time (Tt) is from the 2008 edition of annual school statistics edited by the Standing Conference of German Länder Education Ministers, which corrects the data for Brandenburg primary schools such that only grades one to four are taken into account (see Standing Conference of German Länder Education Ministers, 2002, 34). All other data is from various publications by the Federal Statistical Office of Germany. The final panel data set covers yearly data (1993-2006) for the five East German Länder (BB, MV, SN, ST, TH). Earlier years are not included due to the transformation process in the East German educational system (Weiß and Weishaupt, 1999, 114). The East German panel thus contains 70 (5x14) observations. An identical data set is created for the 8 West German non-city Länder (BW, BY, HE, NI, NW, RP, SL, SH), which yields 112 (8x14) observations. The city states Bremen and Hamburg are excluded from the sample to guarantee the most comparable data with the East German data set. The city states have different socioeconomic backgrounds and also somewhat different institutions regarding the tasks of the Länder (see Chapter 2). Recall that the only purpose for the analysis of West Germany is to compare the findings from East Germany.

The measurement of the number of teachers (T) and teaching time (Tt) is worth a more detailed presentation (see Standing Conference of German Länder Education Ministers 2006c). The number of teachers (T) is measured as full-time equivalents (fte). Spare teachers, i.e. substitute or supply teachers who are used to prevent instructional time from being cancelled due to illness etc., are also billed, irrespective of whether this "on-call capacity" was actually used or not.[17] As discussed in Chapter 2, the teacher/student-ratio (T/St) is therefore considered to be an excellent resource indicator, but is less well-

[17] Note that in Germany the term substitute teacher (Vertretungsreserve) denotes teachers who are on call for the case that another teacher cannot give classroom instruction for illness, accidents, etc. Generally, these teachers are employed as regular teachers within the same school and serve some part of their working time on call.

suited to describe the learning environment of students (Standing Conference of German Länder Education Ministers, 2002, 96). Teaching time (Tt) is measured as total teaching hours in a Land, whether or not the instruction is obligatory. Additional language courses or special interest courses, etc., are therefore also taken into account. Teaching that is performed by substitute teachers due to illness, etc., is not counted twice. Hence, Tt/Cl is an appropriate measure of the teaching input into the production process in primary education and can be compared across Länder. This is less so in the case of Tt/T, because spare teaching capacity is not billed. Fewer teaching hours per teacher, therefore, may also reflect a higher spare teaching capacity on call. Since the coefficients in this study are identified from within-Länder variation, limited cross-Länder comparability is rather unproblematic. However, in interpreting Tt/T, some caution is warranted since less teaching hours per teacher may also reflect that more spare teaching capacity was available.

Table 3.1 reports summary statistics for the East German and West German panel data sets. Generally, the teacher/student-ratio in the East German Länder is on average about 16% higher than in West Germany. The minima for this ratio are identical while the standard deviation for the West German Länder is only 1/3 of the East German standard deviation. Examining the spending components, Table 3.1 shows that East German teachers teach about 6% less on average than their West German counterparts. In addition, the standard deviation is much higher than in the Western part of the nation. While the teaching load maximum is about 10% lower in the East German Länder, minimum teaching hours per teacher in East Germany are more than 20% below the West German minimum. To some extent this may indicate that more spare capacity was available on call in the East German Länder. Average class size is about 10% smaller in the East German Länder. While teaching hours per class are on average roughly equal across East and West German Länder, the maxima and minima suggest a higher variation in the East German Länder. Foreign students represent an important share of the student cohort in the Western part of the country (about 11% on average), whereas the share of non-German students is marginal in the East German Länder. Table 3.1 shows considerable variation of student numbers in both East and West Germany. However, much of the variation in student numbers – and also in education resources – comes from cross-Länder variation, while the focus of the present study is on variation within Länder.

Table 3.1 Summary statistics (5 East and 8 West German Länder, 1993-2006)

| Variable | Variable description | Sample | Mean | S. d. | Min / Max |
|---|---|---|---|---|---|
| T/St | Fte teacher per student | East | 0.057 | 0.010 | 0.043 / 0.082 |
| | | West | 0.048 | 0.003 | 0.043 / 0.055 |
| NW/T | School locations per fte teacher | East | 0.124 | 0.020 | 0.088 / 0.163 |
| | | West | 0.109 | 0.013 | 0.078 / 0.154 |
| Tt/T | Teaching hours per fte teacher | East | 23.806 | 1.728 | 18.525 / 27.956 |
| | | West | 25.326 | 1.132 | 23.425 / 30.961 |
| St/Cl | Students per class | East | 19.954 | 1.553 | 16.968 / 22.641 |
| | | West | 22.108 | 1.120 | 19.639 / 24.550 |
| Tt/Cl | Teaching hours per class | East | 26.540 | 1.767 | 22.994 / 31.108 |
| | | West | 26.676 | 1.540 | 24.260 / 29.822 |
| St | Number of students | East | 100 446 | 47 050 | 39 888 / 231 189 |
| | | West | 337 773 | 229 701 | 37 350 / 828 374 |
| PR | Real Länder public revenue per capita | East | 3 385 | 242 | 2 802 / 3 824 |
| | | West | 2 522 | 233 | 2 160 / 3 241 |
| PD | Population density: inhabitants per $km^2$ | East | 137 | 59 | 73 / 250 |
| | | West | 280 | 124 | 161 / 531 |
| UR | Unemployment rate | East | 0.186 | 0.021 | 0.142 / 0.221 |
| | | West | 0.095 | 0.019 | 0.055 / 0.136 |
| FS | Share of foreign students | East | 0.015 | 0.009 | 0.002 / 0.034 |
| | | West | 0.110 | 0.036 | 0.052 / 0.173 |
| ES | Share of population older than 60 years | East | 0.237 | 0.031 | 0.170 / 0.290 |
| | | West | 0.232 | 0.017 | 0.194 / 0.266 |

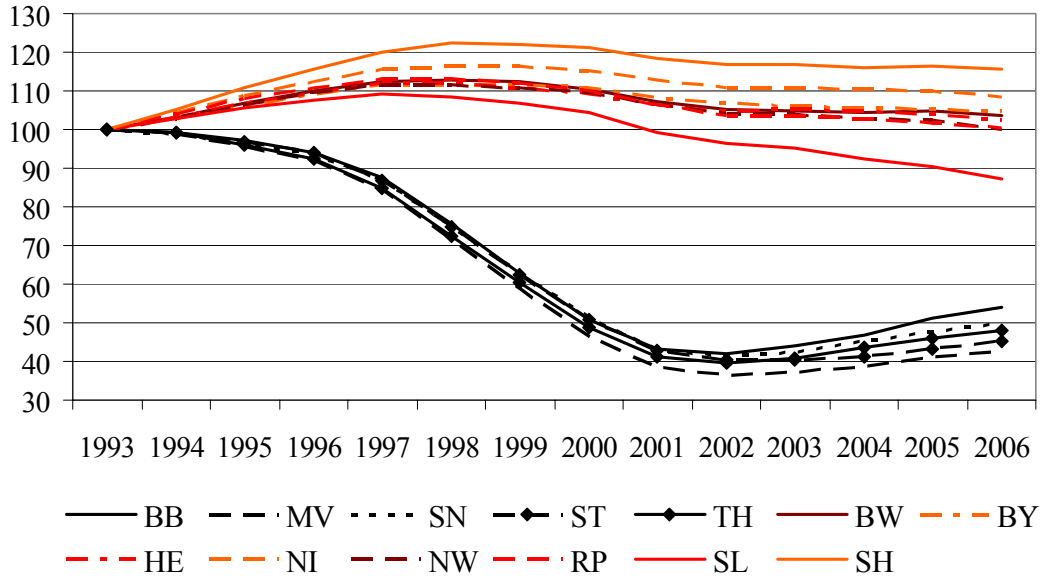
Note: Public revenue per capita is reported in 2000 Euros, with deflation across years using the deflator for government consumption taken from the 2007 Report of the German Council of Economic Experts. Fte denotes full time equivalent teacher.

Figure 3.1 presents the within variation of student cohort size for the East German Länder (black lines) and for the West German Länder (red lines). It is evident that the within variation in East Germany is much stronger than in the Western Länder. The size of the relevant student cohort in Mecklenburg-Vorpomerania (MV) decreases by about 65% from 1993 until 2002, whereas cohorts in Schleswig-Holstein (SH) increase by about 20% from 1993 until 1998.

Moreover, Figure 3.1 shows that the evolutions of student numbers are almost identical across the East German Länder from 1993 until 2000 (see the slopes in Figure 3.1). The correlation coefficient of the time-series variation across the 5 East German Länder over the 1993-2006 period is 99.8%. The within variation across the West German Länder is also highly correlated, but much less compared to East Germany (81.8%). The underlying reason for a high correlation of student numbers in primary schools is that it is almost entirely driven by demographics. Primary education is not influenced by

varying participation rates or differences in the education systems across Länder, etc. The reason for the highly similar demographic variation in East Germany may be that German Reunification induced a sharp decrease in birth rates across all East German Länder in a similar fashion. Moreover, the share of immigrants is generally very low in East Germany. Since immigrants often have different fertility rates compared to natives, a divergent share of immigrants across the West German Länder may be one source of the higher differences in the evolution of student numbers.

Figure 3.1 The number of students in primary schools across the East German Länder (black lines) and across the West German Länder (red lines) (1993-2006). Normalised time series (1993=100)




Data source: Standing Conference of German Länder Education Ministers.

The highly correlated within variation in student cohort size is problematic for the econometric models, which will be described in the following section. Typically, the models that have been used to evaluate the link between cohort size and spending per student exploit panel data, which enables them to account for economy-wide shocks by including year fixed effects (FE) in the specification. Separation of the effects from common shocks and from changes in the size of Länder-specific student cohorts is impossible if the within-Länder variation of cohort size is perfectly correlated across the Länder. In this case, there is strong multi-collinearity of the change in student numbers with the year fixed effects, which has the typical consequences for the estimation (high standard errors, unstable estimation results, see e.g., Kennedy, 2003, 213).

Finally, with respect to the control variables, Table 3.1 shows that the economic and geographic background is considerably different in East and West Germany. The unemployment rate in the West is only about 50% of the East German unemployment rate while population density in the East German Länder is not even half as high as in the West German Länder. Despite the weaker economic situation in East Germany, public revenue per capita in the sample period is on average more than 30% higher than in the West German Länder, due to the strong fiscal equalisation system in Germany and federal grants to the East German Länder.[18]

[18] Federal grants to East Germany follow a declining path and will cease in 2019; for details see Seitz et al. (2007, Chapter 5).

## 3.4 Empirical analysis

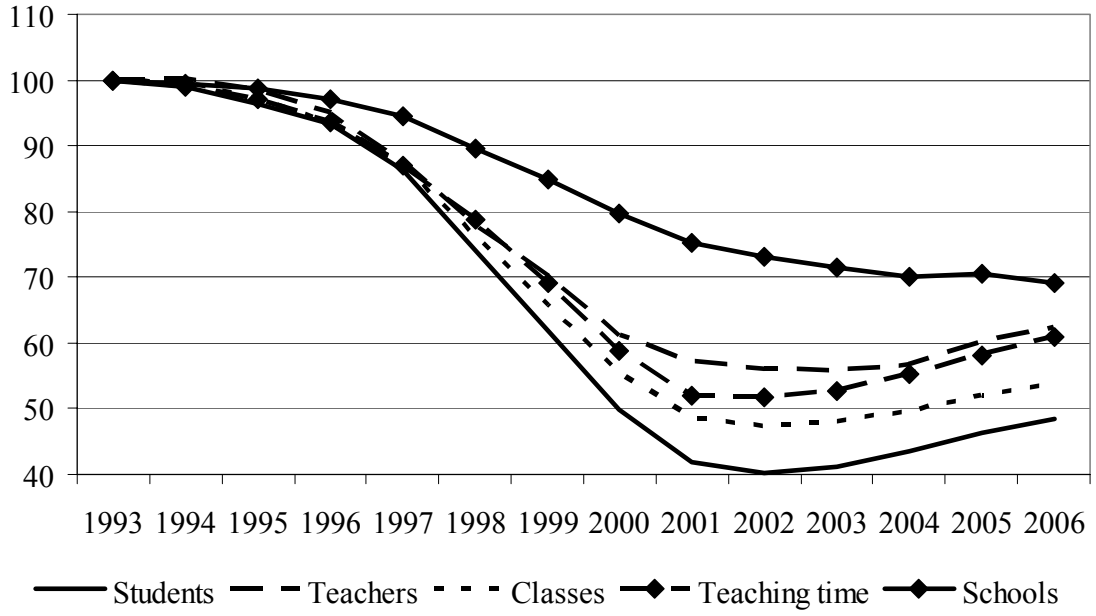
The goal of the empirical analysis is to investigate the effect of the sharp fall in the number of pupils on resource allocation in primary education based on panel data for the five East German Länder over the 1993-2006 period. The results are compared to similar regressions run on West German data for the same period. Section 3.4.1 presents some descriptive evidence on how spending components evolved over time in East and West Germany. The empirical strategy and the corresponding econometric models are described in Section 3.4.2. The results of these models are presented in Section 3.4.3.

### 3.4.1 Descriptive evidence

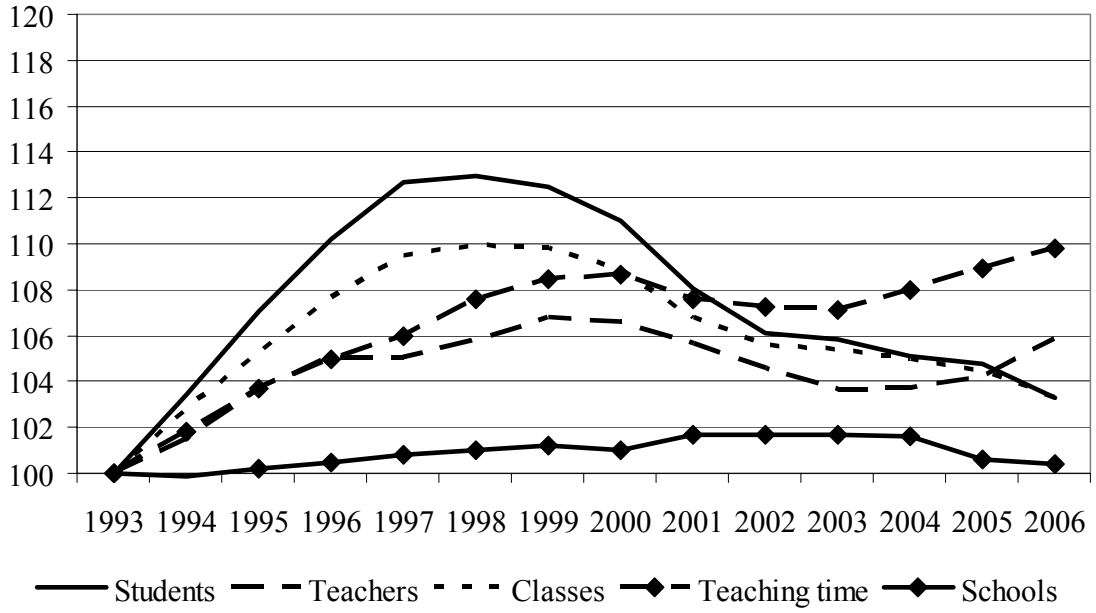
Figures 3.2 and 3.3 give descriptive overviews of the time-series variation in spending components. Figure 3.2 directly reports the number of fte teachers (T), classes (Cl), teaching hours (Tt) and students (St) and Figure 3.3 maps the spending components as given in Equation (3.1).

Figure 3.2 (a) shows that in the East German Länder there is considerable variation in the number of students and in the provision of teaching inputs. Most striking is the 60% decrease in the size of the student cohort from 1993 until 2002. In the same period there is a rather strong increase in the teacher/student-ratio as shown in Figure 3.3 (a). By 2002, the East German Länder employ about 40% more teachers per student than in 1993. After 2002, the number of students begins to pick up slightly by about 10 percentage points, while the teacher/student-ratio decreases by about 10 percentage points. Furthermore, in the East German Länder the number of school locations per teacher peaks at 30% above the 1993 level in 2001. Class size and teaching time per fte teacher reach their minima in 2001 and 2002 at about 85% and 90% of the 1993 level, respectively. Teaching time per class increases rather steadily by about 15% from 1997 until 2006. In West Germany there is relatively little variation in the provision of education resources over the 1993-2006 period. Figure 3.3 (b) shows that public education resources in West Germany remain virtually within a 5% band above or below the 1993 level while the number of students shows a somewhat higher variation (~ +15%; see Figure 3.2 b).

Figure 3.2 The number of students and physical schooling inputs (1993-2006). Normalised time series (1993=100)
(a) East Germany

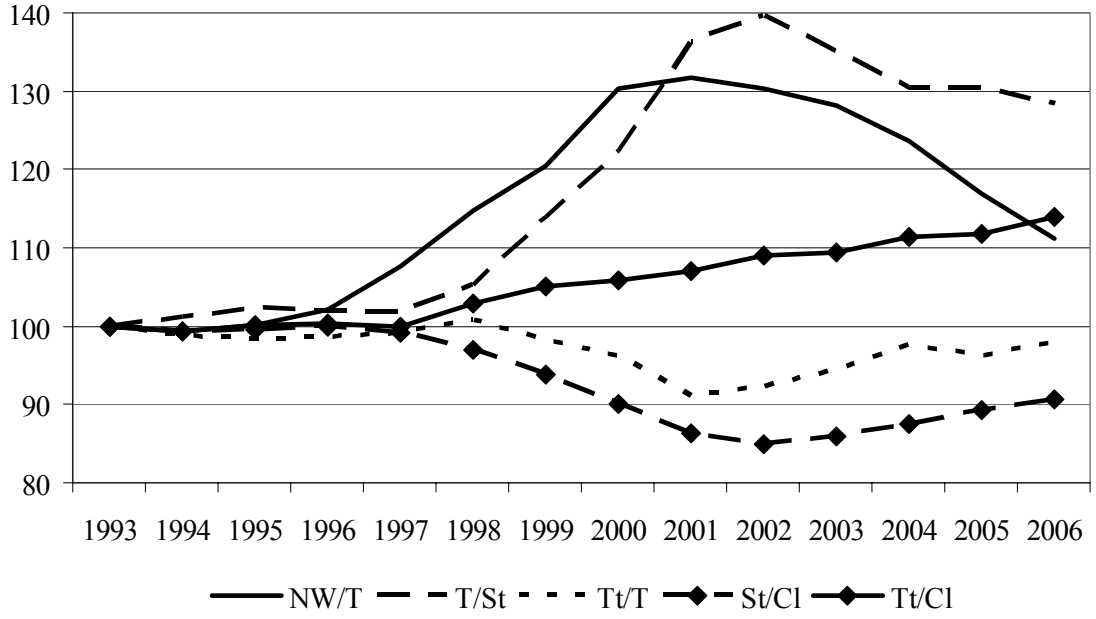



(b) West Germany

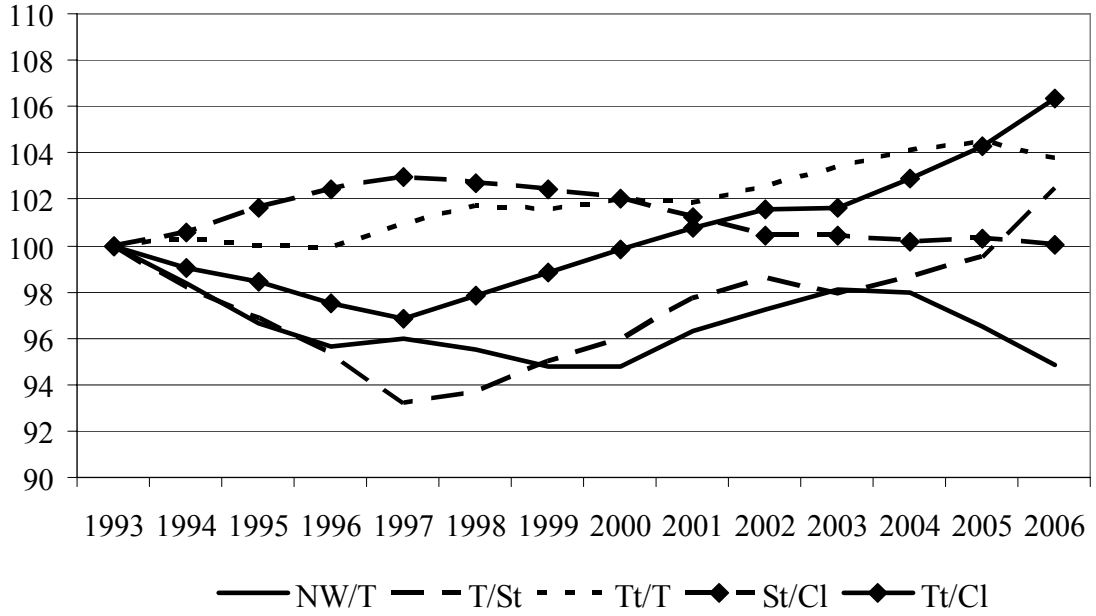



Data source: Standing Conference of German Länder Education Ministers.

Figure 3.3 Key components of education spending (1993-2006).
Normalised time series (1993=100)
(a) East Germany.




(b) West Germany




Data source: Standing Conference of German Länder Education Ministers.

Finally, the policy of resource adjustments in the East German Länder is worth mentioning. Länder governments and teachers' unions have mutually agreed on working time reductions of teachers in primary schools accompanied with a proportional reduction in teachers' wages (about 60% to 80% of a regular full-time teacher). In turn, Länder governments often refrain from firing teachers. These agreements are limited, typically ending in 2010. Working time reductions have been complemented by agreements on early retirement and compensation offers.

### 3.4.2 Empirical strategy and the econometric model

The starting point for a more formal empirical analysis is the decomposition of education spending (Equation 3.1). Rearranging and taking natural logarithms of Equation (3.1) yields:

$$(3.2) \quad \ln\left(\frac{E}{St}\right) = \ln\left(\frac{W}{T} + \frac{NW}{T}\right) - \ln\left(\frac{Tt}{T}\right) - \ln\left(\frac{St}{Cl}\right) + \ln\left(\frac{Tt}{Cl}\right)$$

Note that the adjustment of education expenditures to shifts in the size of the student cohort may affect the physical resource variables on the right side of Equation (3.2). Thus, potentially all spending components are functions of the number of students and deriving (3.2) with respect to ln(St) yields the elasticity of education spending per student to variations in student numbers ($\alpha_{E/St,St}$), which may be written as:

$$(3.3) \quad \alpha_{E/St,St} = \alpha_{(W+NW)/T,St} - \alpha_{Tt/T,St} - \alpha_{St/Cl,St} + \alpha_{Tt/Cl,St}$$

However, not every adjustment package necessarily effects all spending components. If, for example, teaching capacity (T) and schooling infrastructure (NW) are adjusted proportionately to the shifts in the size of the student cohort, all elasticities on the right side of Equation (3.3) will be zero as well as the overall elasticity ($\alpha_{E/St,St}$). If education spending is *not* adjusted to increasing/decreasing student cohorts, only class size (St/Cl) increases/decreases and the other spending components remain unchanged, i.e. only $\alpha_{St/Cl,St}$ takes a value different from 0, namely -1.

Whereas data for the last three elasticities on the right side of Equation (3.3) is available, comparable information on expenditures for primary education is nonexistent

(see Section 2.1). Therefore, some further empirical considerations on $\alpha_{(NW+W)/T,St}$ are necessary. *First*, an effect of primary education student numbers on public sector wages (W/T) is implausible from an institutional point of view in Germany. Primary school teachers earn general public sector wages, but represent only a small fraction of public sector employees. In the sample period, public sector wages were determined at the federal level in negotiations of the federal/Länder governments and public sector unions. Consequently, there is no theoretical foundation for the hypothesis that the number of students in East German primary schools has an effect on general public sector wages (W/T), and thus the elasticity of student numbers on teacher wages can be neglected in the analysis. *Second*, non-wage spending (NW) is not the main function of the Länder level, since the Länder's major responsibility is teacher employment (see Chapter 2). On average about 12% of education budgets at the Länder level are allocated to purposes other than wage-spending. Thus, when one wants to compare the results from this study with the extant literature, one should not neglect non-wage spending completely. As discussed above, the number of school locations may be considered as a proxy variable for non-wage spending in primary education although it is certainly not perfect.

Thus, we have to disentangle the elasticity of wage and non-wage spending $\alpha_{(W+NW)/T,St}$. This can be accomplished by weighting the separate elasticities $\alpha_{W/T,St}$ and $\alpha_{NW/T,St}$ with the respective spending shares from Länder budgets, which gives a correct approximation if the spending shares remain constant over the considered time period. This holds for the sample period (see A.3.4.2). Thus, in Equation (3.4), $\lambda$ is the spending share of staff expenditure in the education budgets of the Länder. Over the 1993-2006 period, $\lambda$ is 0.88.[19]

$$(3.4) \quad \alpha_{E/St,St} = (1-\lambda)\alpha_{NW/T,St} - \alpha_{Tt/T,St} - \alpha_{St/Cl,St} + \alpha_{Tt/Cl,St}$$

Note that while Equation (3.4) allow us to study the *composition* of resource adjustments, an alternative and more precise way to measure the *magnitude* of resource adjustment is given by again considering Equation (3.1) and cancelling down (T/Tt)*(Tt/Cl)*(Cl/St) to (T/St), the teacher/student-ratio, which is considered to be a

[19] This share refers to general school spending, not spending on primary education since the latter is unavailable on a comparable basis.

good resource indicator (see Section 3.3). An alternative, more compact, decomposition is obtained:

$$(3.5) \quad \alpha_{E/St,St} = (1-\lambda)\alpha_{NW/T,St} + \alpha_{T/St,St}$$

The elasticities on the right side of Equations (3.4) and (3.5) can be estimated in a straightforward way by regressing the natural log of the number of students (St) and a set of control variables on each spending component on the right side of Equations (3.4) and (3.5). For Equation (3.5), this gives rise to the following set of equations:

$$(3.6) \quad \ln\left(\frac{NW}{T}\right)_{it} = \alpha_{NW/T,St}\ln(St)_{it} + X'_{it}\Gamma_{NW} + \eta_i^{NW} + v_{it}^{NW}$$

$$\ln\left(\frac{T}{St}\right)_{it} = \alpha_{T/St,St}\ln(St)_{it} + X'_{it}\Gamma_{TSt} + \eta_i^{TSt} + v_{it}^{TSt}$$

The elasticities of Equation (3.4) are similarly estimated:

$$(3.7) \quad \ln\left(\frac{NW}{T}\right)_{it} = \alpha_{NW/T,St}\ln(St)_{it} + X'_{it}\Gamma_{NW} + \eta_i^{NW} + v_{it}^{NW}$$

$$\ln\left(\frac{Tt}{T}\right)_{it} = \alpha_{Tt/T,St}\ln(St)_{it} + X'_{it}\Gamma_{TT} + \eta_i^{TT} + v_{it}^{TT}$$

$$\ln\left(\frac{St}{Cl}\right)_{it} = \alpha_{St/Cl,St}\ln(St)_{it} + X'_{it}\Gamma_{SC} + \eta_i^{SC} + v_{it}^{SC}$$

$$\ln\left(\frac{Tt}{Cl}\right)_{it} = \alpha_{Tt/Cl,St}\ln(St)_{it} + X'_{it}\Gamma_{TC} + \eta_i^{TC} + v_{it}^{TC}$$

While i denotes the Länder, t denotes the years from 1993 to 2006. The coefficients of interest are the student elasticities $\alpha$. Each separate equation gives the student elasticity for a single component of education spending; the overall effect of varying student numbers on education spending per student (E/St) is given by the sum of the elasticities over the two equations (see Equation 3.5) or over the four equations (see Equation 3.4). Note that $\alpha_{NW/T,St}$ is weighted by $(1-\lambda)$. Note also that $\alpha_{T/St,St}$ should prove to be identical to $-\alpha_{Tt/T,St} - \alpha_{St/Cl,St} + \alpha_{Tt/Cl,St}$.

As motivated above, non-wage spending (NW) is approximated by the number of primary school locations. With regard to the student variable, the number of students (St) is preferred to the share of students in Länder populations because in the present study it is a more precise measure of educational demand. Recall that population size in the East German Länder also decreases considerably in the sample period. All students in primary education from first to fourth grade are taken into account. $X_{it}$ denotes a vector of control variables. Regarding the selection of control variables I follow Baum and Seitz (2003). Hence the fiscal capacity of the Länder is controlled for by including the natural log of public revenue per capita (PR) at the Länder level. Due to the strong fiscal equalisation system across German Länder, public revenue is preferred to GDP, because it is a much more appropriate measure of the financial resources at the Länder level. Public revenue is deflated using the government consumption deflator taken from the 2007 Report of the German Council of Economic Experts. Accounting for the settlement pattern of the Land (natural log of population density, PD) is necessary, because school location density cannot decrease arbitrarily; especially in primary education the Länder must assure certain standards with respect to school access and the distance to school. Accomplishing this task is more difficult in the less densely populated Länder. The Länder unemployment rate (UR) is included to control for the overall socio-economic situation of the Länder. Additionally, we control for the share of foreign students (FS). It is obvious from the descriptive statistics that this is a relevant variable in the West German Länder, whereas in East Germany the share of foreign students is rather small. The equations for the East German Länder are nevertheless estimated including the share of foreign students to allow for comparisons with the West German regression results. Furthermore, following the literature, the share of Länder residents older than 60 years is included (o60). 60 years roughly represents real retirement age in Germany in the sample period. However, no a priori hypothesis regarding generational conflict is formulated, since primary education represents only a fraction of the education system at the Länder level and Baum and Seitz (2003) only find very weak evidence towards generational conflict when considering the total education sector. The number of students (St), public revenue (PR) and population density (PD) enter the model as natural logarithms, while the unemployment rate (UR), the share of foreign students (FS) and the elderly share (o60) are expressed as shares. This permits an elasticity-interpretation of all coefficients.

Länder effects $\eta_i$ are included to control for unobserved heterogeneity, which is supposed to capture Länder-specific spending preferences in education or Länder-specific administration of public schools. This heterogeneity can be assumed to stay constant over time, but it cannot be assumed to be uncorrelated with explanatory variables, i.e. public revenue per capita or population density. Thus, the $\eta_i$ are treated as fixed.

In the literature it is standard to include year-specific effects to account for common shocks/trends. These time effects are typically assumed to capture changes in preferences for public education spending or changes in the federal legislation that cause common shifts in spending. Since the considered time period is rather short, these effects should generally be of minor importance. I note that accounting for common shocks is particularly difficult in the regression for East Germany, because within-Länder variation in student numbers highly correlates (see the evidence presented in Section 3.3). Thus, the response in education resources to changes in the size of the student cohort is captured by the year dummies; in particular, it is a problem of strong multi-collinearity of the year fixed effects with the variation in student cohort size (see also e.g., Arellano, 2003, 61 or Poterba, 1997, 54). However, it is well known that not accounting for confounding macro-level trends is also problematic. The regressions are therefore estimated with and without time dummies. Joint significance of the year dummies is tested using an F-test. Note, however, that the null of joint insignificance of these effects is likely to be rejected *due* to the high correlation of variation in student numbers across the East German Länder.

The $v_{it}$ are assumed to be independent of the $\eta_i$. However, it is not sensible to rule out serial correlation. The Wooldridge test for serial correlation in panel data models (Wooldridge, 2002 and Drukker, 2003) indicates that serial correlation is present in four out of five equations. Wooldridge (2002, 284 and 2003, 467) suggests first-differencing of the equation when serial correlation in levels is present or non-stationarity becomes a concern.[20] This applies in particular to the N<T environment. First-differencing wipes out the Länder-specific effects in Equations (3.6) and (3.7) and eliminates strong first-order serial correlation. The first-differenced equation can then be estimated by simple

[20] Testing for stationarity is difficult due to the low power of unit root tests for a short time series dimension.

OLS, which is called the First Difference (FD) estimator, as introduced by Wooldridge (2002, 279). Standard errors are estimated robust in the presence of heteroskedasticity and remaining (weak) serial dependence using the correction of the autocovariance matrix as suggested by Newey and West (1987) (see also Arellano, 2003, 19).[21]

### 3.4.3 Estimation results

This section first presents evidence on the *magnitude* of resource adjustments in East Germany by reporting the results from the T/St and NW/T regressions and by comparing these results to similar evidence for the West German Länder. The *structure* of the resource adjustment is investigated in more detail by performing regressions on the single components of the teacher/student-ratio in Section 3.4.3.2 while Section 3.4.3.3 is an attempt to evaluate the *educational effectiveness* of the adjustment package. Finally, Section 3.4.3.4 reports additional evidence from a reduced sample which only considers data from years in which student cohort size actually decreases (1993-2002).

#### *3.4.3.1 The magnitude of resource adjustments*

Table 3.2 presents the results for the East German Länder. Columns (1) and (2) report the results of the model for the school infrastructure per teacher (NW/T), without and including year fixed effects, respectively. Columns (3) and (4) report the results for the teacher/student-ratio regression (T/St), without and including year fixed effects, respectively.

The regressions estimated for school locations per teacher (NW/T, Columns 1 and 2) suggest a student elasticity of about -0.23 for the model without year-specific effects and -0.12 for the model including year fixed effects. The coefficient obtained from the model including year-specific effects is not significantly different from zero while the F-test confirms joint significance of the year fixed effects at the 5% level. This is not too surprising given that the demographic variation is highly correlated across the East German Länder as discussed in Section 3.3. Thus, a clean identification of the effect from decreasing student cohort size in the presence of year fixed effects is indeed not

[21] With regard to the estimation techniques, one issue deserves further comment. The system of equations shown in (3.6) and (3.7) could principally be estimated by SUR. Compared to single-equation-OLS, efficiency gains could be achieved if errors across equations were highly correlated and if correlation between the regressors over the equations were low. However, in the present study, the set of regressors is identical over the equations; thus SUR is equivalent to OLS. In addition, efficiency gains are arguable in small sample applications (Greene, 2003, 343 and 413).

possible. The model without time dummies is therefore the preferred model and the student elasticity of school infrastructure per teacher should be around -0.2.

Table 3.2 Regression results (5 East German Länder, 1993-2006)

| | Δ ln(NW/T) | | Δ ln(T/St) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Δ ln(St) | -0.232 | -0.122 | -0.506 | 0.132 |
| | (0.128)* | (0.554) | (0.138)*** | (0.458) |
| Δ ln(PR) | 0.088 | -0.579 | -0.067 | 0.667 |
| | (0.164) | (0.373)+ | (0.146) | (0.409)+ |
| Δ ln(PD) | 3.636 | 3.015 | -1.498 | -1.815 |
| | (0.974)*** | (1.240)** | (0.956)+ | (1.177)+ |
| Δ UR | 0.685 | 1.508 | -0.759 | -1.995 |
| | (0.376)* | (1.281) | (0.452)* | (1.153)* |
| Δ FS | 6.277 | 8.160 | -3.841 | -8.052 |
| | (3.270)* | (3.914)** | (3.620) | (4.133)* |
| Δ o60 | 1.517 | 1.087 | -1.974 | 1.121 |
| | (3.527) | (6.132) | (3.109) | (5.228) |
| Constant | 0.001 | 0.024 | -0.002 | -0.025 |
| | (0.020) | (0.033) | (0.016) | (0.032) |
| Observations | 65 | 65 | 65 | 65 |
| Year FE? | No | Yes | No | Yes |
| F (Year FE) | - | 2.60** | - | 3.46*** |
| Adjusted R-squared | 0.54 | 0.54 | 0.44 | 0.50 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively. Joint significance of the year fixed effects is tested using an F (12, 46) test.

Column (3) reports the student elasticity of the teacher/student-ratio (T/St), which is about -0.5 and significantly different from zero at the 1% level. This elasticity suggests that the long-run 50% decrease in student numbers is accompanied by a 25% increase in the teacher/student-ratio, which corresponds with the descriptive evidence presented in Figure 3.3 (a). In contrast, the model including year-specific effects (Column 4) suggests an insignificant student elasticity of the teacher/student-ratio. Taken at face value, the point estimate of about +0.13 implies that the teacher/student-ratio *decreases* with decreasing student numbers, which highly contrasts with the descriptive evidence. Furthermore, there is abundant anecdotal evidence from East Germany that casts considerable doubt on the plausibility of this coefficient: For example, the East German Länder education ministries explicitly report a causal relationship of decreasing student numbers on *higher* teacher/student-ratios (Sächsisches Staatsministerium für Kultus,

2005, 2007a and 2007c). Overall, the evidence supports the concern that the effect from the demographic variation may not be identified in the presence of year dummies. Thus, the model without year fixed effects is the preferred model, which suggests a student elasticity of around -0.5.

Most coefficients are, however, rather robust over both specifications of the NW/T and T/St regressions, with the exceptions of real public revenue per capita (PR) and the number of students (St). Thus, besides the highly cross-Länder correlated student variation, the year dummies cancel out common shocks in Länder public revenue (note, however, that the PR-coefficients are not significantly different from zero in any specification). Here, it is plausible that the time effects may capture economy-wide business cycle effects since one important feature of the fiscal equalisation scheme over the German Länder is that individual Länder revenues are highly sensitive to business cycles affecting the overall German economy, but much less to Länder-specific tax base increases/decreases (Baretti, Huber and Lichtblau, 2002). In particular, for East Germany, the year fixed effects may also capture changes in the magnitude of the federal grants to the East German Länder used to finance the reconstruction of the East German public capital stock. Furthermore, population density is an important determinant of the number of school locations per teacher, which reflects that school density cannot decrease arbitrarily, given that primary students are not expected to walk/drive long distances to school in primary education. While the share of foreign students appears to have some effect on the provision of school infrastructure per teacher and on teacher/student-ratios, the Länder unemployment rate has a weakly significant effect on the teacher/student-ratio.

Table 3.3 Regression results (8 West German Länder, 1993-2006)

| | Δ ln(NW/T) | | Δ ln(T/St) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Δ ln(St) | -0.626 | 0.981 | -0.542 | -0.687 |
| | (0.255)** | (1.405) | (0.077)*** | (0.274)** |
| Δ ln(PR) | 0.113 | 0.136 | 0.028 | 0.008 |
| | (0.295) | (0.355) | (0.027) | (0.029) |
| Δ ln(PD) | 5.064 | 2.757 | 0.382 | 1.027 |
| | (3.878)+ | (2.896) | (0.376) | (0.822) |
| Δ UR | -0.078 | 0.047 | -0.658 | -0.518 |
| | (0.798) | (2.046) | (0.223)*** | (0.528) |
| Δ FS | 0.912 | 4.364 | -0.079 | 0.272 |
| | (2.584) | (4.509) | (0.705) | (0.901) |
| Δ o60 | 3.990 | -1.654 | -2.309 | 1.523 |
| | (2.002)** | (5.008) | (0.797)*** | (1.879) |
| Constant | -0.032 | -0.085 | 0.011 | 0.004 |
| | (0.014)** | (0.057)+ | (0.003)*** | (0.011) |
| Observations | 104 | 104 | 104 | 104 |
| Year FE? | No | Yes | No | Yes |
| F (year eff.) | - | 0.65 | - | 0.81 |
| Adjusted R-squared | 0.07 | 0.07 | 0.55 | 0.53 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively. Joint significance of the year fixed effects is tested using an F (12, 85) test.

Table 3.3 presents the results for the West German Länder. Column (1) presents the estimate of the student elasticity of school infrastructure per teacher as obtained from the model without year fixed effects (-0.63), suggesting that resource adjustment in West Germany is considerably lower than in the East German Länder. This result is not surprising, given that the variation in student numbers is quite low over the sample period in West Germany and given that the adjustment of school infrastructure involves considerable costs. The inclusion of year fixed effects yields a coefficient which is not significantly different from zero and which highly contrasts with the coefficient estimated for the model without year effects as shown in Column (2). This coefficient is difficult to interpret, and may even be spurious due to the limited within variation which makes estimation in the presence of year fixed effects problematic. However, the year fixed effects are not even jointly significant in the estimations for West Germany. Therefore, the models including year dummies are not further considered. Columns (3) and (4) present the estimates for the student elasticity of the teacher/student-ratio. Depending on whether year fixed effects are included in the model, the elasticity ranges

from -0.54 to -0.69, suggesting that resource adjustment in West Germany is less responsive to changes in the size of the student cohort, albeit the differences between East and West German Länder are small and not significantly different from zero.[22]

In contrast to the findings for East Germany, the coefficients estimated for public revenue per capita are quite stable whether or not time effects are included. The reason may be that public revenue in the West German Länder is less dependent on transfers, such that changes to federal transfer schemes do not account for large parts of public budgets.

Table 3.4 Overall student elasticity of education resources in East and West Germany

| Sample | Estimator | Student elasticities of education resources | | |
|---|---|---|---|---|
| | | $\alpha_{E/St,St}$ | $(1-\lambda)\ \alpha_{NW/T,St}$ | $\alpha_{T/St,St}$ |
| East | FD w/o year FE | **-0.54** | -0.23* | -0.51*** |
| | | | (0.13) | (0.14) |
| West | FD w/o year FE | **-0.62** | -0.63** | -0.55*** |
| | | | (0.26) | (0.08) |

Note: Standard errors in parentheses. Point estimates, standard errors and significance levels are taken from Tables 3.2 and 3.3. The overall elasticity is calculated according to Equation (3.5).

Table 3.4 presents total student elasticities of education spending per student $\alpha_{E/St,St}$ for East and West Germany according to the models without time effects. Although the point estimates suggest that there is a difference in resource adjustments between East and West German Länder, this difference is rather low (about 0.1). In the case of the T/St regression, there is considerable overlap in the confidence intervals. Here, the differences are not even statistically significant when the East German elasticity of -0.5 is compared to the West German elasticity obtained from the model including year fixed

[22] When comparing the results for West Germany with the elasticities presented by Baum and Seitz (2003), the elasticity from the present study (-0.62) seems somehow low prima facie. The correct standard of comparison is the Länder level estimate from Baum and Seitz (2003) (-0.75 to -0.78). There are, however, several factors that can explain this difference besides the fact that the considered time period is different (1978-1999 vs. 1993-2006). First, the estimate of the present study could be imprecise since it is based on physical resource indicators. Second, Baum and Seitz (2003) focus on education spending as an aggregate of primary schools, lower secondary schools, higher secondary schools and vocational training. This difference could per se be a reason for a different elasticity but in addition to that, in Baum and Seitz (2003), rising participation rates, e.g. in Gymnasium, may be one of the reasons that contribute to their result, as long as these rising participation rates are not entirely identical across the Länder (if so, rising participation is captured by the year dummies). Moreover, if one considers the estimate obtained from the model including year fixed effects, as shown in Table 3.3, Column (4), the estimated elasticities are indeed virtually identical (-0.77).

effects (-0.69). Significant differences between East and West German Länder arise only in the adjustment of schooling infrastructure.

Thus, compared to the evidence presented in Poterba (1997), the estimates suggest that resource adjustments in the East German Länder have been considerable. However, when comparing the East German elasticity with the results reported in Baum and Seitz (2003), Grob and Wolter (2007) or with the elasticities obtained from similar regressions on West German data, resource adjustments in East Germany appear to be only slightly larger and not significantly different from adjustments in the demographically more stable West Germany. In particular, the estimates suggest that the 50% decrease in the size of student cohorts in East Germany has translated into a 25% increase of spending per student. In other words, if the East German Länder had adjusted education resources with the elasticity of their West German counterparts, education spending per student would have risen by about 30%.

*3.4.3.2 The composition of resource adjustments*

The teacher/student-ratio may be decomposed further to identify the sources of increased resource use per student. Thus, additional regressions as presented in Equation (3.7) are estimated for the East German Länder. Table 3.5, Columns (1), (2) and (3) report the estimates for the student elasticities of teaching time per teacher (Tt/T), class size (St/Cl) and teaching time per class (Tt/Cl), respectively. For the reasons discussed above, only the models without year dummies are reported. A table reporting the results including year fixed effects can be found in Appendix A.3.4.3.2 (a) along with the results for the West German Länder (A.3.4.3.2 b).

The regression of teaching time per teacher on student cohort size (Column 1) suggests that teaching time per fte teacher is an adjustment instrument for Länder education policy in East Germany. The estimated elasticity is 0.25 and is significant at about 13%.[23] The result from the St/Cl regression suggests that class size is also part of the adjustment package. The estimated elasticity of -0.22 is significant at the 1% level.[24] In

[23] Note that the effect works independently of part-time agreements made between the East German Länder and teacher unions during the sample period (primary school teachers in many Länder agreed to work about 70% of their normal working hours, meaning that they earn wages that are proportionately lower). The effect described above applies to *fte* teacher capacity and thus is at work independently of any working-time reduction that is accompanied by a proportionate reduction in teacher wages.

[24] The models including year effects (see A.3.4.3.2 a) suggest for both the Tt/T and St/Cl regressions considerably different estimates of the student-elasticities (-0.26 for the Tt/T regression and -0.06 for the

the Tt/Cl regression, the exogenous variables generally explain very little of the variation in teaching time per class. The number of students yields only quite small and insignificant coefficients, suggesting that teaching input per class has not been increased with redundant teaching capacity, or if so, only to a limited extent. This result implies that increased teaching input per class (see Figure 3.3 a) is independent from shrinking student cohorts.

Table 3.5 Regression results (East German Länder, 1993-2006)

| | (1) Δln(Tt/T) | (2) Δln(St/Cl) | (3) Δln(Tt/Cl) |
|---|---|---|---|
| Δ ln(St) | 0.256 | 0.221 | -0.029 |
| | (0.169)+ | (0.039)*** | (0.077) |
| Δ ln(PR) | -0.097 | 0.076 | -0.089 |
| | (0.164) | (0.030)** | (0.128) |
| Δ ln(PD) | 0.776 | 0.576 | -0.146 |
| | (1.011) | (0.261)** | (0.880) |
| Δ UR | 0.181 | 0.087 | -0.491 |
| | (0.351) | (0.119) | (0.282)* |
| Δ FS | 4.734 | 0.015 | 0.908 |
| | (5.524) | (1.163) | (3.286) |
| Δ o60 | 0.146 | 0.737 | -1.091 |
| | (4.282) | (0.688) | (2.840) |
| Constant | 0.014 | 0.003 | 0.015 |
| | (0.022) | (0.003) | (0.018) |
| Observations | 65 | 65 | 65 |
| Year FE? | No | No | No |
| F (Year FE) | - | - | - |
| Adjusted R-squared | 0.02 | 0.81 | 0.00 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

St/Cl regression). As discussed above, this is not surprising and can be explained by highly correlated student variation, which makes identification of the effect from student cohort size on education resources virtually impossible. Consider e.g. the St/Cl regression: taken literally, the point estimate of the specification including year fixed effects suggests that decreasing student numbers induce larger class size, but this is highly implausible given the descriptive evidence shown in Figure 3.3 (a) and anecdotal evidence from East German Länder education ministries (Sächsisches Staatsministerium für Kultus, 2007b and 2007c).

Summarising the student elasticities for the single components of education spending for East and West Germany, Table 3.6 permits to compare the composition of resource adjustments under conditions of rapid demographic change with policy responses in demographically more stable periods. A first finding is that summing the student elasticities of the single components of education spending according to Equation (3.4) matches the elasticity of the teacher/student-ratio quite well (see Table 3.4).

Table 3.6 Overall student elasticities of single physical resource variables in East and West Germany

| Sample | Estimator | Student elasticities of education resources | | | | |
|---|---|---|---|---|---|---|
| | | $\alpha_{E/St,St}$ | $(1-\lambda)$ $\alpha_{NW/T,St}$ | (-) $\alpha_{Tt/T,St}$ | (-) $\alpha_{St/Cl,St}$ | $\alpha_{Tt/Cl,St}$ |
| East | FD w/o year FE | **-0.54** | -0.23* | 0.26+ | 0.22*** | -0.03 |
| | | | (0.13) | (0.17) | (0.04) | (0.08) |
| West | FD w/o year FE | **-0.62** | -0.63** | 0.00 | 0.35*** | -0.19 |
| | | | (0.16) | (0.12) | (0.06) | (0.14) |

Note: Standard errors in parentheses. Point estimates, standard errors and significance levels are taken from Table 3.5 and A.3.4.3.2 b. The overall elasticity is calculated according to Equation (3.4).

The general message from the decomposition is that the adjustment bundles differ considerably between the East and the West German Länder. *First*, as discussed above, school infrastructure per teacher has been adjusted considerably to falling student numbers in East Germany; note the large difference between the estimates for West and East Germany. *Second*, the adjustment of class size is significantly higher in the East German Länder. The point estimate obtained from East German data is about 2/3 of the West German estimate. Taken literally, the estimated elasticity of 0.22 implies that class size drops by about 10% in the course of the 50% decline of student cohorts in primary education, which roughly corresponds to the descriptive evidence (see Figure 3.3 a). *Third*, there is also a large difference between the student elasticities of teaching time per teacher in East and West Germany. In West Germany, this elasticity is virtually zero whereas the elasticity is estimated to be around 0.25 for the East German Länder. This suggests that the East German Länder use teaching hours per teacher as an adjustment instrument for redundant teaching capacity. Given the definition of the variables teaching time (Tt) and fte teachers (T) (see the discussion in Section 3.3), another possible interpretation is that the East German Länder increase spare capacity, i.e. more substitute teachers have been used to prevent cancellation of teaching time due to the

absence of regular teachers. Note that this effect is large: the estimated elasticities imply that the ratio Tt/T has been reduced by about 12% ceteris paribus. Both interpretations may be valid, i.e. teaching hours per fte teacher are indeed reduced and a larger spare capacity of substitute teachers has prevented the cancellation of instructional time. Anecdotal evidence from Saxony, the largest East German Land, suggests that cancelled teaching time in primary schools dropped almost 50% from 1995 to 1999. Moreover, cancelled time has been on a very low level in primary schools: in 1999, about 0.6% of total instructional time is cancelled, compared to 3.2% in secondary education and to 7.5% in vocational training courses (Sächsischer Landtag, 2000). [25] *Finally*, as discussed above, the estimation results suggest that teaching time per class has not been increased with redundant teaching capacity in East Germany. Again, this is different in West Germany, where an elasticity of about -0.2 is estimated, suggesting that the West German Länder increase/decrease teaching time per class with variations in the size of the student cohort.

*3.4.3.3 An attempt to evaluate the educational effectiveness of resource adjustments*

The following discussion represents a rudimentary attempt to evaluate the educational effectiveness of the adjustment package. We observe that the elasticity of class size to shrinking student cohorts is considerably lower in the East German Länder, which accounts for an important part of the difference between East and West Germany. On the one hand, this is likely not too damaging for students since the results from the education production function literature suggest that the effect of smaller classes on student performance is limited. On the other hand, as stated by Coates (2003), the combination of smaller classes and increased teaching time per class can be an effective way to spend schooling resources in primary education. The estimation results strongly suggest that redundant teaching capacity is not used to increase teaching input per class. However, teaching time per class increases during the sample period (see Figure 3.3 a), obviously for reasons other than the declining student cohort and subsequently abundant teaching capacity. Thus, after all, students may indeed benefit from smaller classes due to the combination of moderately smaller classes with increased teaching time per class.

The results for the student elasticity of teaching time per fte teacher lead to some ambiguity. As stated above, there are two possible interpretations which imply quite

[25] In Saxony, teaching time per teacher (Tt/T) drops by about 6% from 1993 until 1994. In 1999 (2002), teaching loads per teacher are about 7% (17%) below the 1993 level.

different conclusions from the view of educational effectiveness. On the one hand, less teaching time per teacher may be caused by increased spare capacity and less cancellation of teaching time. This interpretation is supported by descriptive evidence, which shows that the loss of instructional time in East German primary education in the early 2000s is low when compared to (i) previous years, (ii) secondary education and (iii) the West German Länder. Evidence presented by Marcotte and Hemelt (2007) suggests that reducing the cancellation of classes may be considered a comparatively effective way of spending resources, although Clotfelter, Ladd and Vigdor (2007) and Miller, Murnane and Willett (2007) indicate that gains may be limited. On the other hand, the student elasticity of teaching time per fte teacher is quite large, which suggests that a portion of the additional resources may be due to a reduction in teaching loads per teacher.

Overall, the adjustment package in the East German Länder probably contains some demographic costs, i.e. increased education spending per student that cannot be expected to be a substantial investment in human capital formation (e.g., decreased teaching hours per fte teacher, reduced class size, etc.). However, there is also some fraction of increased spending per student, which can be assumed to translate into better student performance in the future (less cancellation of instructional time, a combination of smaller classes and increased teaching time per class, etc.).

*3.4.3.4 Isolating the demographic shock: evidence from the 1993-2002 period*

Figure 3.2 (a) shows that whereas the number of school locations falls throughout the sample period, the number of students and teachers stagnates in 2002-2003 and begins to rise again in 2004. This finding produces some concern that the sample period may be too long to yield clean estimates of education policy in the years of decreasing student numbers. Therefore, I re-estimate Equations (3.6) and (3.7) for the 1993-2002 period, bearing in mind that by doing so further reduces the (already quite small) sample. I suggest that the results from the reduced sample are more adequately viewed as a complement to the estimates for the full sample period. Table 3.7 reports the results for all spending components in the East German Länder over the 1993-2002 period.

The lesson to be learned from the estimations based on the shorter sample period is quite clear. Noting a significantly smaller student elasticity of the *teacher/student-ratio*

(-0.2) compared to the full sample period and compared to the West German Länder indicates that teaching capacity is adjusted considerably in the period of the strongest decrease in student numbers until 2002. Figure 3.3 (a) shows this is true especially until 1998, when the teacher/student-ratio only increases to about 5% above the 1993-level, while student numbers have already decreased by about 30%. The elasticities estimated for *teaching time per teacher* (Tt/T), *class size* (St/Cl) and *teaching time per class* (Tt/Cl) are not significantly different from the elasticities estimated for the full sample period, but the point estimates tend to be smaller than the full-sample-results. In particular, the smaller student elasticity of teaching time per teacher (Tt/T) accounts for about 2/3 of the difference between the 1993-2006-estimate and the 1993-2002-estimate. In summary, the resource adjustments are considerable in times of shrinking cohort size but are not carried much further in the following years.

Table 3.7 Regression results (5 East German Länder, 1993-2002)

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Δ ln(NW/T) | Δ ln(T/St) | Δln(Tt/T) | Δln(St/Cl) | Δln(Tt/Cl) |
| Δ ln(St) | -0.487 | -0.206 | 0.042 | 0.164 | 0.000 |
| | (0.143)*** | (0.121)* | (0.150) | (0.054)*** | (0.128) |
| Δ ln(PR) | 0.161 | -0.123 | -0.114 | 0.091 | -0.146 |
| | (0.155) | (0.135) | (0.170) | (0.028)*** | (0.132) |
| Δ ln(PD) | 3.752 | -2.467 | 1.822 | 0.852 | 0.207 |
| | (0.903)*** | (0.882)*** | (1.256)+ | (0.306)*** | (0.919) |
| Δ UR | 0.666 | -0.794 | 0.288 | 0.155 | -0.351 |
| | (0.423)+ | (0.457)* | (0.287) | (0.127) | (0.235)+ |
| Δ FS | 4.377 | -3.897 | 1.604 | 0.050 | -2.244 |
| | (4.066) | (4.577) | (4.910) | (1.473) | (2.553) |
| Δ o60 | -6.306 | 8.036 | -4.653 | -0.063 | 3.321 |
| | (6.334) | (6.280) | (6.231) | (2.291) | (4.262) |
| Constant | 0.034 | -0.044 | 0.037 | 0.002 | -0.004 |
| | (0.038) | (0.037) | (0.034) | (0.011) | (0.019) |
| Year FE? | No | No | No | No | No |
| Observations | 45 | 45 | 45 | 45 | 45 |
| Adjusted R-squared | 0.38 | 0.40 | 0.00 | 0.72 | 0.00 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

For *school infrastructure*, the adjustment is less strict when looking at the shorter period (-0.49) compared to the full sample period until 2006 (-0.23), consistent with the view of sluggish adjustment problems. Apparently, Länder and Gemeinden (local

governments) face problems of sluggish adjustment in the provision of school buildings and this adjustment takes more time than for teaching capacity. Consequently, the overall student elasticity of education spending per student for the 1993-2002 period is thus given by about $-0.21 + \lambda\,(-0.49) = -0.27$.

Yet, these findings are inconsistent with the view that the East German Länder experience major problems in adjusting the number of fte teachers. Rather, the adjustment of teaching capacity begins quickly and stops early. Figure 3.2 (a) reveals that teaching capacity is significantly adjusted only until 2000 when student cohorts are still decreasing. Thereafter, teacher employment stagnates and begins to increase in 2004. We would expect that the number of teachers should continue to decrease even beyond 2000 when there are major problems in adjusting teaching capacity to decreasing student cohort size. Consequently, a large part of the inelastic response estimated for the 1993-2006 period is rooted in the post-2000 period due to causes other than teacher employment protection. [26] [27]

A political-economic interpretation of this result is that Länder governments have an easier task explaining the need to cut teacher employment in times of dramatic losses in the number of students. This becomes much more difficult as soon as student numbers stagnate or begin to increase. Specifically for the post-2001 period in Germany, politicians may have faced problems explaining resource cuts in public education due to the so-called "PISA-Schock" in 2001. The publication of the German PISA results by the OECD in autumn 2001 is somewhat comparable to the "Sputnik-crisis" in the U.S. in the late 1950s. At the time the PISA results revealed that the German education system was not as good as commonly believed, and created pressure on policymakers to improve learning conditions and maintain the same educational levels as other

[26] It is not clear whether this result easily generalises to West Germany since the structure of teacher employment is different between East and West Germany (see Chapter 2). Whereas in East Germany, most teachers are employed as regular public sector employees, in West Germany, many teachers are public servants who enjoy special employment protection.

[27] To check whether teacher employment protection was *any* problem for the Länder governments, one may estimate models as in Equation (3.6) and (3.7) but containing leaded student numbers in addition to contemporaneous student numbers. Cohort size is known with certainty about 6 years in advance. If Länder governments face *some* difficulties in cutting teaching capacity, it is rational for them to begin the adjustment process in advance. In such models, leaded values of student numbers yield significant coefficients in the regressions of the teacher/student-ratio (T/St, at the 20% significance level) and of class size (St/Cl, at the 5% significance level). The results show that in both models about 30% of the adjustment response may have been initiated one period in advance, which in turn suggests that Länder governments in East Germany face at least *some* restrictive employment protection in the adjustment process.

industrialised countries. This public opinion may have complicated the implementation of further resource adjustments in public education. Typically, one should try to control for the PISA-Schock by introducing time effects to the model, which is impossible due to the difficulties with the time effects described above. Thus, I cannot easily claim that the results are net of possible changes in public education demanded by parents, political factions and the like following the publication of the PISA results.

## 3.5 Conclusions

Previous empirical evidence for several countries about the link between school spending and student cohort size suggests that total education spending is not adjusted proportionately to varying sizes of the student cohort. According to these results, a large decrease in the student cohort should translate into an important increase in education spending per student rather than into a significant decrease in resources allocated to public education. This chapter attempts to test if this result holds true under conditions of rapid demographic change using panel data on primary education in the five East German Länder (1993-2006) where the birth rates collapsed after the fall of the Iron Curtain in 1990. An advantage of using data on primary schools is that the estimation results are not biased by increasing participation rates which may distort elasticities estimated for higher levels of education. To evaluate what rising education expenditures per student actually finance, education spending per student is decomposed into physical resource indicators such as class size, teaching time per class, etc.

I find that resource adjustment in the East German Länder appears to be particularly strong in times of decreasing student cohorts (1993-2002). The data for this period suggests a student elasticity of education spending per student of about -0.27, which is considerably smaller than the state level estimates from the literature, which range from about -0.6 to -1.0. Apparently, adjustment efforts faded in the following years when student numbers stagnated and began to increase later. The data for the full period (1993-2006) suggests a student elasticity of education spending per student of -0.54 (-0.5 for the teacher/student-ratio). This elasticity is still smaller than most results from the literature, but not significantly different from the elasticity estimated for the demographically more stable West Germany (-0.62). My estimation results imply that the 50% decline in primary school students caused education spending per student in East Germany to increase by about 27% (teacher/student-ratio: +25%).

One plausible interpretation of the fading adjustment efforts after 2000-2001 is that Germany's politicians faced increased resistance from pressure groups such as teachers' unions and parents in times of stagnating or increasing student cohort size. In particular, in 2001 when student numbers had stagnated, publication of the PISA results in the autumn had considerable repercussions for the public debate, and may have shifted

spending preferences for public education upward. Hence, it cannot be ruled out that fading adjustment efforts after 2001 are confounded with effects from the PISA-Schock. In some sense, the evidence found for the reduced sample (1993-2002) may be "cleaner" from confounding factors and we may conclude that there is some evidence in the direction of sharper resource adjustments during times of strong and rapid demographic change.

As to the underlying adjustment mechanism, the findings from the reduced sample challenge the view that the East German Länder experienced major problems in adjusting teaching capacity due to teacher employment protection (at least with the East German model of teacher employment).

The decomposition of spending per student identifies the channels of increased resource use per student. Somewhat surprisingly, an important fraction of the increase is caused by declining teaching load per teacher. This effect is large and has two possible sources: either teaching loads per teacher were reduced or the Länder increased spare teaching capacity to prevent teaching time from being cancelled due to unexpected absences of teachers. Decreasing class size contributes only moderately to rising expenditures per student when compared to the West German Länder, but still accounts for an important fraction of increased spending per student. Teaching time per class steadily increased over the sample period; however, the estimates suggest that this increase was independent from the decreasing size of the student cohorts. A short survey of relevant results from the literature of education production functions suggests that this adjustment package contains some fraction of demographic costs but also investments in human capital formation which may translate into improved student performance. In fact, there is some anecdotal evidence; in the 2006 PISA test, the East German Länder considerably improved their performance compared to earlier editions of the test. In particular in 2006 (2001), three (two) East German Länder ranked among the top five in mathematics (*Saxony*, *Thuringia* and Mecklenburg-Vorpomerania), three (one) in sciences (*Saxony*, Thuringia and Saxony-Anhalt) and two (one) in reading (Saxony and Thuringia). The students who were tested in 2006 (grade 8) left primary schools in 2002. Thus, they may have benefited from more generous resource endowments in primary school (and subsequently also in lower secondary education).

# 4 LOWER SECONDARY EDUCATION: THE POLITICAL ECONOMY OF ABILITY-TRACKING IN THE WEST GERMAN LÄNDER

## 4.1 Introduction

Ability-tracking, which is the sorting of students into different types of schools by their ability, is practised in many industrialised nations. While some begin tracking at the age of 10 (Austria and Germany), others track later (e.g., France and Japan), or have comprehensive systems (e.g., Sweden and the U.S.). Given that recent empirical evidence suggests that tracked education systems increase educational inequality and may also reduce mean performance (see e.g., Hanushek and Wößmann, 2006), this chapter discusses distributional conflicts as a possible political-economic rationale for the existence of tracked education systems.

Germany practises pronounced ability-tracking. At the same time, recently presented evidence suggests that the correlation of a child's track choice with parental background is comparatively strong in Germany (see Chapter 2). In short, students from a high-education or high-income background have significantly higher probabilities of attending a high-ability track.[28] These stylised facts coincide with the intensive ideological debates about education policy in West Germany, which arose with the implementation of comprehensive schools in the early 1970s. Ideological conflicts long shaped education policy in West Germany – at least until the first publication of the nation's PISA results in 2001 ("PISA-Schock"). While the Conservatives have argued in favour of early tracking, Social Democrats have traditionally advocated comprehensive schools, offering joint education for all tracks (see Chapter 2 and Stern, 2000, 29, 116, 119 and 125).

Against this background, the chapter tests whether partisan theory can help to explain why tracking is practised in Germany. In particular, ability-tracking may facilitate the concentration of benefits on specific constituencies via two channels: *first*, the tracking

[28] This link holds also for educational achievements in general (Hanushek, 1986, 1163; Ermisch and Francesconi, 2001 or Wößmann, 2004).

of students *itself* can be sufficient to concentrate beneficial peer effects among high-ability students, which are predominantly from high-income/high-education households ("peer group effects").[29] *Second*, ability-tracking permits to focus public education spending on those tracks in which the constituencies' children are overrepresented. Political parties representing high-education households would then advocate spending on the high-ability tracks while politicians representing low-education households would tend to support higher spending on the low-ability tracks.

Partisan hypotheses for German political parties are derived in Section 4.2. Section 4.3 describes the data. The empirical analysis consists of two parts: Section 4.4 tests whether German political parties support/oppose the practise of ability-tracking along the lines that partisan theory predicts and Section 4.5 provides evidence about the question whether political parties increase/decrease public resources for the tracks in which their constituencies are overrepresented. Panel data for 10 West German Länder in the 1979-2006 period suggests that political parties virtually always act in the direction predicted by partisan theory although not always significantly different from zero. In particular, political parties support tracked systems if they represent high-education households and oppose tracking if they represent low-education households. The results for the distribution of public resources across tracks are weaker but still support partisan theory.

[29] The practise of tracking can have important effects on student performance via the influence of classmates (e.g. higher level discussion in class, less disruption). There is considerable empirical evidence for the existence of these peer influences, from both econometric studies (e.g. Burke and Sass, 2008) and from experiments (e.g. Falk and Ichino, 2006).

## 4.2 Background: partisan theory in public education

### 4.2.1 Partisan theory

I start my investigation of the effects of party ideology on public education by referring to the literature on partisan theory, which dates to Hibbs (1977) and Tufte (1978). The former article is among the most frequently cited work in political science (Sigelman, 2006).[30] Generally, the essence of partisan theory is the assumption that political parties' policies are shaped by ideology and that different political parties, when in office, pursue different goals and policies. In economics and political science, this assumption is not as commonplace as one might suspect. Very prominent strands of the literature on voting and electoral cycles assume that parties are only engaged in maximising votes and winning elections, thereby allowing no room for party ideology (Median voter theorem, Downs, 1957 or opportunistic political cycles, see e.g., Nordhaus, 1975 or Rogoff and Sibert, 1988). As opposed to these opportunistic models, partisan theory highlights the ideological motivation of politicians and their parties. As Alesina, Roubini and Cohen (1997, 45) state: *"opportunistic policymakers choose policies solely to win elections, [whereas] partisan policymakers want to win in order to implement their desired policies"*. Thus, different parties are assumed to represent specific clientele in the electorates and, when in office, mainly pursue and advocate for the interests of their core constituencies. The typical hypothesis is that left-wing parties pursue policies benefiting lower to middle class households, such as reducing unemployment, increasing economic growth and following less strict inflation policies. In contrast, right-wing governments are usually predicted to target containing inflation while being less concerned about unemployment. Tufte (1978) and Hibbs (1987a) substantiate these hypotheses with empirical evidence on the relative costs and benefits of inflation and unemployment for low- and high-income households and on the socioeconomic background of political parties' members and their constituencies. Alesina (1987) formalises and modifies Hibbs' work such that voters, workers, etc., form expectations rationally (rational partisan theory), which limit the governing parties' possibilities to exploit the trade-offs between inflation and unemployment stated by the short-run Phillips-curve. Nevertheless, the qualitative predictions of Hibbs' model also hold in Alesina's framework.

[30] For a more detailed presentation of traditional and rational partisan models as well as empirical work testing partisan theory for macroeconomic outcomes, fiscal policy and public education see A.4.2.

In empirical investigations, party ideology has been tested in its impact on macroeconomic outcomes and has performed quite well compared to other political-economic theories. Partisan theory has also been tested in its impact on policy instruments, such as monetary or fiscal policy and has performed somewhat better in fiscal policy (see Alesina, Roubini and Cohen, 1997). Of course, politically motivated manipulations of fiscal policy may not only affect unemployment/inflation but can also impose more direct fiscal benefits and costs, e.g., those induced by public education.

### 4.2.2 Partisan theory in public education

Few studies test partisan theory in public education. Generally, most of those studies focus on testing the general hypothesis that left-wing governments spend more resources on public education than right-wing governments, thereby merely borrowing the original hypothesis by Hibbs and Tufte for the education sector. Studies testing this hypothesis for OECD countries tend to confirm the hypothesis (Castles, 1989; Boix, 1997; Busemeyer, 2006 and 2007) whereas empirical evidence on data for the U.S., France and Germany is mixed (Fusarelli, 2002 and Saeki, 2005 as well as Colburn and Horowitz, 2003 for the U.S.; Bilek, 2005 for France and Galli and Rossi, 2002; Potrafke, 2006; Schmidt et al., 2006; Tepe, 2007 and Oberndorfer and Steiner, 2006 for Germany; see also A.4.2 for an encompassing overview of this work).[31]

From a theoretical view, the general hypothesis that left-wing governments spend more public resources on education is not entirely convincing. This hypothesis bears the implicit assumption that low-income households are always better off demanding higher public expenditures on education. However, the redistributive character of public education and thus an individual's net benefit from public education is a rather complex function of the level of public education spending, national tax system, degree of publicness of the education system, individual educational participation, social returns from education and so on. The distributional effects of increases in public education

[31] Note that there is some evidence for the influence of Socialists on public education spending for the Nordic countries, which use the Socialists' share in parliament/council as a control variable (Falch and Rattsø, 1997 and 1999 for Norway or Heinesen, 2004 for Denmark). They usually find positive effects of the Socialists' share in parliament/council on education spending.

spending are therefore not clear-cut and a theoretical prediction for the preferences of left/right-wing governments on the *overall level* of education spending is not trivial.[32]

This chapter assumes a more realistic picture of the education system. Specifically, I incorporate the fact that education systems in many nations are characterised by systems of ability-tracking. Ability-tracking is generally considered questionable from an equality-of-opportunity perspective. Some researchers even question the practise of tracking on efficiency grounds (see the overview in Meier and Schütz, 2007; Hanushek and Wößmann, 2006). A *political-economic* rationale for the existence of ability-tracking, however, can be found in its distributional effects, which can be described using partisan theory. The remainder of the chapter first motivates potential partisan influence on the system of ability-tracking (Section 4.2.2.1) and then gives some intuition for partisan influence on resource allocation across tracks (Section 4.2.2.2).

*4.2.2.1 The practise of ability-tracking*

The starting point is an education production function:

$$(4.1) \quad h = h(a, m, r)$$

Students' human capital *h* depends on students' own ability *a*, mean ability in class *m*, and the resources spent on education *r* (see e.g., Meier and Schütz, 2007). If an education system places students with high ability in one track and students with low ability in another, students' performance may be affected by two channels. Mean performance *m*, which is of course higher in the high ability track, may have a (typically positive) effect on student performance. Furthermore, ability-tracking of students permits differentiation of educational resources *r* such that resources are predominantly allocated to the high- or to the low-ability track.

The distribution of public resources across tracks is the subject of Section 4.2.2.2 while this section deals with mean performance in class. One prominent channel by which mean performance in class can affect an individual's educational achievements is the influence by classmates. These "peer group effects" describe spillover effects such that

[32] Deriving such a hypothesis becomes even more complex in cross-country studies, given the important differences in political, fiscal and education institutions (see Schmidt, 1996; Alesina, Roubini and Cohen, 1997, 247 and Franzese, 2002, 44).

good students strongly contribute to classroom discussions, aid students with below-average capabilities, contribute to a high motivation in class and less frequently disturb classroom instruction, thereby helping to improve the learning achievements of their peers (see e.g., Hanushek and Wößmann, 2006).

Peer effects are quite difficult to measure empirically. The problems include the separation of school effects and peer group effects, or the endogenous assignment of peers and teachers. Moreover, such studies require high-quality data sets, which allow researchers to identify *class* peers, i.e. the students who share classrooms and not merely the grade level. Beside these difficulties, most studies find at least small positive effects on students' achievements from having high-ability peers in their class (McEwan, 2003; Hanushek, Kain, Markman and Rivkin, 2003; Ammermüller and Pischke, 2006). Thus, tracking involves redistributions of educational opportunities; typically low-ability students suffer from the practise of ability-tracking (see e.g., Epple, Newlon and Romano, 2002; Hanushek and Wößmann, 2006; Meier and Schütz, 2007). In a recent study, Burke and Sass (2008) exploit a very rich data set covering all Florida public school students in grades three to ten over a five-year period. The results suggest that low-ability students benefit from sharing classrooms with high-ability peers but also well-performing students suffer from being in a class with low-ability students.[33] Experimental studies – although having more stylised settings – basically confirm that students with below-average capabilities benefit from having high-ability students in class (see e.g., Falk and Ichino, 2006). Together, these results suggest that any school reform involving changes in the intensity of ability-tracking causes redistributions from low-ability to high-ability students and vice versa.[34]

Thus, it follows from this discussion that tracking benefits students in the tracks for high-ability students, who predominantly have a "good" parental background in terms of education, income or profession. Chapter 2.2 showed that the link between students' track choices and their parents' education, income or profession is particularly strong in Germany. In turn, households whose children have a higher probability of attending a

[33] Hanushek and Wößmann (2006), however, find that both weak and strong students suffer when tracking is practised. Still, students in the high-ability track may gain from tracking in relation to students who are grouped in the low-ability track

[34] It is disputed whether the practise of grouping students according to their ability has a negative or positive effect on aggregate educational achievement. Meier and Schütz (2007, 24) conclude that there is probably no major effect from tracking on students' mean performance while Hanushek and Wößmann (2006) find weak evidence that early tracking negatively affects students' mean performance.

high-ability track (public servants, white-collar workers, parents with high educational degrees) are overrepresented among the electoral constituencies and members of specific political parties in Germany, as shown in Chapter 2.4. It is clear that the two smaller political parties – FDP and the Green Party – have party members who hold higher educational degrees than SPD members. With respect to their electoral constituencies, both of these parties are overrepresented among voters with high educational degrees and among self-employed and civil servants. The differences between the SPD and CDU are less pronounced than the differences between the SPD and FDP/Green Party. However, CDU party members have a somewhat higher probability of holding a university degree and a lower probability of holding only a degree from Hauptschule compared to SPD members. Differences between the SPD and CDU are stronger when looking at their voters' professions. The CDU is highly overrepresented among civil servants whereas the SPD is somewhat overrepresented among blue-collar workers. Under the central partisan hypothesis, namely that political parties pursue the interest of their members and core constituencies, we would expect that the CDU, FDP and the Green Party support ability-tracking in order to maintain positive peer group effects among their constituencies' offspring whereas Social Democrats oppose the tracking of students.

Regarding the design of the German education system, the present study cannot analyse the establishment of ability-tracking in 19th-century Germany and its re-establishment in the early 1950s due to the non-availability of data. However, existing data allows analysing the question whether ability-tracking is supported by political parties, or whether parties engage in the abolishment of ability-tracking. In particular, we can measure the intensity of ability-tracking in a Land by looking at the share of students who are educated in some type of comprehensive education ($St^{COMPREHENSIVE} / St^{TOTAL}$). $St^{COMPREHENSIVE}$ denotes the number of students enroled in comprehensive schools and $St^{TOTAL}$ is the total number of students in lower secondary education (see Chapter 2.1). The partisan hypotheses can thus be written as in Table 4.1, where the partisan orientation of the CDU, FDP and Green Party is shown relative to SPD.

Table 4.1 Hypotheses for partisan influence on the structure of the education system (relative to SPD)

| | CDU | FDP | Green Party |
|---|---|---|---|
| $St^{COMPREHENSIVE} / St^{TOTAL}$ | - | - | - |

Note: Social Democrats (SPD) are the reference group, i.e. Länder governments under participation of the CDU, FDP and the Green Party are predicted to decrease the importance of comprehensive schools relative to Länder governments under participation of the SPD.

The ideological debates accompanying the introduction of comprehensive schools in the early 1970s provide some anecdotal support for these hypotheses. Social Democrats argued in favour of comprehensive schools while the Conservatives defended ability-tracking. These positions may be explained by conflicts concerning the distribution of positive peer group effects from high-performance students. High-income households/Conservatives are interested in keeping positive spillovers from high-performance students within the tracks for high-performance students, given that their children are overrepresented in these tracks. For the CDU and FDP these predictions are largely consistent with their electoral manifestos and thus, not surprising. Moreover, the latter parties explicitly state in their electoral manifestos the goal of supporting gifted students. For the Green Party, however, partisan theory predicts a different education policy than stated in it own electoral manifestos (see Chapter 2 and Stern, 2000). Whereas partisan theory predicts that the Green Party supports ability-tracking, its manifestos explicitly demand the implementation of a comprehensive school system.

*4.2.2.2 Resource allocation across tracks*

In addition to the direct effect working through the concentration of peer group effects, ability-tracking allows focussing public education resources *r* (see Equation 4.1) on specific constituencies given the links between students' track choices, parental background and voting decisions (see above). One can borrow an appropriate theoretical background from the literature on voting on public education, pioneered by Stiglitz (1974). Although this literature describes individual voting decisions, we can adapt this framework for partisan theory by considering the voting decisions by political parties' median voters.

Stiglitz (1974) assumes that households maximise utility $U_i = U_i(G, C_i)$ over publicly provided education services, G, for the households' children and over all other private consumption $C_i$ (or after tax income). Households *i* only differ in their exogenously

given income, or what is equivalent, in parents' education.[35] Further, it is assumed that there is a proportional income tax rate $\tau$ for financing public education, which yields the public budget constraint $G = T = \tau\Sigma_i Y_i$. Progressive income tax and regressive effects of the consumption taxes are assumed to result in taxation proportional to income, which is standard in the literature. Voters are assumed to be identical to taxpayers. Moreover, the utility functions are assumed to be identical across individuals and assumed to be quasi-concave, which yields single-peaked preferences and thus, the existence of a majority voting equilibrium (see Mueller, 2003, 87). Finally, a uniform public service is assumed, i.e. participation rates do not differ between high-income and low-income households. [36]

Given that the public sector is highly dominant in lower secondary education in Germany (~ 92% of students are enroled in public schools), Stiglitz' framework of a pure public provision of education may be considered adequate for describing the German education system (see Chapter 2 and Kemnitz and Weizsäcker, 2003).[37] In such a public system, the voting outcome is straightforward, namely households vote for the level of public education such that the marginal rate of substitution between public education G and private consumption $C_i$ equals the ratio of the household's income, $Y_i$, to average income, $Y_{mean}$, i.e. the household's tax price of public education (Stiglitz, 1974, 354). Since a single-dimensional issue is considered, a majority voting equilibrium exists. Under the assumption that preferences for education G are monotonic in income $Y_i$, the decisive voter is the voter with median income, $Y_{median}$.[38] Therefore, the public education budget and the income tax rate depend on the median voter's income relative to average income.

Partisan theory's core assumption, namely, that political parties differ (right-wing parties represent rich households and left-wing governments represent poor

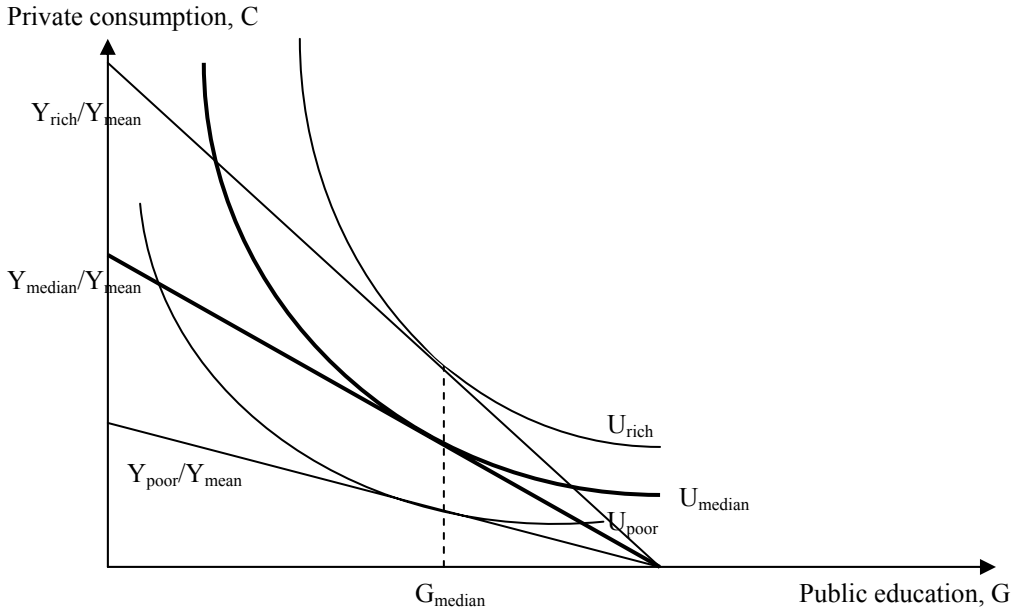
[35] In this section, the terms rich households and high-education households are used in parallel (poor households and low-education households).
[36] It is standard in the literature on voting in public education to consider the public spending on education G as a proxy for the quality of schooling. Thus, discussions on the effect of resources on educational achievement are suppressed (see the short discussion in Section 3.2.3, or Hanushek, 1986).
[37] One may argue that the existence of *one* private school is sufficient for the theoretical possibility of opting out of the public system. However, in reality, a reasonable quantity of private schools is necessary for the practical availability of alternatives: spatially, with respect to contents and religious orientation, etc.
[38] The existence of the voting equilibrium does not depend on G being monotonic in $Y_i$. But the household earning median income $Y_{median}$ will generally not be the decisive voter (Stiglitz, 1974, 355).

households), is easily accounted for in this framework by analysing rich and poor households' voting decisions. Their voting is shaped by an income effect (relatively wealthier households demand more public education) and by a substitution effect, which works through the higher tax price for public education (due to the proportional tax rate, relatively wealthier households demand less public education). Which effect dominates is an empirical question. Evidence from U.S. survey data suggests that the two effects cancel each other out, i.e. high-income and low-income households do not differ significantly in their preferences for the level of public education (see Figure 4.1) (see Bergstrom, Rubinfeld and Shapiro, 1982; for more evidence, see Gradstein, Justman and Meier, 2005, 50).[39] In summary, incorporating the core partisan assumption in standard voting models for public education casts doubt on the validity of a general partisan-hypothesis that low-income households, i.e. left-wing governments, generally demand higher public education spending than high-income households, i.e. right-wing governments.[40]

[39] When there are private alternatives, high-income households can opt out of public schooling while still having to contribute to public education. In this case high-income households do not necessarily support public education (see Epple and Romano, 1996a or the presentation in Gradstein, Justman and Meier, 2005, chapter 7). The decisive voter is then a household with income below the median income. Given the empirical estimates on the dominance of the substitution/income effect, this result suggests that high-income households are the only group voting for lower public education spending whereas middle- and low-income groups are supporting comparable levels of public education spending. This result holds also for the case when private education may be added on top of public education services (Epple and Romano, 1996b and Gouveia, 1997).

[40] At least the discussion reveals some underlying assumptions of this hypothesis. It is either assumed that there is sufficient private education for high-income households to opt out of the public system or that the substitution effect dominates the income effect for high-income households or that the income tax rate is sufficiently progressive for rich households to vote against public education.

Figure 4.1 Predictions for spending preferences on public education of high-income ($Y_{rich}/Y_{mean}$), median income ($Y_{median}/Y_{mean}$) and low-income groups ($Y_{poor}/Y_{mean}$).




Source: Based on Stiglitz (1974) and evidence by Bergström, Rubinfeld and Shapiro (1982); see text.

A simple extension allows us to account for ability-tracking in the education system.[41] Ability-tracking is introduced by splitting education spending, G, into spending on tracks for high-performance students, $G^H$, and low-performance students, $G^L$, such that $G = G^H + G^L$. The modified utility function is:

$$(4.2) \quad U_i = U_i(G^H, G^L, C_i)$$

Given the empirical evidence, children from rich/high-education households have an above average participation in the track for high-performance students whereas educational participation of poor/low-education households' offspring is biased towards the low-performance track. Specifically, it is assumed here that more than 50% of rich households' offspring is enroled in the high-performance track whereas more than 50% of the poor households' offspring is enroled in the low-performance track.[42] Thus, an

[41] Note that the extension of the standard model developed here is highly stylised. It assumes that the size of the total education budget is decided separately from the distribution of public resources between two educational tracks.

[42] Moreover, it is assumed that public expenditures on $G^H$ and $G^L$ are both financed out of general public sector budgets and that the private returns to education dominate the social returns. In addition, it is assumed that educational participation is exogenous with respect to the level of spending in the high- and low-performance tracks, which is of course rather a short- to medium-run assumption.

average rich household derives comparatively more utility from increases in $G^H$ than from increases in $G^L$:

$$(4.3) \quad \frac{\partial U_{rich}}{\partial G^H} > \frac{\partial U_{rich}}{\partial G^L}$$

where $U_{rich}$ denotes utility for a high-income household. An inverse statement holds for the poor households. Yet, as in Stiglitz (1974), this model does not permit a theoretical prediction on poor and rich households' voting decisions with respect to the *level* of public education. If, for example, $G^H$ is increased, a rich household's utility change is:

$$(4.4) \quad \frac{dU_{rich}}{dG^H} = \underbrace{\frac{\partial U_{rich}}{\partial G^H}}_{>0} + \underbrace{\frac{\partial U_{rich}}{\partial C}}_{>0} \underbrace{\frac{\partial C}{\partial \tau} \frac{\partial \tau}{\partial G^H}}_{<0} \gtrless^{?} 0$$

It is not clear if the positive effect on utility, derived from an increase in $G^H$, the first argument on the right side of (4.4), dominates the negative effect from an increase in taxes necessary to finance increased spending, the second argument on the right side of (4.4). Thus, a rich household's utility change is unclear even if $G^H$ is increased. However, if overall spending on public education, $G = G^H + G^L$, is held constant (and thus, also the income tax rate $\tau$), there is no increase in the tax burden, i.e. the second term on the right-hand side of (4.4) is equal to zero. In this case, necessarily, $G^L$ must decrease, given that $G = G^H + G^L$. The change in utility for a rich household is:

$$(4.5) \quad \frac{dU_{rich}}{dG^H} = \underbrace{\frac{\partial U_{rich}}{\partial G^H}}_{>0} + \underbrace{\frac{\partial U_{rich}}{\partial G^L}}_{>0} \underbrace{\frac{\partial G^L}{\partial G^H}}_{=-1} > 0$$

It is reasonable to assume that the positive effect on rich households' utility from the first summand on the right side of (4.5) will generally outweigh the negative effect from the second summand even though there may be positive social returns from a good quality of education services in the lower track. This is justified by the higher educational participation of rich households' offspring in the high-ability track (see Equation 4.3) and the empirical observation that private returns to education usually

exceed social returns. Note that increasing $G^H$ in Equation (4.5) is equivalent to increasing the share of spending on $G^H$ while G is held constant. Thus, under plausible assumptions, one should expect that high-income households vote for *relative* increases in public spending on high-performance tracks irrespective of the total level of education spending. The opposite should hold for low-income households.

In the framework of partisan theory, this implies that the median voter of right-wing parties, which are elected by high-income/high-education households, advocates that a higher share of public education spending is targeted towards high-performance tracks whereas the median voter of left-wing parties advocates the opposite. Note that only the focus on the composition of education spending ensures identification of the partisan effect because available empirical evidence on the redistributive character of the tax system and on the importance of social returns to education do not allow predictions on poor and rich households' preferences for the *overall level* of education spending.

When applying this discussion to Germany (see also Chapter 2.1), it is obvious that *Gymnasium* is the highest educational track in German lower secondary education and *Hauptschule* is the lowest educational track. However, as set out in Chapter 2, some Länder have engaged in consolidating Haupt- and Realschule into one school type (Schulen mit mehreren Bildungsgängen) such that only a limited number of Hauptschulen remain in some Länder. Accordingly, these school types have a student body that is biased towards low- to middle performance students (Baumert and Schümer, 2001). Thus, *joint schooling* is used as an alternative to represent the low ability-track for those Länder in the process of abolishing Hauptschule (e.g., Saarland).

For an application to the German political system, recall the discussion on political parties in Chapter 2.4 and in Section 4.2.2.1. The evidence on electoral constituencies and on members' educational background suggests that – relative to the SPD – the CDU, FDP and the Green Party when in office spend a higher share of public resources on Gymnasium and a lower share on Hauptschule and joint schools.[43] Table 4.2 summarises the theoretical predictions for partisan influence of German political parties on relative resource use in lower secondary education. Superscript GYM, TOTAL, HAUPT and JOINT denote Gymnasium, overall lower secondary education,

[43] Note that, technically, this prediction requires that at least 50% of high-income households' offspring is enroled in the high-performance track.

Hauptschule and joint schools, respectively. $Resources^{GYM}/Resources^{TOTAL}$ denotes for example resource use on Gymnasium relative to resource use in overall lower secondary education. Note that Social Democrats are the reference group. Thus, a plus/minus indicates that Länder governments under participation of the CDU, FDP or the Green Party are predicted to increase (decrease) spending on Gymnasium (Hautpschule, joint schools) *relative* to overall spending in lower secondary education and *relative* to SPD Länder governments.

Table 4.2 Hypotheses for partisan influence on the composition of education spending (relative to SPD)

| Composition of education spending | CDU | FDP | Green Party |
|---|---|---|---|
| $Resources^{GYM} / Resources^{TOTAL}$ | + | + | + |
| $Resources^{HAUPT} / Resources^{TOTAL}$ | - | - | - |
| $Resources^{JOINT} / Resources^{TOTAL}$ | - | - | - |

Note: Social Democrats (SPD) are the reference group, i.e. Länder governments under participation of CDU, FDP and the Green Party are predicted to increase (decrease) the share of spending on Gymnasium (Hauptschule and joint schooling) relative to Länder governments under participation of the SPD.

## 4.3 Data and summary statistics

The data set comprises information on lower secondary education. Information about students and teachers derives from various editions of annual school statistics edited by the Standing Conference of German Länder Education Ministers. All other data is from various publications by the Federal Statistical Office of Germany, the Federal Employment Office (unemployment rate) or from the Länder education ministry homepages (information on party affiliation of education ministers). A panel data set of all West German Länder (without Berlin), i.e. 10 Länder, over the 1979-2006 period is constructed, which contains BW, BY, HB, HH, HE, NI, NW, RP, SL and SH. The East German Länder are not included, because the ideological discussions about the education system have essentially been a West German phenomenon (see also the discussions in Chapters 1 and 2). For relative resource endowments in lower secondary education (Section 4.5), the panel begins in 1981 because earlier years are unavailable. Thus, the panel contains 280 (10x28) or 260 (10x26) observations, respectively.

Table 4.3 reports summary statistics. If first differences are used in the estimation, they are reported here. Two definitions of comprehensive schooling will be tested in the following section: As described in Chapter 2, *Comprehensive schools* (Gesamtschulen) offer the most integrated type of schooling that is currently provided in Germany. *Joint schooling* denotes a broader definition of comprehensive education. It includes the students who are enroled in comprehensive schools, Schulen mit mehreren Bildungsgängen and Orientierungsstufe. Table 4.3, Panel (a) presents the summary statistics for the share of students enroled in comprehensive schools and joint schools, which show that both experience rising importance over the sample period (+0.3% per year, respectively). Note that the standard deviation is larger for joint schooling, which may be explained by the fact that joint schooling is an aggregate of different school types. Educational policy, which changes any of the school types that are included in the definition of joint schooling, contributes to the variance. For more detailed descriptive evidence see also Figure 4.2. For example, the minimum of -31% in the change of the importance of joint schooling reflects the abolishment of Orientierungsstufe in Lower Saxony in 2004.

Table 4.3 Summary statistics (10 West German Länder, 1979-2006)

| Variable | Variable description | Mean | S.d. | Min / Max |
|---|---|---|---|---|
| (a) Intensity of ability tracking | | | | |
| $\Delta$ ($St^{COMPREHENSIVE}/St^{TOTAL}$) | 1st diff of share of students in lower sec. edu. enroled in a comprehensive school (Gesamtschule) | 0.003 | 0.006 | -0.005 / 0.038 |
| $\Delta$ ($St^{JOINT}/St^{TOTAL}$) | 1st diff of share of students in lower sec. edu. enroled in Gesamtschulen, Schulen mit mehreren Bildungsgängen and in Orientierungsstufe | 0.003 | 0.023 | -0.311 / 0.069 |
| (b) Resource variables | | | | |
| $\Delta$ ($TSt^{GYM}/TSt^{TOTAL}$) | 1st diff of teacher/student-ratio in Gymnasium relative to all lower sec. edu. | -0.003 | 0.019 | -0.128 / 0.065 |
| $\Delta$ ($TSt^{HAUPT}/TSt^{TOTAL}$) | 1st diff of teacher/student-ratio in Hauptschule relative to all lower sec. edu. | 0.005 | 0.038 | -0.313 / 0.319 |
| $\Delta$ ($TSt^{JOINT}/TSt^{TOTAL}$) | 1st diff of teacher/student-ratio in joint education relative to all lower sec. edu. | -0.003 | 0.039 | -0.133 / 0.280 |
| (c) Control variables | | | | |
| $\Delta$ ln ($St^{TOTAL}$) | Growth rate of the number of Students in lower secondary edu. | -0.012 | 0.037 | -0.111 / 0.040 |
| $\Delta$ ($St^{GYM}/St^{TOTAL}$) | 1st diff of share of students in lower sec. edu. enroled in Gymnasium | 0.003 | 0.011 | -0.012 / 0.130 |
| $\Delta$ ($St^{HAUPT}/St^{TOTAL}$) | 1st diff of share of students in lower sec. edu. enroled in Hauptschule | -0.006 | 0.009 | -0.042 / 0.058 |
| $\Delta$ ($St^{JOINT}/St^{TOTAL}$) | 1st diff of share of students in lower sec. edu. enroled in joint education | 0.003 | 0.024 | -0.020 / 0.069 |
| $\Delta$ ln (PR) | Growth rate of public revenue p.c. | 0.003 | 0.043 | -0.157 / 0.222 |
| $\Delta$ ln (PD) | Growth rate of population density | 0.003 | 0.006 | -0.022 / 0.021 |
| $\Delta$ UR | 1st diff of Länder unemployment rate | 0.003 | 0.010 | -0.028 / 0.039 |
| $\Delta$ o60 | 1st diff of share of Länder population over 60 years old | 0.002 | 0.002 | -0.004 / 0.007 |
| (d) POLITICAL | | | | |
| SPD | SPD participation in Länder government = 1, otherwise = 0 | 0.57 | 0.50 | 0 / 1 |
| CDU | CDU participation in Länder government = 1, otherwise = 0 | 0.49 | 0.50 | 0 / 1 |
| FDP | FDP participation in Länder government = 1, otherwise = 0 | 0.24 | 0.43 | 0 / 1 |
| Green Party | Green Party participation in Länder government = 1, otherwise = 0 | 0.15 | 0.35 | 0 / 1 |
| Other | Participation in Länder government by any other party = 1, otherwise = 0 | 0.02 | 0.15 | 0 / 1 |
| COALSIZE | Coalition size (number of political parties) | 1.48 | 0.54 | 1 / 3 |
| ELECTION | Year with Länder election = 1, otherwise = 0 | 0.25 | 0.43 | 0 / 1 |

Table 4.3 continued

| | | | | |
|---|---|---|---|---|
| (e) alternative definition of POLITICAL | | | | |
| SPD | SPD single-party government = 1, otherwise = 0 | 0.26 | 0.44 | 0 / 1 |
| SPD-FDP | SPD-FDP coalition = 1, otherwise = 0 | 0.09 | 0.28 | 0 / 1 |
| SPD-Green | SPD-Green coalition = 1, otherwise = 0 | 0.14 | 0.34 | 0 / 1 |
| SPD-FDP-Green | SPD-FDP-Green coalition =1, otherwise = 0 | 0.01 | 0.10 | 0 / 1 |
| SPD-Other | SPD-Other coalition = 1, otherwise = 0 | 0.01 | 0.12 | 0 / 1 |
| CDU | CDU single-party government = 1, otherwise = 0 | 0.28 | 0.45 | 0 / 1 |
| CDU-FDP | CDU-FDP coalition = 1, otherwise = 0 | 0.14 | 0.35 | 0 / 1 |
| CDU-FDP-Other | CDU-FDP-Other coalition = 1, otherwise = 0 | 0.01 | 0.08 | 0 / 1 |
| GRANDCOAL | SPD-CDU or CDU-SPD coalition = 1, otherwise = 0 | 0.06 | 0.25 | 0 / 1 |
| (f) Political couleur of Länder education minister | | | | |
| KultSPD | SPD education minister = 1, otherwise = 0 | 0.56 | 0.50 | 0 / 1 |
| KultCDU | CDU education minister = 1, otherwise = 0 | 0.44 | 0.50 | 0 / 1 |
| KultFDP | FDP education minister = 1, otherwise = 0 | 0.01 | 0.08 | 0 / 1 |

Note: Public revenue per capita is reported in 2000 Euros, with deflation across years using the deflator for government consumption taken from the 2007 Report of the German Council of Economic Experts. The sample contains 10 West German Länder (excluding Berlin), over the 1979-2006 period (except resource indicators in Panel b and the student demand control variables in Panel c, which cover only the 1981-2006 period).

Panel (b) of Table 4.3 presents summary statistics of the variables that are used to test the hypotheses on relative resource use per student: Teacher/student-ratios in specific ability-tracks are considered relative to teacher/student-ratios in total lower secondary education.[44] For example, to test the hypotheses on relative resource use in Gymnasium, the teacher/student-ratio in Gymnasium ($TSt^{GYM}$) is considered relative to teacher/student-ratios in all lower secondary eduation ($TSt^{TOTAL}$), i.e. $TSt^{GYM}/TSt^{TOTAL}$. The latter ratio decreases over the sample period by 0.3% per year. When looking at relative teacher/student-ratios in Hauptschulen, we observe increasing resource use per student (+0.5%). In joint schools, relative teacher endowments per student decreases (-0.3% per year). These summary statistics reveal that resource endowments per student exhibit more or less pronounced trends, which highlights the importance of year fixed effects and gives an intuition for the results of the unit root tests in Section 4.4.2 and 4.5.2. There are some pronounced increases/decreases in relative teacher/student-ratios, which can be seen from the maxima/minima in Panel (b). For example, in joint schools

[44] The number of teachers is reported in full-time equivalents (fte); see Chapter 2.

in Lower Saxony there is a strong increase in relative teacher/student-ratios (+28%), due to the abolishment of Orientierungsstufe and Schulen mit mehreren Bildungsgängen. In the latter school types, resource use per student is typically lower than in Gesamtschulen, such that the abolishment of these school types, results in a positive change. Another example is the strong decrease in relative teacher/student-ratios in Saarland in 2000-2001. In the process of abolishment of Hauptschulen in this Land (consolidated with Realschulen), the number of teachers drops more sharply than student enrolment. In Hesse, the variation in teacher/student-ratios is generally higher than in other Länder (see also the evidence presented in Section 4.5.1).

The share of students enroled in Gymnasium ($St^{GYM}/St^{TOTAL}$) and joint schools ($St^{JOINT}/St^{TOTAL}$) increases by 0.3% per year, respectively, whereas relative enrolment in Hauptschule decreases by an annual average of about 0.5% over the sample period (see Table 4.3, Panel c). This suggests that part of the trend in relative teacher/student-ratios may be explained by sluggish resource adjustment or cohort size effects, as discussed in Poterba (1997), Baum and Seitz (2003), or Chapter 3. The size of the student cohort in lower secondary education ($St^{TOTAL}$) decreases by about 1% per year (Panel c) (see also Figure 2.5). Cohort size decreases considerably in the early 1980s. Länder public revenue per capita and population density increase moderately over the sample period (0.3% per year). Some Länder experience pronounced increases and decreases in public revenue per capita. The maxima of more than 20% reflect the onset of federal bailout transfers to the Länder Saarland and Bremen in 1994. The minimum reflects a pronounced decrease in public revenue in Hamburg in 1979-1980 during the second global oil crisis. The slightly positive trends of the unemployment rate and the elderly share (+0.25% and +0.2% per year, respectively) reflect the increasing structural unemployment and an ageing society in Germany across the sample period. Note the comparatively smooth development of the elderly share in comparison with the higher standard deviation of the growth of public revenue or of the change of the unemployment rate, which are also driven by business cycles.

POLITICAL is a set of dummy variables capturing political parties' time in office in the German Länder (SPD, CDU, FDP Green Party, Other) (see Table 4.3, Panel d). These dummy variables take the value of 1 if the political party participates in a Länder government and 0 if it does not. When the election occurs during the first six months of

the year, government participation of this party is – admittedly simplified – coded for the full year. When the election occurs during the last six months of the year, government participation is assumed to begin in January of the next year. As an additional control, coalition size COALSIZE captures the number of political parties forming the Länder government. Note that the four most important political parties form 98% of the governing parties in the sample. Other parties (Other) have almost no importance (only in Hamburg: Statt-Partei 1994-1997 and Schill-Partei/Partei Rechtsstaatlicher Offensive 2002-2003). We observe, too, that the Social Democrats participate in almost 60% of Länder governments while the Christian Democrats participate in almost 50% of Länder governments. The two smaller political parties form part of Länder governments less frequently (FDP 24%; Green Party 15%). Average coalition size is 1.5 over the sample period, which highlights the importance of coalition governments in the proportional political system in Germany. Table 4.4 presents bivariate correlation coefficients among the political dummies. The correlations reveal the predominant coalition patterns: SPD-Green Party and CDU-FDP. Note the strong negative correlation of SPD with CDU.

Table 4.4 Correlations among political parties' years in office (10 West German Länder, 1977-2006)

| | SPD | CDU | FDP | Green P. | Other |
|---|---|---|---|---|---|
| SPD | 1 | -0.886* | -0.163* | 0.353* | 0.031 |
| CDU | | 1 | 0.092 | -0.398* | -0.048 |
| FDP | | | 1 | -0.165* | 0.026 |
| Green Party | | | | 1 | -0.057 |
| Other | | | | | 1 |

Note: * denotes significance at the 5% level.

An alternative set of political dummy variables directly accounts for every coalition combination by a separate dummy variable. Table 4.3, Panel (e) reveals that CDU and SPD single-party governments are the most frequent type of government (28% and 26% of years in government in the sample, respectively). SPD-Green, CDU-FDP and SPD-FDP are the second most-frequent coalition combinations, with 14%, 14% and 9% of the years in government, respectively. Coalitions formed by SPD-CDU or CDU-SPD govern about 6% of the years in government, and other coalition combinations are of marginal importance. Table 4.3, Panel (f) shows the Länder education minister is a SPD (CDU) party member in 56% (44%) of the years. Additionally, there are two FDP education ministers in Hamburg in very short time periods.

## 4.4 Empirical analysis I: political influence on the education system and the practise of ability-tracking

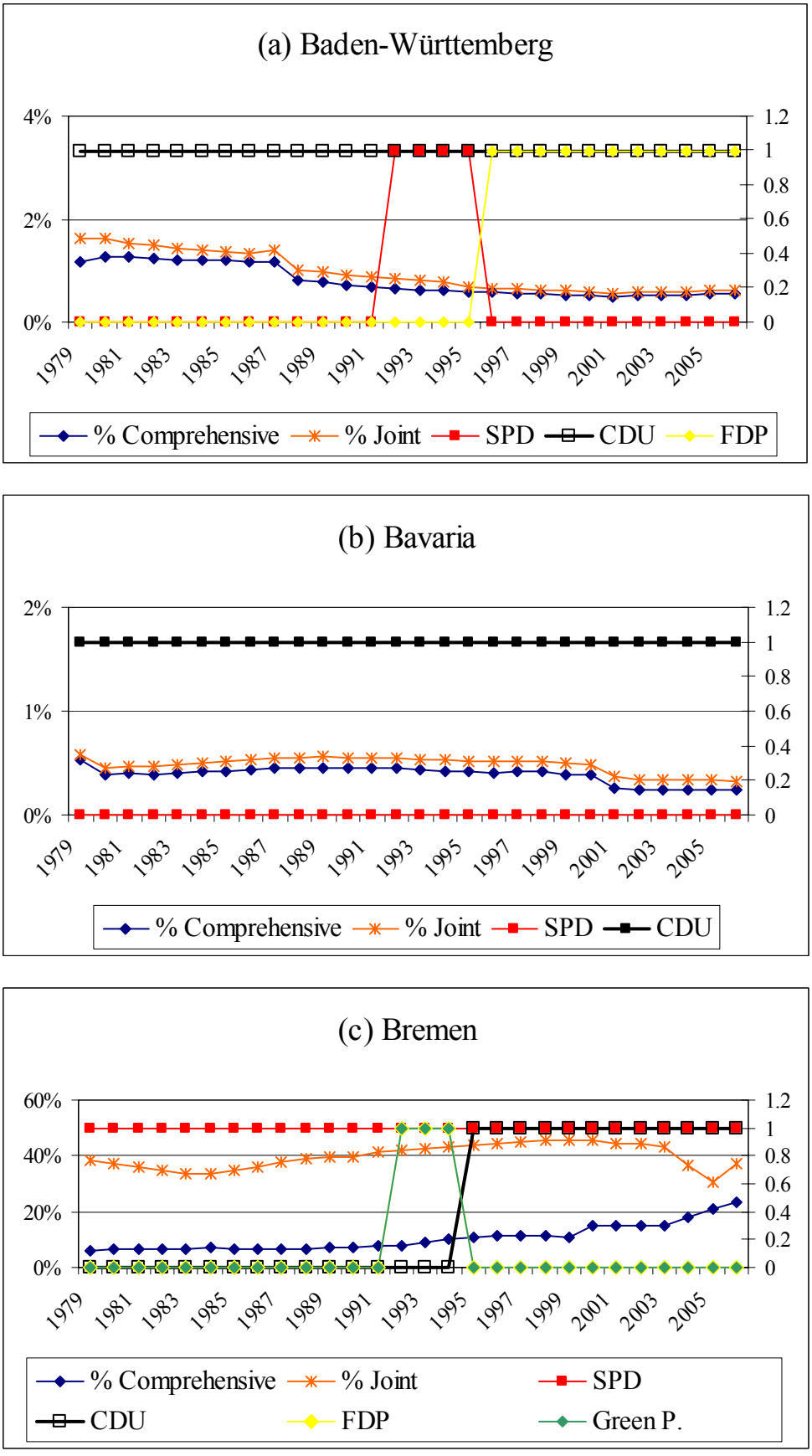
The goal of this section is to provide empirical evidence about whether German political parties support or oppose the system of ability-tracking along the lines that partisan theory predicts (see Table 4.1). In particular: Do CDU, FDP and the Green Party decrease the importance of comprehensive schooling relative to Social Democrats in the West German Länder over the 1979-2006 period?

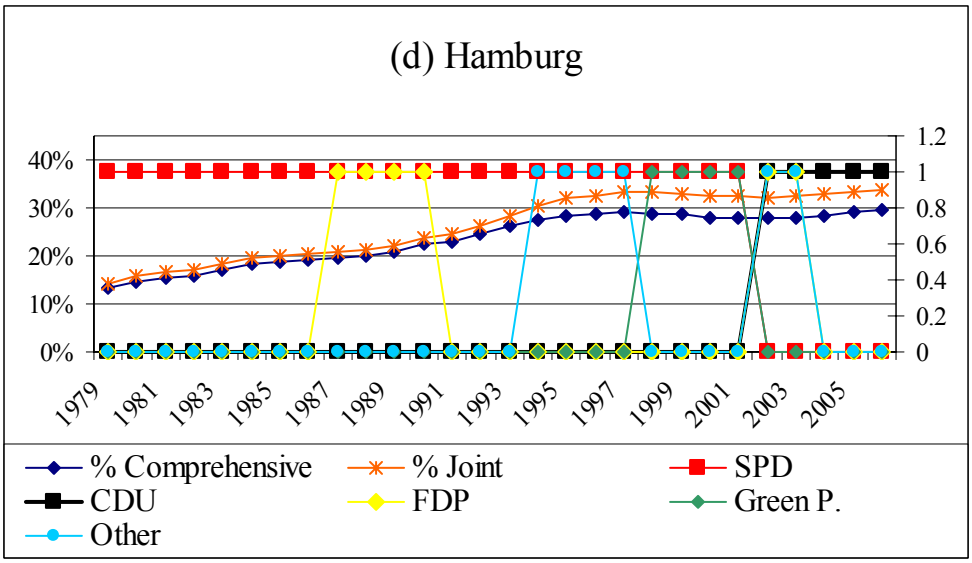
### 4.4.1 Descriptive evidence

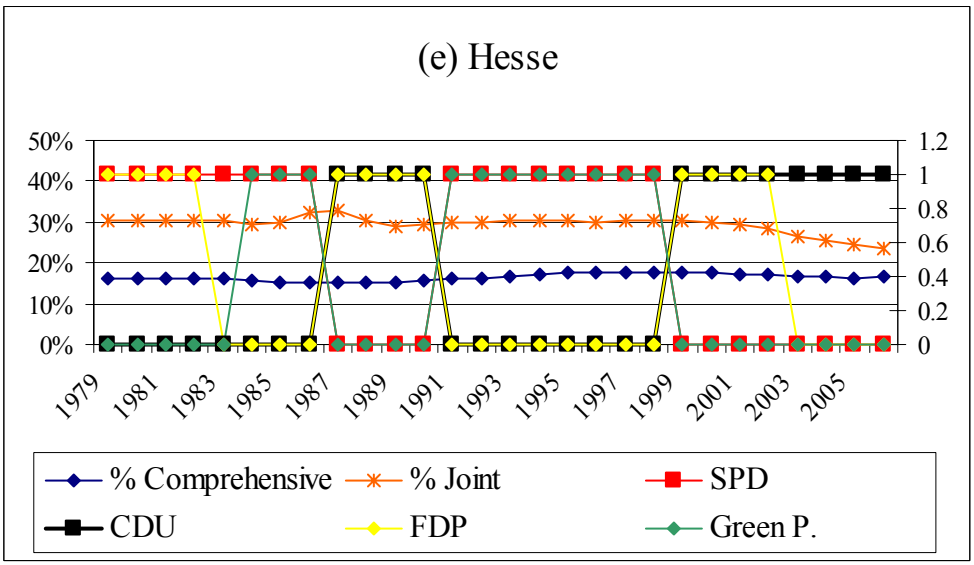
*4.4.1.1 Some charts*

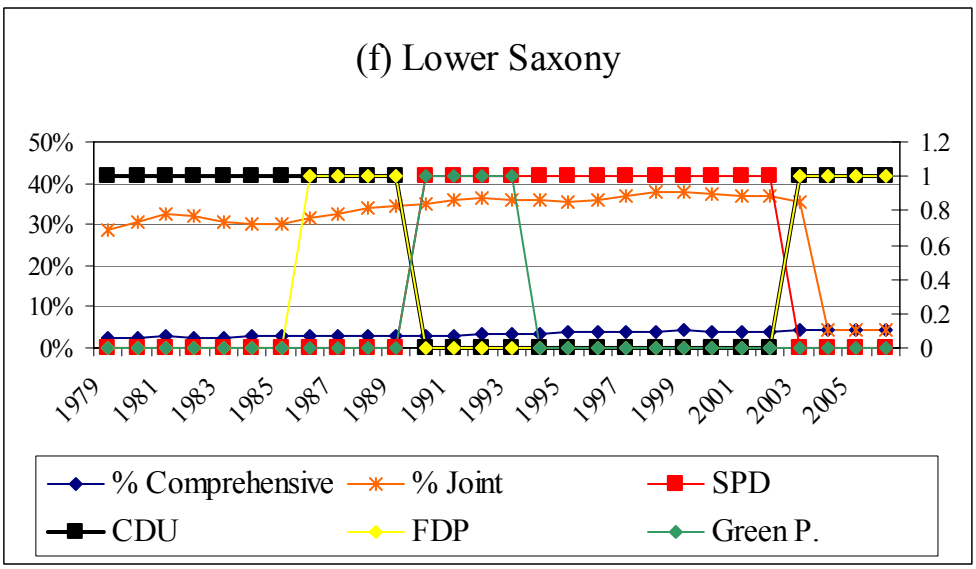
My first approach to analyse the question of whether political parties exert the predicted influence on the education systems is to provide graphs of individual Länder time series of political parties' time in office and the share of students enroled in some type of comprehensive schooling (out of the total number of students in lower secondary education). As explained above, two different definitions are tested: comprehensive schools offer the most integrated type of schooling that is currently provided in Germany; joint schools offer comprehensive education in a broader sense. Figure 4.2 shows 10 Länder-specific graphs, each of which displays time series of the share of students enroled in comprehensive or joint schools (left scale) from 1979 to 2006. Political parties' time in office over this period is depicted on the right scale. The time in office is coded as a dummy variable, i.e. a value of 1 denotes participation of a political party in the Länder government, while a 0 indicates that this political party has not participated in the Länder government in the respective year.

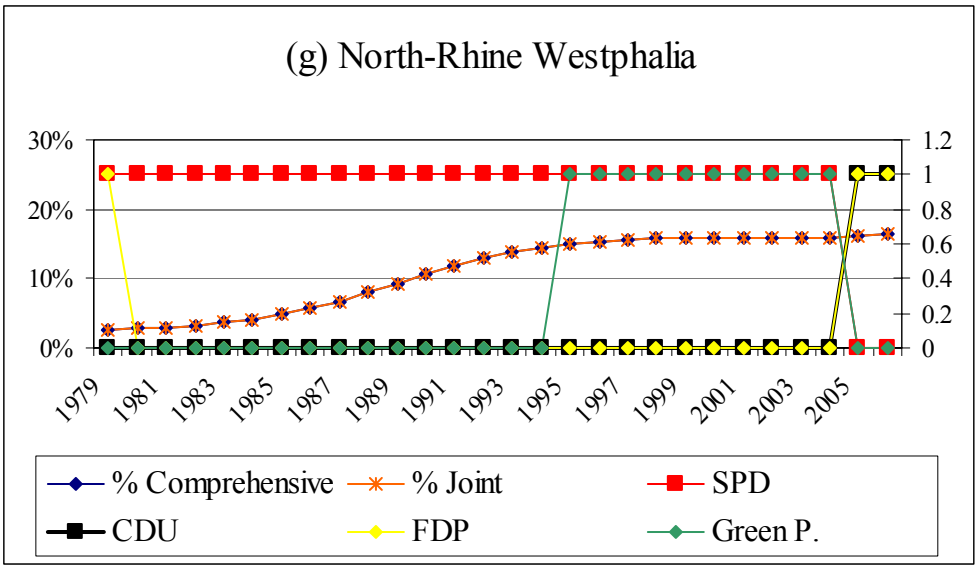
Figure 4.2 Government participation and the intensity of ability-tracking (1979-2006)

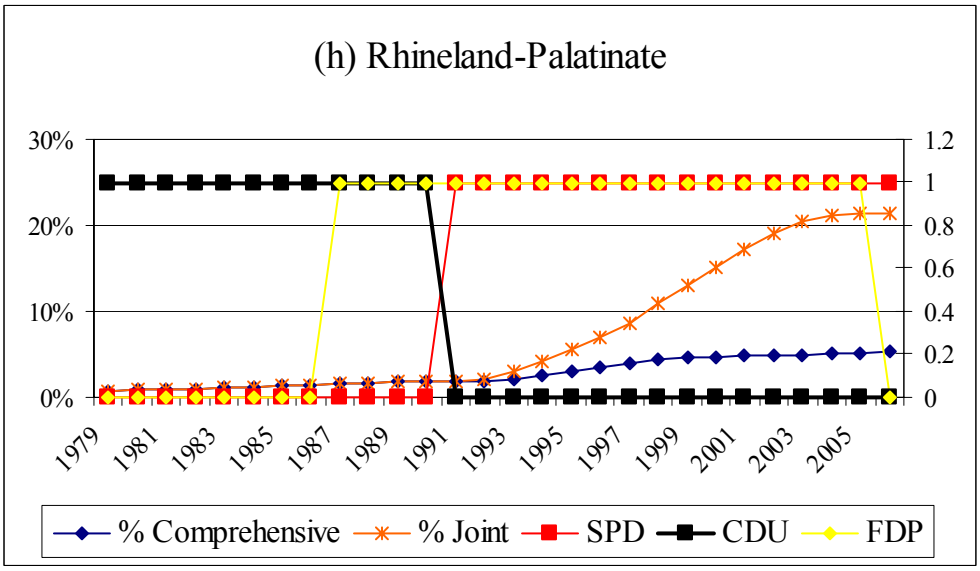


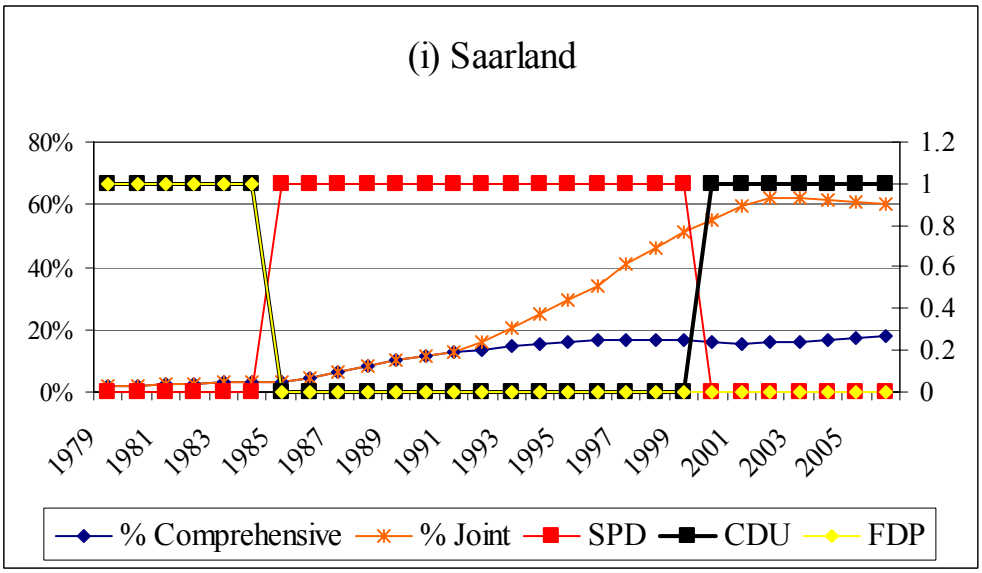

(d) Hamburg
40%
30%
20%
10%
0%
1.2
1
0.8
0.6
0.4
0.2
0
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
% Comprehensive
% Joint
SPD
CDU
FDP
Green P.
Other

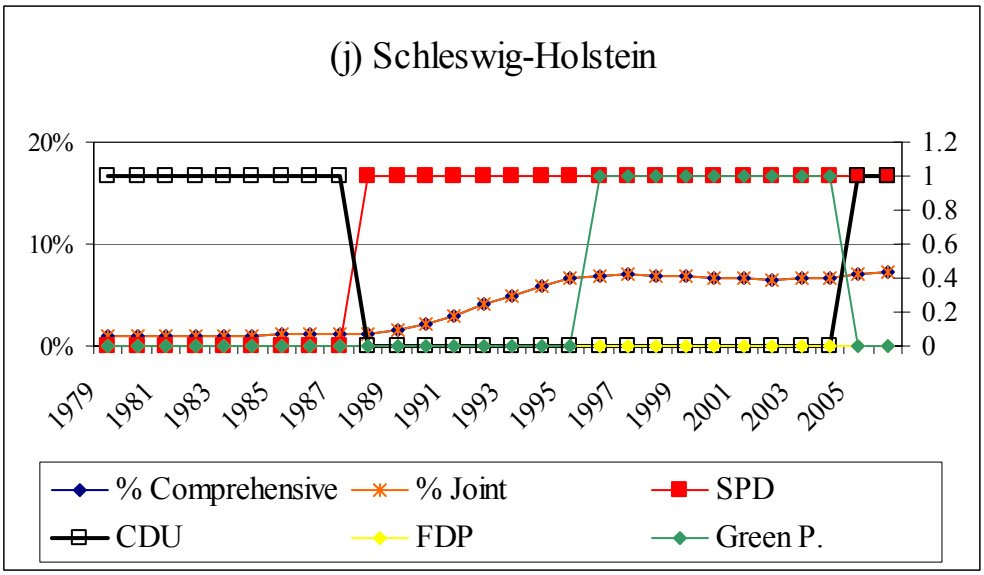

(e) Hesse
50%
40%
30%
20%
10%
0%
1.2
1
0.8
0.6
0.4
0.2
0
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
% Comprehensive
% Joint
SPD
CDU
FDP
Green P.


(f) Lower Saxony
50%
40%
30%
20%
10%
0%
1.2
1
0.8
0.6
0.4
0.2
0
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
% Comprehensive
% Joint
SPD
CDU
FDP
Green P.


(g) North-Rhine Westphalia
30%
20%
10%
0%
1.2
1
0.8
0.6
0.4
0.2
0
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
% Comprehensive
% Joint
SPD
CDU
FDP
Green P.


(h) Rhineland-Palatinate
30%
20%
10%
0%
1.2
1
0.8
0.6
0.4
0.2
0
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
% Comprehensive
% Joint
SPD
CDU
FDP


(i) Saarland
80%
60%
40%
20%
0%
1.2
1
0.8
0.6
0.4
0.2
0
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
% Comprehensive
% Joint
SPD
CDU
FDP




Note: The share of students enroled in comprehensive and joint schools is depicted on the left scale. Länder government participation is depicted on the right scale (see text). Data sources: Standing Conference of German Länder Education Ministers (% Comprehensive and % Joint) and Federal Statistical Office of Germany (Länder government participation of the political parties).

In the considered time period, the Conservatives (CDU/CSU) strongly dominate the Länder governments in Baden-Württemberg and Bavaria. Figures 4.2 (a) and (b) show that in these Länder the share of students enroled in comprehensive or joint schooling is marginal, below 2%, and quite stable, showing little variation.

On the contrary, the Länder governments of Bremen, Hamburg and North-Rhine Westphalia are dominated by the SPD (see Figures 4.2 c, d and g). Comprehensive/joint schooling was already of considerable importance in the early 1980s in Bremen and Hamburg. In North-Rhine Westphalia, comprehensive schooling increases considerably in the sample period. Note that in Hamburg, increasing importance of comprehensive schooling is pronounced during times of single-party SPD governments and somewhat attenuated during times of coalition governments. Since the late 1990s, the importance of comprehensive/joint schooling stagnates at around 40% under SPD-Green and CDU governments. In Bremen, however, comprehensive schooling gains importance under the SPD-CDU coalition. In joint schooling, there are two contrasting developments in the early 2000s: while Orientierungsstufe is abolished, Schulen mit mehreren Bildungsgängen are newly founded under the SPD-CDU coalition.

Rhineland-Palatinate, Saarland and Schleswig-Holstein experience strong increases of the share of students in comprehensive/joint schooling, starting with the takeover of SPD-dominated governments in the mid 1980s/early 1990s (see Figures 4.2 h, i and j).

Note the increase is more pronounced under the single-party SPD government in Saarland than under a SPD-FDP coalition in Rhineland-Palatinate. Note, too, that in Schleswig-Holstein, the importance of comprehensive schooling is even slightly reinforced under the CDU-dominated grand coalition (CDU-SPD) elected in 2005.

In Hesse and Lower Saxony, both of which can be characterised as swing states, there is no major trend in the importance of joint or comprehensive schooling (see Figures 4.2 e and f). There is, however, some small-scale variation. The share of students enroled in comprehensive/joint schools mostly increases under SPD-led governments and decreases after a change of government towards the CDU. Note that the brusque drop in the importance of joint schooling in Lower Saxony after the takeover of a CDU government in 2003 can be attributed to the abolishment of the Orientierungsstufe (joint education of students in grades 5 and 6; see Chapter 2).

Overall, the graphs show that in Länder with no significant government participation of the Social Democrats, comprehensive/joint schooling appears to have scant importance (Bayern, Baden-Württemberg). Moreover, the graphs suggest that Länder governments under participation of the CDU generally do not reduce the provision of comprehensive/joint schools at large scale after their implementation by the previous SPD-dominated governments (North-Rhine Westphalia, Hamburg, Schleswig-Holstein), with two exceptions: Lower Saxony, where the Conservative government abolished Orientierungsstufe in 2004, and to a lesser degree, Hesse from 1999 to 2006.

There is some interesting evidence beyond the sample period of this study. Recall that comprehensive schools are first implemented in 1968 in West-Berlin and from the early 1970s in the other Länder. In all Länder governed by CDU dominated governments (CDU or CDU-FDP) in the 1974-1978 period (Baden-Württemberg, Bavaria, Rhineland-Palatinate, Saarland, Schleswig-Holstein), less than 2% of students are enroled in comprehensive schools in 1979, but in the Länder with SPD-dominated governments (SPD or SPD-FDP) in the 1974-1978 period joint schooling is already quite important (i.e. Bremen: 40%, Hamburg: 15% and Hesse: 30%). Lower Saxony is governed by SPD as well as by CDU in the pre-1979 period. The exception is North-

Rhine Westphalia, which is dominated by Social Democrats, but the share of students enroled in comprehensive schools is quite low in 1979.[45]

*4.4.1.2 Some correlations*

To begin with a more formal analysis of the link between political parties and the intensity of ability-tracking, Table 4.5 reports the bivariate correlations of political parties' time in office with the share of students enroled in comprehensive ($St^{COMPREHENSIVE}/St^{TOTAL}$) and joint schooling ($St^{JOINT}/St^{TOTAL}$).

Table 4.5 Correlations of political parties' years in office with the share of students enroled in comprehensive/joint schooling (10 West German Länder, 1979-2006)

| | SPD | CDU | FDP | Green P. | Other |
|---|---|---|---|---|---|
| $St^{COMPREHENSIVE}/St^{TOTAL}$ | 0.365* | -0.322* | -0.064 | 0.265* | 0.369* |
| $St^{JOINT}/St^{TOTAL}$ | 0.308* | -0.216* | -0.075 | 0.139* | 0.130* |

Note: * denotes significance at the 5% level.

The correlations of the SPD, CDU and FDP agree with the hypotheses (Table 4.1). SPD-dominated Länder governments are significantly and positively correlated with the share of students enroled in comprehensive/joint schools while CDU-dominated Länder governments are negatively correlated with this share. Länder governments under participation of the FDP are negatively but insignificantly correlated with the share of students enroled in comprehensive schools. Länder governments under participation of the Green Party are positively correlated with comprehensive schooling, which is not in line with the hypothesis. However, note that due to the coalition patterns in the sample period (SPD-Green Party), correlations of the share of students enroled in comprehensive/joint schools with the Green Party's time in office are somewhat predetermined by the close relation to Social Democrats (because the Länder dominated by SPD have a higher share of comprehensively educated students on average).

Table 4.6 presents correlation coefficients of the *differenced* share of pupils enroled in comprehensive schooling with political parties' time in office. Differencing wipes out the information on the shares itself, such that there is some "control" for the political

[45] North-Rhine Westphalia deserves some special attention. There were SPD and SPD-FDP governments in the 1970s. The SPD-FDP coalition (Ministerpräsident Heinz Kühn, SPD) was preparing a school system, which would provide lower secondary education exclusively in the form of comprehensive schools. However, the implementation of this reform was stopped by a petition for a referendum with unprecedented success (voter participation of about 30%) in 1978. The referendum was supported by teacher unions, Christian churches, associations of parents and the CDU.

history of the Länder. In fact, these correlations show that when the Green Party's times in office are separated out from the SPD-dominated political history of the Länder, the correlation coefficient for the Green Party turns negative, which contrasts with the Green Party's electoral manifestos (see Chapter 2 and Stern, 2000). The correlation coefficients for SPD, CDU and FDP are more robust and retain their signs and significance level, because their coalition patterns are more diversified. Note that the most important difference still arises between SPD and CDU governments.

Table 4.6 Correlations of political parties' years in office with the first difference of the share of students enroled in comprehensive/joint schooling (10 West German Länder, 1979-2006)

| | SPD | CDU | FDP | Green P. | Other |
|---|---|---|---|---|---|
| $\Delta$ ($St^{COMPREHENSIVE}/St^{TOTAL}$) | 0.362* | -0.238* | -0.109 | -0.129* | 0.064 |
| $\Delta$ ($St^{JOINT}/St^{TOTAL}$) | 0.190* | -0.224* | -0.097 | -0.029 | 0.036 |

Note: * denotes significance at the 5% level.

### 4.4.2 Stationarity

As is well known, panel data is also subject to the problem of spurious regressions (Granger and Newbold, 1974) (see e.g., the survey in Baltagi, 2005). This is particularly true for a long and narrow panel structure, i.e. this data set (N=10 and T=28). Entorf (1997, pp. 291) shows that t-ratios based on the estimation of fixed effects models with I(1) panels can be highly misleading.[46] To ensure that the FE estimator does not merely capture spurious relationships, the panel data set is tested for the existence of a unit root.

A battery of tests can be used to check for the existence of a unit root in panel data. Some of these tests assume a common unit root for the 10 Länder (Levin, Lin and Chu test, Breitung test and Hadri test) while others allow for the possibility that unit root processes differ across the Länder (Im, Pesaran and Shin test, ADF – Fisher test and PP – Fisher test). Generally, unit root tests are considered to have quite low power in detecting unit roots (Baltagi, 2005, 238). However, as a whole, the test results shed some light on stationarity/nonstationarity of the panels in this study.

[46] Entorf (1997) also shows that this problem can arise with short (N>T) panels in the case of random walks with drift.

Table 4.7 Panel unit root tests on ($St^{COMPREHENSIVE}/St^{TOTAL}$) (10 West German Länder, 1979-2006)

| Test | Statistic I | p-value | Unit root? | Statistic II | p-value | Unit root? |
|---|---|---|---|---|---|---|
| (1) Levin, Lin and Chu | -2.484 | 0.007 | no | -6.416 | 0.000 | no |
| (2) Breitung | - | - | | -1.416 | 0.078 | yes |
| (3) Im, Pesaran and Shin | 2.457 | 0.993 | yes | -3.583 | 0.000 | no |
| (4) ADF – Fisher | 12.755 | 0.888 | yes | 63.722 | 0.000 | no |
| (5) PP – Fisher | 7.582 | 0.994 | yes | 4.727 | 0.998 | yes |
| (6) Hadri | 9.539 | 0.000 | yes | 6.473 | 0.000 | yes |

Note: Unit root/No unit root is based on $p<0.05$. Statistic I includes individual Länder effects; statistic II includes individual Länder effects and individual linear time trends. Tests (1) – (5) are based on the null hypothesis of the existence of a unit root. Test (6) is based on the null hypothesis of no unit root. Tests (1), (2) and (6) assume a common unit root process for all 10 Länder time series; tests (3) – (5) allow for the possibility of individual unit roots in the 10 Länder time series. Lag length is selected based on Schwartz Information Criterion. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Table 4.8 Panel unit root tests on ($St^{JOINT}/St^{TOTAL}$) (10 West German Länder, 1979-2006)

| Test | Statistic I | p-value | Unit root? | Statistic II | p-value | Unit root? |
|---|---|---|---|---|---|---|
| Levin, Lin & Chu | -3.041 | 0.001 | no | -6.470 | 0.000 | no |
| Breitung | - | - | | -0.798 | 0.213 | yes |
| Im, Pesaran & Shin | 1.050 | 0.853 | yes | -1.318 | 0.094 | yes |
| ADF – Fisher | 17.353 | 0.630 | yes | 50.076 | 0.000 | no |
| PP – Fisher | 7.169 | 0.996 | yes | 2.973 | 1.000 | yes |
| Hadri | 8.900 | 0.000 | yes | 6.267 | 0.000 | yes |

Note: Unit root/No unit root is based on $p<0.05$. Statistic I includes individual Länder effects; statistic II includes individual Länder effects and individual linear time trends. Tests (1) – (5) are based on the null hypothesis of the existence of a unit root. Test (6) is based on the null hypothesis of no unit root. Tests (1), (2) and (6) assume a common unit root process for all 10 Länder time series; tests (3) – (5) allow for the possibility of individual unit roots in the 10 Länder time series. Lag length is selected based on Schwartz Information Criterion. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Table 4.7 presents the results of the unit root tests on the share of students enroled in comprehensive schools and Table 4.8 reports the results for the share of students enroled in joint schools. In both tables, Statistic I is a unit root test that allows for individual Länder effects and Statistic II is a unit root test that incorporates individual Länder effects and Länder-specific time trends. Some caution is necessary when interpreting the results of the Hadri test (6), because it works with the reverse null hypothesis of *no* unit root while all other tests assume the existence of a unit root under the null hypothesis.

The unit root tests that include only individual Länder effects (and no individual time trends) indicate that the panels for comprehensive schools and joint schools are not stationary (Statistic I in Tables 4.7 and 4.8). The evidence is quite clear. For both shares, four out of five tests indicate that the panel is I(1). The evidence is less clear when individual time trends are included. For the share of students enroled in comprehensive schools, three tests indicate a nonstationary panel while three others suggest that this is not the case (Statistic II in Tables 4.7). In the case of joint schooling, four tests indicate that the panel is I(1) while two tests suggest a stationary panel. Moreover, it is not clear whether individual linear time trends may alleviate nonstationarity because there is no bright line between the results of tests assuming common or individual unit root processes.

Breitung (2000) presents evidence suggesting that the unit root tests by Levin, Lin and Chu as well as Im, Pesaran and Chin suffer from very low power when individual time trends are included (see Statistic II, Baltagi, 2005, 243). Indeed, the Levin, Lin and Chu test indicates a stationary panel for both variables while the Breitung test cannot reject the null of the existence of a unit root at the 10% confidence level. Thus, in summary, it is ambiguous whether the panels including individual time trends contain a unit root, although the evidence weakly suggests that there is indeed still a unit root.

We can try to deal with the nonstationarity of the panel by including time fixed effects, which may somewhat mitigate the problem. When the panel is indeed I(1), first-differencing the data is a valid approach to obtain a stationary panel. To check the stationarity of the first-differenced panels, similar unit root tests are conducted for the differenced share of students enroled in comprehensive/joint schooling (see Appendix A.4.4.2 for these results). For the share of students enroled in comprehensive schools the tests clearly show that first-differencing yields stationary panels. For the share in joint schools, the evidence is less clear when individual time trends are included. Thus, panel data regressions are run on first-differenced data of the share of students enroled in comprehensive schools, which can be considered a robust benchmark. As a robustness check, we can also run the regressions using joint schools as a measure for the adoption of comprehensive education (Section 4.4.4.1) and using the shares of students enroled in comprehensive schools itself (and not on the first differences of the shares, see Section 4.4.4.4).

### 4.4.3 Baseline model

The goal of this section is to provide econometric evidence about whether German political parties exert the predicted influence on the intensity of ability-tracking over the 1979-2006 period in West Germany. A properly specified econometric analysis is useful for distinguishing the influence from the different political parties in coalition governments, and for distinguishing political influence from other confounding factors such as the abundance of public resources, or the settlement structure of the Länder.

The endogenous variable is the *intensity of ability-tracking*, measured as the first difference of the share of students enroled in comprehensive schools, $\Delta(St^{COMPREHENSIVE}/St^{TOTAL})$. The key exogenous variable is *political parties' time in office*, which is captured by a vector of dummy variables, POLITICAL, for government participation of the CDU, FDP, the Green Party, and other political parties (Other). The Social Democrats, SPD, are the reference category. These dummy variables take the value of 1 if the political party participates in a Länder government and 0 if it does not (see Section 4.3). As an additional control, coalition size COALSIZE captures the number of political parties that form the Länder government. The political variables are not differenced to allow for identification of the parties' time in office. The following equation is estimated for 10 West German Länder *i* over the 1979-2006 period *t*:

$$(4.6) \quad \Delta \frac{St_{it}^{COMPREHENSIVE}}{St_{it}^{TOTAL}} = POLITICAL_{it}'\beta + \eta_i + \theta_t + v_{it}$$

Länder effects $\eta_i$ are included to control for Länder-specific and time-invariant preferences regarding the design of the education system. This unobserved heterogeneity, however, cannot be assumed uncorrelated with the political couleur of the Länder governments. Thus, the $\eta_i$ are treated as fixed. Fixed year effects $\theta_t$ are included to account for common shifts/shocks in preferences for the design of the education system (like the publication of the PISA tests), which are potentially quite important, because the considered time period is lengthy, including German Reunification. This econometric setup implies that the coefficients are identified from variations within the Länder that are not explained by country-wide shocks/shifts.[47]

[47] Note that equation (4.6) corresponds to a level-specification, which controls for Länder fixed effects, year fixed effects and linear Länder-specific time trends. Thus, the model presented in equation (4.6) implicitly also controls for Länder-specific trends.

Finally, $v_{it}$ denotes a classical, zero mean, constant variance, error term. Although the data is differenced, we cannot rule out weak serial correlation and heteroskedasticitiy. As suggested by Arellano (2003, 19) for the structure of the data set at hand, standard errors are estimated robust in the presence of heteroskedasticity and serial correlation (up to 3 lags) using the method presented by Newey and West (1987).

Table 4.9 Political parties' influence on the share of students enroled in comprehensive schools (10 West German Länder, 1979-2006)

| | $\Delta(St^{COMPREHENSIVE}/St^{TOTAL})$ |
|---|---|
| CDU | -0.002 |
| | (0.001)*** |
| FDP | -0.006 |
| | (0.004)* |
| Green Party | -0.009 |
| | (0.003)** |
| Other | -0.007 |
| | (0.003)** |
| COALSIZE | 0.006 |
| | (0.004)* |
| Länder FE | Yes |
| Year FE | Yes |
| Observations | 270 |
| Adjusted R-squared | 0.33 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

The results of the econometric model (Equation 4.6) appear in Table 4.9. The coefficients estimated for the CDU, FDP and the Green Party show the predicted signs. Länder governments under participation of these political parties decrease the share of students enroled in comprehensive schools. The coefficients of CDU and Green Party are significant at the 1% and 5% level respectively whereas the FDP coefficient is only marginally significant at the 10% level.

One may, however, argue that the structure of the education system is driven by other Länder-specific but time-varying factors, as for example available public resources at the Länder level or the overall economic situation of the Länder. To ensure that the coefficients of the political variables do not merely capture other omitted variables,

Equation (4.6) is augmented by (the first difference of) a standard demand model for public education, X:

$$(4.7) \quad \Delta \frac{St_{it}^{COMPREHENSIVE}}{St_{it}^{TOTAL}} = POLITICAL'_{it}\beta + \Delta X'_{it}\gamma + \eta_i + \theta_t + v_{it}$$

Specifically, X incorporates the natural logarithm of cohort size, i.e. the number of students in lower secondary education, $\ln(St^{TOTAL})$. X also contains the natural log of real Länder public revenue per capita, PR, to account for the Länder financial resources. Due to the strong fiscal equalisation across the Länder, public revenue per capita is a more useful resource proxy compared to Länder-level GDP per capita. PR is deflated using the government consumption deflator supplied by the German Council of Economic Experts (2007). The Länder unemployment rate, UR, is used as a proxy for the overall socioeconomic situation. The natural log of population density, PD, is important because the provision of comprehensive schooling may be more attractive in times of less population density. The share of foreign students is not included in the vector of control variables because this variable does not yield a single significant coefficient in the regressions on West German data (Table 3.3), even at the 20% level and there is a considerable amount of controls for unobservable heterogeneity (see footnote 47). Furthermore, o60 accounts for the share of Länder populations over 60 years of age to control for possible generational conflict. However, we expect this variable to be of little importance (see also Baum and Seitz, 2003). Note that St, PR and PD enter the model as natural logarithms while UR and o60 are defined as ratios. Recall that the demand model for public education, X, is differenced. The first difference of the logs and ratios in X permits the interpretation of all coefficients as elasticities, with the exception of POLITICAL.

Table 4.10 presents the modified regression results. The inclusion of the control variables does not result in important changes of the coefficients estimated for the political variables. Indeed, the point estimates are virtually unchanged, whereas the significance levels of the coefficients estimated for FDP, Other and coalition size falls below the 10%-level. The CDU and Green Party dummy coefficients remain almost unchanged.

Table 4.10 Political parties' influence on the share of students enroled in comprehensive schools, including control variables (10 West German Länder, 1979-2006)

| | $\Delta(St^{COMPREHENSIVE}/St^{TOTAL})$ |
|---|---|
| CDU | -0.002 |
| | (0.001)** |
| FDP | -0.005 |
| | (0.003)+ |
| Green Party | -0.008 |
| | (0.003)** |
| Other | -0.005 |
| | (0.003)+ |
| COALSIZE | 0.005 |
| | (0.003)+ |
| $\Delta$ ln ($St^{TOTAL}$) | 0.017 |
| | (0.051) |
| $\Delta$ ln (PR) | -0.018 |
| | (0.015) |
| $\Delta$ ln (PD) | 0.059 |
| | (0.113) |
| $\Delta$ UR | -0.055 |
| | (0.136) |
| $\Delta$ o60 | 0.386 |
| | (0.492) |
| Länder FE | Yes |
| Year FE | Yes |
| Observations | 270 |
| Adjusted R-squared | 0.33 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

The significant effects estimated for CDU and Green Party government participation are considerable in magnitude. CDU participation in a Länder government almost eliminates the upward trend of enrolment in comprehensive schools (see the sample mean in Table 4.3: +0.3%-0.2% = 0.1%). Green Party participation in a Länder government reduces the growth of enrolment in comprehensive schools by 1.5 standard deviations, which implies that the upward trend in enrolment in comprehensive schools is reversed by the Green Party (+0.3%-0.8% = -0.5%). However, for real policy outcomes, note that the Green Party has only participated in Länder governments in coalitions with the SPD, which exerts moderating effects. The moderating effect from coalition governments is also confirmed by the coefficient of COALSIZE, which is positive but not significantly different from zero in Table 4.8, suggesting that

educational policy by coalition governments is more moderate than educational policy by single-party governments. [48]

The coefficients estimated for the control variables indicate that the share of students enroled in comprehensive schools is a characteristic of the Länder education system that is strongly influenced by public policy. Obviously, other factors are of negligible importance. In particular, cohort size and population density do not have significant effects on the intensity of ability-tracking. Note, however, that population density is a slowly moving variable, the impact of which is hardly identified in an FE environment because much of its variation is between Länder. Public revenue per capita does not affect the share of students either even though some comprehensive schools are associated with rather cost-intensive full-time schooling.

### 4.4.4 Robustness checks

This section tests whether the main conclusions of the baseline model are robust against a series of modifications of the econometric setup and different definitions of the endogenous and exogenous variables. [49]

#### *4.4.4.1 An alternative measure for comprehensive schooling*

This robustness check analyses whether the baseline results hold when using a different definition of the endogenous variable. Recall that the baseline results are obtained by estimating the effect of the political variables on the share of students enroled in comprehensive schools. Here, Equations (4.6) and (4.7) are re-estimated using the *share of students enroled in joint schools* as the endogenous variable. Table 4.11, Column (1) presents the results for the model without control variables and Column (2) shows the results for the model including control variables.

[48] This finding is in accordance with the literature on partisan theory, which highlights the moderating effect of proportional political systems (see e.g. Alesina, Roubini and Cohen, 1997, 7).

[49] A considerable number of robustness checks are provided in this section. One may, of course, conduct more tests. Some tests have been performed but are not considered interesting enough to be reported: different variables capturing the age of Länder governments were tested as political variables (linear, quadratic) but yielded very insignificant coefficients. COALSIZE was tested as a binary variable, which did not yield different results.

Table 4.11 Political parties' influence on the share of students enroled in joint schools (10 West German Länder, 1979-2006)

| | (1) $\Delta(St^{JOINT}/St^{TOTAL})$ | (2) $\Delta(St^{JOINT}/St^{TOTAL})$ |
|---|---|---|
| CDU | -0.008 | -0.008 |
| | (0.003)** | (0.004)** |
| FDP | -0.004 | -0.004 |
| | (0.007) | (0.006) |
| Green Party | -0.003 | -0.003 |
| | (0.005) | (0.005) |
| Other | 0.001 | 0.001 |
| | (0.006) | (0.006) |
| COALSIZE | -0.002 | -0.002 |
| | (0.005) | (0.005) |
| $\Delta$ ln ($St^{TOTAL}$) | | -0.181 |
| | | (0.198) |
| $\Delta$ ln (PR) | | 0.005 |
| | | (0.034) |
| $\Delta$ ln (PD) | | -0.010 |
| | | (0.302) |
| $\Delta$ UR | | -0.566 |
| | | (0.408)+ |
| $\Delta$ o60 | | 1.457 |
| | | (1.819) |
| Länder FE | Yes | Yes |
| Year FE | Yes | Yes |
| Observations | 270 | 270 |
| Adjusted R-squared | 0.16 | 0.16 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

Again, the results confirm the hypotheses. The signs estimated for CDU, FDP and the Green Party are in line with the hypotheses in Table 4.1. However, only the estimated effect for CDU is significantly different from zero at the 5% level (both, in the model with and in the model without control variables). The coefficients estimated for FDP and the Green Party are not significantly different from zero. The coefficient estimated for the CDU dummy suggests that the effect is larger for joint schools than for comprehensive schools. A change in government from SPD to CDU reverses the upward trend in enrolment in joint schooling (+0.3% - 0.8% = -0.5%), which is a larger effect than in the baseline model (+0.3% - 0.2% = 0.1%). However, in terms of the standard deviation, the effect is comparable (about 1/3 s.d.). Note that the relation among the coefficients estimated for CDU, FDP and the Green Party is reversed.

Obviously, governments under participation of CDU oppose joint schooling more strongly than the other two parties whereas this relation is different for comprehensive schools. In summary, the regressions using joint schooling as the endogenous variable confirm the hypotheses from Section 4.2 but the results are somewhat weaker than those estimated for comprehensive schools.

The coefficients estimated for the control variables are not significantly different from zero as suggested by the baseline model. Note that the $R^2$s suggest that Equations (4.6) and (4.7) explain more of the variation in the share of students enroled in comprehensive schools than in joint schools, which may be because joint schooling is an aggregate of three different school types.

*4.4.4.2 An alternative measure for POLITICAL: the coalition pattern*

In this section we test a different definition of the key exogenous variables. Recall that POLITICAL is a set of dummy variables which accounts for separate political parties. This allows us to sort out the influence of political parties on the education system and directly matches the hypotheses from Section 4.2. This definition of POLITICAL is, however, somewhat artificial since it gives "clean" ceteris paribus effects for the parties, holding constant all other parties' government participation. An alternative is to account for each coalition combination with a dummy variable. This definition may analytically be less interesting because it does not report ceteris paribus coefficients of the political parties. It is, however, closer to the real world. Thus, every coalition combination formed by the political parties is represented by a separate dummy variable: SPD single-party governments are the base category. The historical SPD coalition governments are the SDP-Green Party, SPD-FDP, SPD-FDP-Green Party and SPD-Other. One dummy variable captures CDU single-party governments and two others capture CDU-FDP and CDU-FDP-Other coalitions. A final dummy variable captures grand coalitions comprising SPD-CDU coalitions, irrespective of whether the Länder prime minister represents the SPD or the CDU. Generally, the problem with this definition of the political parties is that for some dummies there is only a very limited number of observations for some dummies. Some coalitions form only once in our sample (SPD-FDP-Green Party, SPD-Other, CDU-FDP-Other). Table 4.12 depicts the results for regressions as shown in equation (4.6) and (4.7) but with the modified definition of the vector POLITICAL.

Table 4.12 Political parties' influence on the share of students enroled in comprehensive schools, Coalition patterns (10 West German Länder, 1979-2006)

| | (1) $\Delta(St^{COMPREHENSIVE}/St^{TOTAL})$ | (2) $\Delta(St^{COMPREHENSIVE}/St^{TOTAL})$ |
|---|---|---|
| SPD-FDP | -0.002 | -0.002 |
| | (0.001) | (0.002) |
| SPD-Green Party | -0.003 | -0.004 |
| | (0.001)*** | (0.001)*** |
| SPD-FDP-Green Party | 0.001 | 0.003 |
| | (0.003) | (0.003) |
| SPD-Other | -0.001 | -0.000 |
| | (0.002) | (0.002) |
| CDU | -0.003 | -0.003 |
| | (0.001)*** | (0.001)** |
| CDU-FDP | -0.003 | -0.003 |
| | (0.001)** | (0.001)** |
| CDU-FDP-Other | -0.005 | -0.004 |
| | (0.002)*** | (0.002)* |
| Grand Coalition | 0.004 | 0.003 |
| | (0.003) | (0.003) |
| $\Delta$ ln ($St^{TOTAL}$) | | 0.016 |
| | | (0.053) |
| $\Delta$ ln (PR) | | -0.020 |
| | | (0.015)+ |
| $\Delta$ ln (PD) | | 0.101 |
| | | (0.111) |
| $\Delta$ UR | | -0.050 |
| | | (0.134) |
| $\Delta$ o60 | | 0.217 |
| | | (0.555) |
| Länder FE | Yes | Yes |
| Year FE | Yes | Yes |
| Observations | 270 | 270 |
| Adjusted R-squared | 0.33 | 0.34 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

The estimates for the alternative definition of the political variables accord well with the definition of single parties (compare Tables 4.9, 4.10 and 4.11). Recall that here the base category is the single-party SPD government. The estimation results suggest that SPD-Green Party, CDU-FDP coalitions and single-party CDU governments pursue a significantly different education policy compared to single-party SPD governments and

that they are associated with a lower share of students enroled in comprehensive schools. The magnitude of the effects are also well in line with the results from the baseline models. While the effect estimated for the CDU is -0.2% per year in the baseline model (Tables 4.9 and 4.10), Table 4.12 suggests that the coefficient for CDU single-party governments is -0.3%. Thus, according to the results in Table 4.12, the CDU truly eliminates the upward trend in comprehensive schooling. Due to the formulation as coalition governments in Table 4.12, the other coefficients are less comparable, but generally match the baseline estimates quite well.

Two results are not in line with the baseline model: *first*, grand coalitions do not appear to pursue an education policy that is significantly different from single-party SPD governments. This may be due to the fact that a SPD-dominated grand coalition (Bremen 1995-2006) is mixed with CDU-dominated grand coalitions (Baden-Württemberg 1992-1995; Schleswig-Holstein 2005-2006). Splitting up these coalitions results in very few observations per dummy and is therefore avoided. *Second*, coalitions made up of SPD, FDP and the Green Party obviously, though not significantly different from zero, advocate more comprehensive schooling than single-party SPD governments, which is not in line with the hypotheses formulated in Section 4.2. Partisan theory would suggest that the FDP and the Green Party engage in weakening SPD's bias towards comprehensive schooling. Recall, however, that there is only one SPD-FDP-Green Party coalition (Bremen 1992-1994). A possible interpretation may be that the Social Democrats are able to dominate their small coalition partners; although the FDP and the Green Party accumulate a considerable share of votes: 9.5% and 11.4%, respectively.

*4.4.4.3 Another measure for POLITICAL: the Länder education ministers*

We can also argue that the political couleur of the Länder education minister is more important than whether or not a specific political party participates in a Länder government. In this case, the political influence on education policy is measured by the party affiliation of the education minister. In the sample period, education ministers are almost always members of the SPD or CDU with one exception (Hamburg, October 2001-March 2004: Rudolf Lange/Reinhard Soltau). Thus, model (4.6) and (4.7) are re-estimated with the vector POLITICAL capturing the political orientation of the Länder education minister. Again, SPD membership of the education minister is coded as the

base category. CDU or FDP memberships of the education minister are coded as dummy variables. Table 4.13 reports the results.

Table 4.13 The effect of education ministers' party affiliation on the share of students enroled in comprehensive schools (10 West German Länder, 1979-2006)

| | (1) $\Delta(St^{COMPREHENSIVE}/St^{TOTAL})$ | (2) $\Delta(St^{COMPREHENSIVE}/St^{TOTAL})$ |
|---|---|---|
| Education Minister CDU | -0.003 | -0.002 |
| | (0.001)*** | (0.001)** |
| Education Minister FDP | -0.004 | -0.003 |
| | (0.002)** | (0.002)+ |
| $\Delta$ ln ($St^{TOTAL}$) | | 0.014 |
| | | (0.053) |
| $\Delta$ ln (PR) | | -0.023 |
| | | (0.016)+ |
| $\Delta$ ln (PD) | | 0.045 |
| | | (0.119) |
| $\Delta$ UR | | -0.051 |
| | | (0.138) |
| $\Delta$ o60 | | 0.555 |
| | | (0.526) |
| Länder FE | Yes | Yes |
| Year FE | Yes | Yes |
| Observations | 270 | 270 |
| Adjusted R-squared | 0.30 | 0.31 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

Not surprisingly, the results are quite similar the baseline model. If the education minister belongs to the CDU, fewer students enrol in comprehensive schools. The effect is significant at the 5% level (in the model with controls). The magnitude of the effect corresponds well to the coefficient obtained from the baseline model. The effect estimated for the FDP education minister is only significantly different from zero in the model without control variables and at the 20% level in the model including control variables. The magnitude of the coefficients corresponds to the coefficients from the baseline model.

*4.4.4.4 Dynamic model on the share itself (and not on differenced data)*

The goal here is to test whether the baseline results hold if one understands the strong serial dependence in the data as an integral part of the econometric model instead of differencing the panel. The reason for the use of the differenced share of students enroled in comprehensive schools is that the unit root tests do not give a completely clear picture of whether or not the panels are stationary. The first difference of the panel is, however, stationary, which is clear from the unit root tests on the first-differenced data. Thus, standard econometric methods (designed for use with stationary data) can be used with the differenced series. In every case, given the results of the unit root tests, it is natural to worry about strong serial correlation, in which case first differencing is also an appropriate approach to estimate the model (Wooldridge, 2003, 410).[50] Thus, the results from the baseline-model may be considered an excellent benchmark for other models.

There are concerns that first-differencing the data involves loss of information and complicates the identification of public policy's impact on the education system. The specific issues are:

(i) The dynamics of adjustment of the education system should be explicitly modelled and not differenced away. Thus, one may advocate the estimation of dynamic models, which allow deriving short- and long-run responses.

(ii) Less importantly, FE on the share itself implies a more efficient use of the available information compared to running a FE model on differenced data. However, due to the small cross-sectional dimension of the panel (n=10), the loss of observations caused by first-differencing is quite small (~ 4%).

Additionally, one may argue that, if Länder governments change very infrequently (e.g., Baden-Württemberg or North-Rhine Westphalia) or do not change at all in the entire sample (Bavaria), first-differencing may complicate or render impossible identifying the impact of political parties on the education system. However, the identification problem does *not* disappear when running the FE model on the share itself because these coefficients are also identified from within-Länder variation and not from information on the shares itself. If we intend to exploit the information on *the share itself*, we need some type of between-estimation (see Section 4.4.4.5).

[50] The Wooldridge (2002) and Drukker (2003) test for serial correlation in panel data models strongly confirms the presence of serial correlation in the share of students enroled in comprehensive or joint schooling (p-value for both series < 0.000).

Equations (4.6) and (4.7) are re-estimated using as endogenous variable the share of students enroled in comprehensive schools (not differenced). Note that for this exercise it is a prerequisite that the data is stationary, which is contrary to what was assumed for the baseline model, because otherwise the coefficients may be spurious (Beck and Katz, 2004, Entorf, 1997 or Kennedy, 2003). Thus, in this Section, we check the robustness of the baseline results against a dynamic specification using information on the share itself. The following model is estimated:

$$(4.8) \quad \frac{St_{it}^{COMPREHENSIVE}}{St_{it}^{TOTAL}} = \phi \frac{St_{it-1}^{COMPREHENSIVE}}{St_{it-1}^{TOTAL}} + POLITICAL_{it}'\beta + X_{it}'\gamma + \eta_i + \theta_t + v_{it}$$

The estimation of this model deserves explanation. It is well known that if the time dimension of the panel is not very large the naïve FE estimation of model (4.8) yields biased and inconsistent estimates of the true parameters, for both the lagged endogenous variable as well as for the other exogenous variables. Even though the time-invariant error component $\eta_i$, which is correlated with the lagged endogenous variable, is typically wiped out by the introduction of Länder dummies, the lagged endogenous variable is still correlated with the lagged error ($v_{it-1}$).[51] This introduces a source of endogeneity to the set of regressors. As shown by Nickell (1981) the consistency of the FE estimator in a dynamic panel data model hinges on a large T. Moreover, the FE estimates are biased and the bias disappears only as T -> ∞ ("Nickell-bias", see e.g., Baltagi, 2005, 135). This is already true in the absence of serial correlation; however, the endogeneity problem becomes more important in the presence of serial dependence. In this case, the lagged endogenous variable is also correlated with the contemporaneous error ($v_{it}$). Indeed, the Wooldridge test for serial correlation in panel data models (Wooldridge, 2002 and Drukker, 2003) suggests the presence of serially correlated errors in the dynamic model (W 2002: $p<0.01$).[52]

Econometric research has experienced considerable advances in finding consistent and unbiased estimators for the dynamic panel data model (see e.g., Anderson and Hsiao, 1981, or Arellano and Bond, 1991). These models, however, rely on the assumption of

[51] Alternatively, if the time-invariant error component $\eta_i$ is wiped out by the within-transformation, the lagged endogenous variable is correlated with the time-demeaned error $v_{it} - v_{it-1}$

[52] The Durbin-Watson statistic is not reliable in the presence of endogenous regressors while Durbins'h statistic is not implemented in Stata for use with panel data (Wooldridge, 2003, 399).

$N \rightarrow \infty$ or at least $N > T$, which holds for many typical micro-panels, such as the German Socioeconomic Panel (GSOEP) or the Panel Study of Income Dynamics (PSID) in the U.S. (see Arellano, 2003, 84 and 129; and Nickell, 1981). For many macro-panels, however, the typical structure is $T > N$, which makes the estimation of dynamic panel data models less straightforward. Judson and Owen (1999), Beck and Katz (2004) as well as Bruno (2005) study the $T > N$ case. They use Monte-Carlo simulations to quantify the biases in the estimates for the coefficients/standard errors of the lagged endogenous and the exogenous variables when estimated with FE. These studies quite unanimously conclude that for the structure of this data set ($n = 10$, $T = 28$, serial dependence), the bias of the "naïve" FE model does not affect the sign of the coefficients. In particular, the evidence presented by Judson and Owen (1999) and Beck and Katz (2004) suggests that even for the case of strong serial dependence the empirical bias of the "naïve" FE estimation should not exceed -6% for the coefficient of the lagged endogenous variable and +15 % for the coefficients of the other regressors. Moreover, the "naïve" FE model outperforms micro-econometric estimators for dynamic panel data such as Anderson and Hsiao (1981) or Arellano and Bond (1991) in terms of efficiency (see Judson and Owen, 1999 and Beck and Katz, 2004).

Thus, the choice of an estimator for the model presented in equation (4.8) is not easy. A *first* option is to estimate the model by "naïve" FE and accept the Nickell-bias, given that it will not affect the sign of the key exogenous variables (POLITICAL). *Second*, one may consider an IV approach. Arellano (2003, pp. 129) recommends estimation by 2SLS for the $T > N$ case. The applicability of the IV approach depends of course on the availability of good instruments. All previously estimated models suggest that the political dummy variables have comparatively high explanatory power for the change in the share of students enroled in comprehensive schools. Thus, to instrument the lagged share of students in comprehensive schools, the lagged political dummy variables CDU and Green Party are used in addition to lagged population density. These variables yield the most significant effects in the "naïve" FE estimation (see Column 1 of Table 4.14). The two approaches are problematic, but the joint evidence from both may give information about the robustness of the baseline results for POLITICAL in light of a dynamic specification.[53]

[53] Kiviet (1995) proposes a bias correction of the static FE model. Monte-Carlo evidence presented in Judson and Owen (1999) and Beck and Katz (2004) suggests that this estimator performs slightly better than the static FE model. However, for the bias correction, this model requires an initial estimate from a

To sum up, the dynamic model as set out in equation (4.8) is estimated by two different econometric approaches. Model (1) is a classical FE model. Model (2) is an IV regression using the lagged political dummy variables CDU and Green Party as well as lagged population density as instruments, which is estimated by 2SLS. In both models, the standard errors are estimated robust in the presence of serial correlation and heteroskedasticity as suggested by Newey and West (1987). The results are reported in Table 4.14.

The results confirm that the share of students enroled in comprehensive schools is virtually a nonstationary variable and that the results should be interpreted with considerable caution. The IV estimation seems to work well since the instruments are reasonably correlated with the lagged share of students, as shown by the Anderson statistic. At the same time, the Hansen-J test for overidentifying restrictions (comparable to the Sargan test used in the presence of heteroskedasticity-robust estimation; see Bauer, Fertig and Schmidt, 2009, 333 for an overview) suggests that the IVs are not correlated with the error-term and thus may be considered valid instruments. The coefficients estimated for the lagged share of students in comprehensive schools are quite similar in the naïve FE and in the IV FE model; the difference may indeed be explained by the Nickell-bias simulated in Judson and Owen (1999), which suggested -6%. My own estimates suggest ~ -5%.[54] Note the higher standard error of the instrumented variable (lagged share of students in comprehensive schools) which is not surprising. The results for the political variables are very robust. The sign and the magnitude of the political variables are similar to those estimated in the baseline model whereas the significance level is somewhat lower than in the baseline model.

consistent estimator (e.g. Arellano and Bond, 1991), which is a difficult choice for the 10x28 data structure. I also estimate the Kiviet (1995)-model where the initial consistent estimate is taken from Arellano and Bond (1991) and standard errors are bootstrapped with 500 replications. The results (point estimates and confidence intervals) are virtually identical with the results obtained from the classical FE model (Model 1).

[54] When testing different sets of IVs, the range of the estimation results for $\phi$ in Model (2) is from 0.95 to 1.05, confirming that the variable is nonstationary.

Table 4.14 Dynamic model of political parties' influence on the share of students enroled in comprehensive schools (10 West German Länder, 1979-2006)

| | (1) $St^{COMPREHENSIVE}/St^{TOTAL}$ | (2) $St^{COMPREHENSIVE}/St^{TOTAL}$ |
|---|---|---|
| $(St^{COMPREHENSIVE}/St^{TOTAL})_{t-1}$ | 0.952 | 0.999 |
| | (0.023)*** | (0.068)*** |
| CDU | -0.003 | -0.003 |
| | (0.001)*** | (0.001)*** |
| FDP | -0.004 | -0.004 |
| | (0.003)+ | (0.003)+ |
| Green Party | -0.007 | -0.008 |
| | (0.003)** | (0.003)** |
| Other | -0.005 | -0.007 |
| | (0.004)+ | (0.005)+ |
| COALSIZE | 0.004 | 0.005 |
| | (0.003)+ | (0.003)+ |
| ln $(St^{TOTAL})$ | 0.009 | -0.005 |
| | (0.017) | (0.025) |
| ln (PR) | -0.019 | -0.015 |
| | (0.012)+ | (0.012) |
| ln (PD) | -0.092 | -0.032 |
| | (0.058)+ | (0.095) |
| UR | 0.019 | 0.015 |
| | (0.051) | (0.051) |
| o60 | -0.069 | -0.025 |
| | (0.084) | (0.110) |
| IVs for lagged endogenous variable | - | lagged CDU<br>lagged Green Party<br>lagged ln(PD) |
| Anderson-statistic,<br>IV relevance test,<br>H0: equation is under-identified | - | 22.370*** |
| Hansen-J-statistic,<br>Test of overidentifying restrictions,<br>H0: IVs are valid | - | 0.178 |
| Länder FE | Yes | Yes |
| Year FE | Yes | Yes |
| Observations | 270 | 270 |
| Adjusted R-squared | 1.00 | 1.00 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

In summary, there are three major lessons from the estimations using the share of students enroled in comprehensive schools (and not the first difference of this share).

*First*, the panel is indeed not stationary. The (consistent and unbiased) IV estimate indicates that the panel follows a random walk. Thus, one should be extremely cautious in interpreting the results. *Second*, given the first result, fortunately the level-specifications strongly confirm the results from the baseline model since all level-specifications give the same signs for the political influence on the education system. In comparison to the Social Democrats, all political parties appear to advocate a lower share of students in comprehensive schools. The coefficients across the two models are very robust: compared to the models on differenced data, the level-specifications in most cases even suggest almost identical magnitudes of the coefficients. The significance levels are somewhat lower than in the baseline specification. This is not surprising – at least for the IV regression. The coefficients of the control variables also show a quite consistent picture compared to the estimation using differenced data. *Third*, if one is willing to consider the panel as stationary, the level-specifications suggest that there are pronounced differences between the short- and long-run effects from the political parties. The long-run coefficients are considerably higher (see Beck and Katz, 2004 or Pindyck and Rubinfeld, 1998). The dynamic FE model (Column 1 in Table 4.14) suggests that the long-run effect on the share of students in comprehensive schools caused by a change from SPD to CDU is about -6%. Of course, these long-run effects can only become effective during the lengthy incumbency of one political party, which may be observed in Figure 4.2 (h) and (i) for Rhineland-Palatinate and Saarland.

If there are indeed differences between the short- and long-run effects of political influence on the education system, these differences should also show up in terms of differences between the *within estimations*, which have been presented up to this point and the results from *between estimations*, which may be considered long-run coefficients and, which will be presented next.

*4.4.4.5 Exploiting the variation across Länder (between estimations)*

This section tests whether the baseline results hold when exploiting the between-Länder variation instead of the within-Länder variation. Recall that the baseline model is an FE-model run on first-differenced data. Both the fixed effects and the differenced data are very important parts of the econometric model as explained above, because they permit obtaining consistent and unbiased estimates. However, these characteristics of the baseline model involve loss of information. Specifically, the coefficients are identified

from the variation within Länder that is not explained by economy-wide shocks or Länder-specific trends; in particular the coefficients are *not* identified from the share itself. This raises some identification issues. Consider Bavaria (see Figure 4.2 a). In the sample period from 1979 through 2006, Bavaria experiences no change of government (CSU). Identification of CSU's influence based on the within-Länder variation clearly fails. Note that this applies irrespective of whether the first-difference or the deviations-from-Länder-means transformation is used or whether Länder dummies are introduced. Instead, information on the *share itself* (i.e. the share of students enroled in comprehensive schools) is needed to identify party influence in this case. Consequently, as a complement to the baseline model, we can exploit the cross-Länder variation of the sample. However, instead of the textbook between estimator, which is obtained by performing an OLS regression on the Länder means (see e.g., Greene, 2003), it appears more helpful from a political-economic view to consider the share of students enroled in comprehensive schools in 2006 as a result of political action taken during the sample period 1979-2006:

$$(4.9) \quad \left(\frac{St^{COMP}}{St^{TOTAL}}\right)_i^{2006} = \alpha + \beta \sum_{1977}^{2006} CDU_i + \delta \sum_{1977}^{2006} FDP_i + \delta \sum_{1977}^{2006} Green_i + v_i$$

where e.g., ΣCDU is a simple variable that counts government participation by the CDU (years), irrespective of whether within coalition governments or as single-party governments. Thus, this very simple, stylised econometric model relates the share of students in comprehensive schools in 2006 to the accumulated years in government for CDU, FDP and the Green Party over the sample period 1979-2006.

A variant of this model corrects Equation (4.9) for the initial (1979) level of comprehensive schooling such that only the change in the share of students enroled in comprehensive/joint schooling over the 1979-2006 period is attributed to the political couleur of Länder governments in this period.[55]

$$(4.10)\quad \left(\frac{St^{COMP}}{St^{TOTAL}}\right)_i^{2006} - \left(\frac{St^{COMP}}{St^{TOTAL}}\right)_i^{1979} = \alpha + \beta\sum_{1977}^{2006} CDU_i + \delta\sum_{1977}^{2006} FDP_i + \delta\sum_{1977}^{2006} Green_i + v_i$$

In both models, due to the strong negative correlation of SPD- and CDU times in office (see Table 4.4) it is not possible to include the years in government by both parties, which would be a source of strong multi-collinearity.[56] Note that this econometric model involves only 10 observations (10 West German Länder) and thus can only be estimated in a reduced-form, suppressing control variables and concentrating only on the political dummy variables. Although suppressing control variables does not seem to be much of a disadvantage (see e.g., Tables 4.10), it also means that we cannot even control for *observed* heterogeneity, important in cross-sectional regressions, given that no control for *un*observed heterogeneity is possible. From an econometric view this implies that the estimator is not consistent since the error may still be correlated to exogenous variables. Thus, these models are more adequately viewed as multivariate correlations and *cannot* be viewed as fully-fledged econometric models.

Table 4.15, Column (1) presents the cross-sectional regression as shown in Equation (4.9). Column (2) presents the results for Equation (4.10). These reduced-form regressions confirm the main conclusions from the baseline model. Länder with histories of CDU-dominated governments have education systems with a lower share of students enroled in comprehensive schools. This finding is significantly different from zero in both specifications, of course keeping in mind all of the limitations mentioned supra. Taken literally, the estimates suggest that one additional year of CDU government suppresses the share of students enroled in comprehensive schools by about 1%. This implies that a four-year incumbency would translate into a 4% decrease in the share of students in these schools. FDP government participation has a smaller impact

[55] See also the discussion on the 1979 level of comprehensive schooling in Section 4.4.1.1 and Chapter 2.
[56] Note that including all political parties does not change the relation between the political parties. It does, however, suppress the confidence levels of the coefficients, which is not surprising, given the strong negative correlation between SPD and CDU years in government (see e.g. Kennedy, 2003, 212).

on the education system while government participation by the Green Party has a somewhat larger negative effect (in Column 2). The latter two effects are only significant when we correct for the initial (1979) share of comprehensive schooling. Generally, the corrected model (Equation 4.10) fits the data better than Equation (4.9). This is not surprising given that in some Länder with mixed political records, there is already a considerable degree of comprehensive schooling in 1979 (e.g., Hesse or Hamburg). Equation (4.10) attributes only the 2006-1979 change in the share of students in comprehensive schools to the political couleur of the Länder during 1979-2006. Overall the results obtained from the between regressions support the findings from the within-Länder regressions. Moreover, the between models also suggest that there may indeed be differences between short- and long-run effects, although not as pronounced as implied by the model on the share itself (previous section).

Table 4.15 Between Länder estimation: Political parties' influence on the share of students enroled in comprehensive schools (10 West German Länder)

| | (1) $(St^{COMPREHENSIVE}/St^{TOTAL})_{2006}$ | (2) $\Delta^{2006\text{-}1979}(St^{COMPREHENSIVE}/St^{TOTAL})$ |
|---|---|---|
| ΣCDU | -0.010 | -0.010 |
| | (0.004)** | (0.002)*** |
| ΣFDP | -0.003 | -0.006 |
| | (0.005) | (0.002)** |
| ΣGreen Party | -0.006 | -0.012 |
| | (0.008) | (0.003)** |
| Constant | 0.312 | 0.295 |
| | (0.092)** | (0.041)*** |
| Observations | 10 | 10 |
| Adjusted R-squared | 0.38 | 0.78 |

Note: Standard errors in parentheses. ***, **, * and + denote significance at the 1%, 5%, 10% and 20% level.

*4.4.4.6 Reverse causality: from education policy to election outcomes?*

A final, but important concern with the baseline results is reverse causality, i.e. educational policy can possibly exert an influence on Länder election outcomes. This would be a serious problem for the econometric models presented to this point, because it implies that the political dummy variables in POLITICAL could not be considered exogenous. In this case, the models would yield inconsistent and biased estimates. Therefore, in this section, I consider the potential endogeneity of the political variables.

There is no simple argument to rule out the endogeneity concern; however, the importance should be limited for the following reasons. *First*, although certainly an important public task at the German Länder level, education is hardly the only issue in Länder election campaigns. *Second*, note that only *lower secondary education* is considered here, i.e. only a subset out of total public education at the Länder level. *Third*, the provision of an increased number of comprehensive schools is – in the vast majority of the cases – solely an *offer* to parents/students. Enrolment in comprehensive schools is voluntary; parents/students can also opt to enrol in a school of the traditional system.[57] *Fourth*, from an econometric view, concerns that causality runs from the change in the share of students in comprehensive schools to the political couleur of the Länder government can be discarded in about 3/4 of the observations since Länder governments are only elected every fourth or fifth year.

In summary, although we may consider the scope of the reverse causality concern to be limited, to some degree it remains a valid objection against the main results. Robustness checks against this concern are difficult. Below, I offer two possible empirical strategies: (1) The use of instrumental variables and (2) a re-specification of the econometric model based on a separation of exogenous from potentially endogenous variation in POLITICAL.

The first strategy requires the choice of appropriate *instruments*, which are obviously difficult to find in this case. One may think of lagged values of the political dummy variables. However, in most cases, these lagged values embody the same endogeneity concern as the contemporaneous values (if the lagged values come from the same incumbency). In about 1/4 of the cases, the lagged values may have nothing to do with the following values (if the lagged values come from the preceding incumbency). Thus, lagged values are inadequate instruments.[58] In fact, it is virtually impossible to find appropriate instruments for the political dummy variables in the within estimations. Finding appropriate instrumental variables is easier for the between-Länder estimations, i.e. the share of Catholics in the Länder is a reasonably suited instrument for the years in office of CDU governments. The share of Catholics (average share for 2000-2006) is correlated with CDU years in government by about 40%, which is, however, quite low

[57] This applies only to a limited degree to joint schools as far as these replace the traditional system.
[58] Notwithstanding, such an IV model is tested using the first and second lag of the political dummy variables as instruments for the contemporaneous values. The model is estimated using 2SLS. The results are virtually identical to the baseline results.

and thus may be subject to the problem of weak instruments (see e.g., Bauer, Fertig and Schmidt, 2009, 327). Table 4.16 presents the results for 2SLS between-estimations, using the share of Catholics as an instrument for CDU years in government. Model (1) is the IV counterpart of Equation (4.9) while Model (2) is the IV counterpart of Equation (4.10).

Table 4.16 IV Between Länder estimation: Political parties' influence on the share of students enroled in comprehensive schools (10 West German Länder)

| | (1) $(St^{COMPREHENSIVE}/St^{TOTAL})_{2006}$ | (2) $\Delta^{2006\text{-}1979}(St^{COMPREHENSIVE}/St^{TOTAL})$ |
|---|---|---|
| ΣCDU, instrumented by %Catholics | -0.033 | -0.012 |
| | (0.077) | (0.015) |
| ΣFDP | -0.007 | -0.006 |
| | (0.015) | (0.003)** |
| ΣGreen Party | -0.032 | -0.014 |
| | (0.092) | (0.018) |
| Constant | 0.749 | 0.337 |
| | (1.527) | (0.298) |
| Observations | 10 | 10 |

Note: Standard errors in parentheses. ***, **, * and + denote significance at the 1%, 5%, 10% and 20% level.

The results show that the significance level of the (instrumented) CDU variable falls below 10% while the sign remains unchanged. The magnitude of the CDU coefficient increases in column (1) but remains almost unchanged in column (2). However, the results are very difficult to interpret given the small sample of 10 observations and the problems associated with the cross-sectional data mentioned supra. Thus, the interpretation of this result should not be pushed to the limit.

The second strategy is to think about the possible endogeneity of the political dummy variables as a mis-specification of the model. As argued above, the endogeneity concern may be ruled out in about 3/4 of the observations, simply because the political couleur of the Länder governments only changes every fourth or fifth year and thus, *can only* be influenced in election years. The dummy variables in the non-election years are clearly exogenous of the contemporaneous change in the share of students enroled in comprehensive schools. Thus, I re-specify the econometric model such that the

exogenous political variation is disentangled from the potentially endogenous dummy variables in election years. Equation (4.11) presents such a model:

$$\Delta \frac{St_{it}^{COMPREHENSIVE}}{St_{it}^{TOTAL}} = \left(ELECT_{it} * POLITICAL_{it}\right)'\beta + \left(NONELECT_{it} * POLITICAL_{it}\right)'\chi + \delta OTHER_{it} + \phi COALSIZE_{it} + \Delta X_{it}'\gamma + \eta_i + \theta_t + v_{it} \quad (4.11)$$

Essentially, Equation (4.11) is simply a variant of Equation (4.7) that additionally distinguishes between election (ELECT) and non-election years (NONELECT). ELECT takes the value of 1 in an election year, zero otherwise. NONELECT takes the value of 1 in a non-election year, zero otherwise. These dummies are interacted with the vector of political dummy variables to separate exogenous from potentially endogenous political dummies.[59] Social Democrats in non-election years are chosen as the reference group to avoid the dummy variable trap. POLITICAL is interacted with *both* dummies, ELECT *and* NONELECT to clearly separate the potentially endogenous political variables. Note that only the relevant political variables CDU, FDP and Green Party are interacted. The dummy Other consists of few observations. In addition, Other and COALSIZE are merely control variables. The remainder of the model is identical to the baseline models discussed in Section 4.4.3.

[59] Note that the separation between election and non-election years is not entirely selective due to the assignment of incumbencies to the contemporaneous year if the election is held in the first half of the year and to the following year if the election is held in the second half of the year.

Table 4.17 Separation of exogenous and potentially endogenous political variation: Political parties' influence on the share of students enroled in comprehensive schools (10 West German Länder, 1979-2006)

| | (1) $\Delta(St^{COMPREHENSIVE}/St^{TOTAL})$ | (2) $\Delta(St^{COMPREHENSIVE}/St^{TOTAL})$ |
|---|---|---|
| CDU | | -0.002 |
| | | (0.001)** |
| FDP | | -0.005 |
| | | (0.003)+ |
| Green Party | | -0.008 |
| | | (0.003)** |
| ELECT | | -0.002 |
| | | (0.001)* |
| CDU*NONELECT | -0.003 | |
| | (0.001)*** | |
| FDP*NONELECT | -0.006 | |
| | (0.004)+ | |
| Green Party*NONELECT | -0.009 | |
| | (0.004)** | |
| SPD*ELECT | -0.002 | |
| | (0.001)** | |
| CDU*ELECT | -0.004 | 0.000 |
| | (0.001)*** | (0.001) |
| FDP*ELECT | -0.005 | 0.002 |
| | (0.003)+ | (0.001) |
| Green Party*ELECT | -0.007 | 0.001 |
| | (0.003)** | (0.002) |
| Other | -0.007 | -0.006 |
| | (0.004)* | (0.004)+ |
| COALSIZE | 0.006 | 0.005 |
| | (0.004)+ | (0.003)+ |
| $\Delta$ ln ($St^{TOTAL}$) | 0.009 | 0.012 |
| | (0.053) | (0.052) |
| $\Delta$ ln (PR) | -0.016 | -0.017 |
| | (0.015) | (0.015) |
| $\Delta$ ln (PD) | 0.058 | 0.053 |
| | (0.112) | (0.113) |
| $\Delta$ UR | -0.058 | -0.061 |
| | (0.131) | (0.134) |
| $\Delta$ o60 | 0.344 | 0.356 |
| | (0.510) | (0.509) |
| Länder FE | Yes | Yes |
| Year FE | Yes | Yes |
| Observations | 270 | 270 |
| Adjusted R-squared | 0.34 | 0.33 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

The results are reported in Table 4.17. Column (1) is the model discussed above while the model in column (2) is a more "classic" specification, which includes the original vector POLITICAL plus the ELECT dummy and interactions of ELECT with CDU, FDP and Green Party. For interpretation, Model (1) is more convenient because it allows interpreting all coefficients of the political dummies relative to SPD governments in non-election years. Moreover, Model (1) separates exogenous from potentially endogenous variation in a strict fashion whereas the coefficients from Model (2) are identified from both election and nonelection years. Model (2) only accounts for potentially differing results in election years and serves to confirm that the somewhat nonconformist specification of Model (1) yields basically identical results compared to a more traditional specification.

The first finding is that the main results from the baseline model are supported. The coefficients estimated for the interactions of NONELECT with CDU, FDP and Green Party dummy (the exogenous variation in these dummies) strongly confirm the results from the baseline model. Relative to SPD Länder governments in non-election years, CDU and the Green Party reduce the share of students enroled in comprehensive schools.

The coefficients estimated using the interactions of ELECT with the political dummy variables (the potentially endogenous variation) show that the CDU and the Green Party effects are quite robust. The magnitude of the coefficients increases somewhat for CDU and decreases about 25% for the Green Party. The significance level is comparable to the baseline model. Interestingly, the results in Table 4.17 suggest that Social Democrats pursue different educational policies in election and non-election years, namely in election years, the SPD pursues an educational policy similar to that of the CDU. This may indicate endogeneity problems with the SPD governments, which is, however, difficult to imagine given that CDU and Green Party dummies have quite robust effects. CDU, Green Party and Social Democrat success in Länder elections is of course not independent. But there is an alternative interpretation for this finding. Recall that the share of students in comprehensive schools is increases in the sample period. All of the results suggest that Social Democrats are the only proponent of comprehensive schooling. Social Democrats are therefore the only political party that has to *act* in order to change the structure of the education system. The CDU, FDP and

Green Party can maintain the status quo. Thus, it is indeed plausible that Social Democrats need time to initiate changes in educational policy while the CDU, FDP and the Green Party pursue more stable educational policies, because in many cases they do not have to modify the education system. Model (2) implies identical information. Here, educational policy by SPD governments in election years can be read from the coefficient of the ELECTION dummy. Note, too, that the results for the control variables are virtually identical to those obtained from the baseline model. Thus, in summary, both models do not support the endogeneity concerns for POLITICAL. However, they can of course not entirely sweep away these concerns.

### 4.4.5 Summary

The presented evidence supports the partisan hypotheses for the CDU and the Green Party and less so for FDP. The charts, correlation coefficients and the econometric evidence based on the within- or between variation of the data suggest that Social Democrats are the strongest proponent of some type of comprehensive education. Given the electoral manifestos of the CDU, it is not too surprising that this party opposes comprehensive education. It is, however, surprising that the Green Party obviously pursues a similar policy – inconsistent with their electoral manifestos, but consistent with the prediction from partisan theory. The results for government participation of the FDP are often not significantly different from zero, which is surprising given that FDP members and FDP constituency hold higher educational degrees on average than CDU members. Thus, overall, the evidence supports partisan theory, but other driving forces may also exist.

Note that the results of this section are quite robust across various types of specifications and ways of exploiting the available information. Moreover, note that the baseline model controls for a considerable degree of unobservable heterogeneity. *First*, the coefficients are net of economy-wide shocks or shifts in education spending, such as may have occurred due to the publication of the PISA results. *Second*, the coefficients are net of Länder-specific, but time-invariant factors, which may influence the structure of the education system, such as Länder-specific preferences for a specific educational structure. *Third*, implicitly, as explained in Section 4.4.3, the baseline model also controls for Länder-specific trends (e.g., Länder-specific trends in preferences for public spending on education, etc.).

## 4.5 Empirical analysis II: political influence on resource allocation across tracks

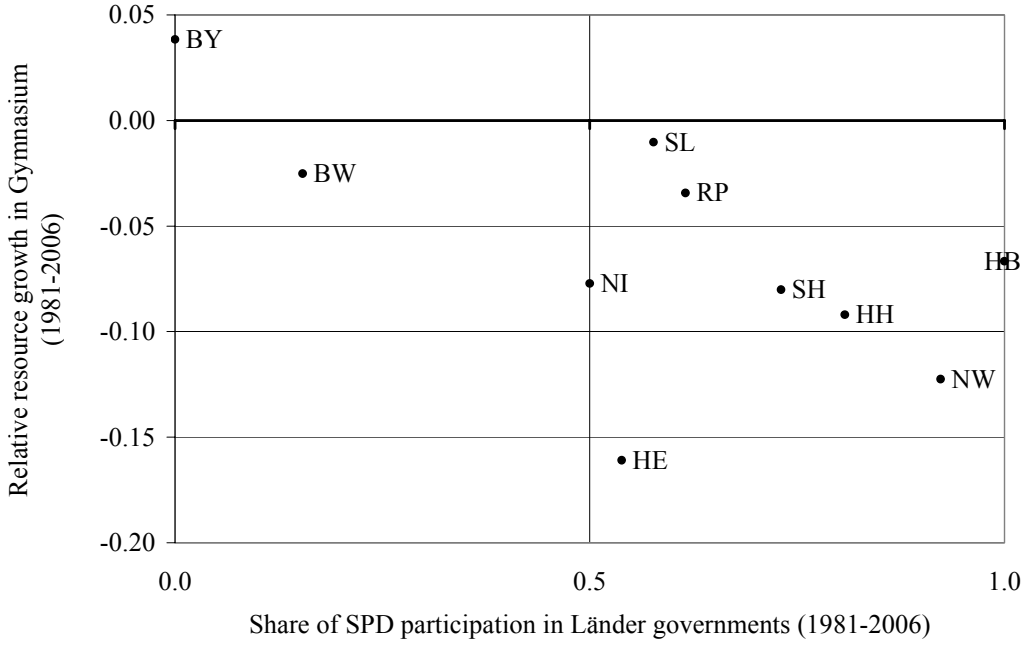
The second part of the empirical analysis provides empirical evidence about the question whether political parties distribute public resources across tracks along the lines predicted by partisan theory (see Table 4.2). Specifically: do the CDU, FDP and the Green Party advocate higher teacher/student-ratios in Gymnasium relative to overall teacher/student-ratios and relative to SPD over the 1981-2006 period in West Germany?

### 4.5.1 Descriptive evidence

*4.5.1.1 Some charts*

As discussed in Section 4.3, the teacher/student-ratio is used as a resource proxy for education spending per student; specifically, to test the partisan hypotheses on resource allocation across tracks, the *relative* teacher/student-ratio in Gymnasium is considered, i.e. $(T/St^{GYM})/(T/St^{TOTAL})$. Alternatively, the hypotheses can be tested for Hauptschulen and joint schooling. Figure 4.3 plots the 1981-2006 change in relative resource endowments, $\Delta^{2006\text{-}1981}((T/St^{GYM})/(T/St^{TOTAL}))$ against the share of years that Social Democrats participate in Länder governments, i.e. $\Sigma SPD/T = \Sigma SPD/26$.

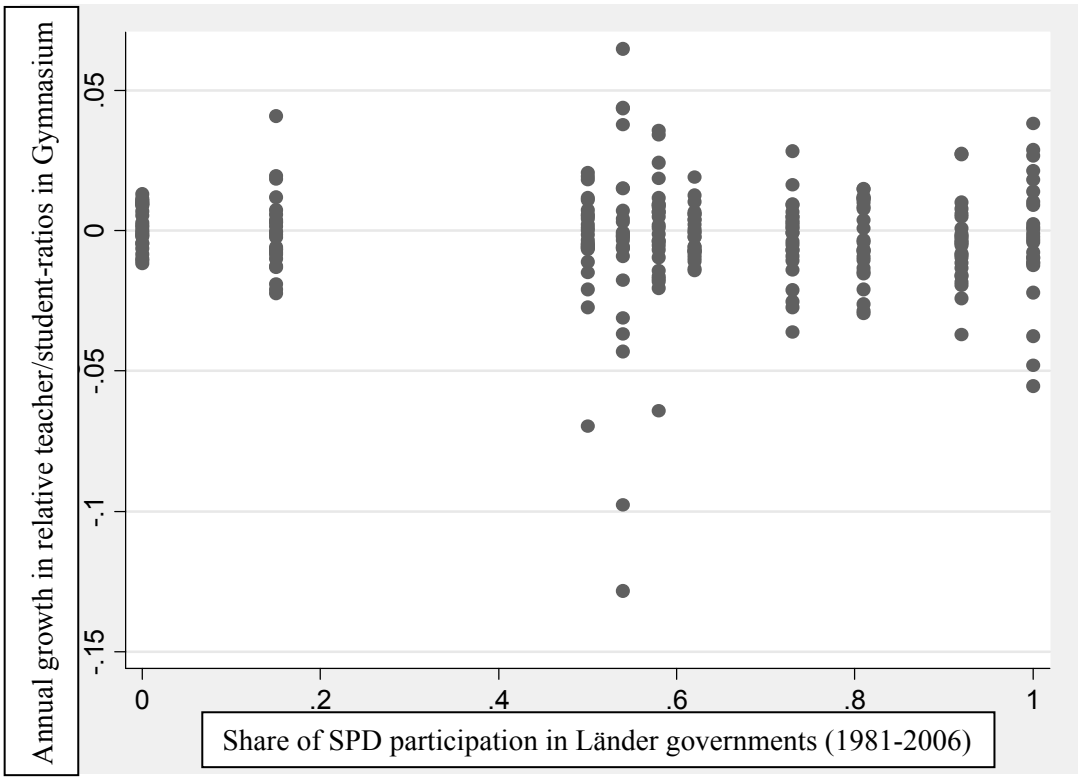
Figure 4.3 The share of Länder government participation by SPD (X-axis) and the change in relative resource endowments in Gymnasium over the 1981-2006 period (Y-axis).




Data source: Standing Conference of German Länder Education Ministers.

Each dot represents one West German Land. There is a weak negative correlation, i.e. Länder with longer SPD-histories tend to have decreased relative resource endowments in Gymnasium relative to the other Länder. This first descriptive evidence is thus in line with the predictions from partisan theory. As a matter of course, Figure 4.3 is based only on 10 observations. Figure 4.4 is based on *annual* changes in relative resource endowments in Gymnasium, $\Delta((T/St^{GYM})/(T/St^{TOTAL}))$, and not on the 1981-2006 change, but has the same X-axis as Figure 4.3. Thus, the Länder appear in the same order as described above. Of course, we observe a similar weak negative correlation of the SPD share in Länder governments with changes in relative resource endowments in Gymnasium. In addition, the variance in the change of relative resource endowments in Gymnasium appears to increase towards the middle of the X-axis, which suggests that in the Länder where different political parties share the responsibility over the 26 years, there is a higher variance in relative resource endowments across tracks.

Figure 4.4 The share of Länder government participation by SPD over the 1981-2006 period (X-axis) and the annual change in relative resource endowments in Gymnasium (Y-axis).

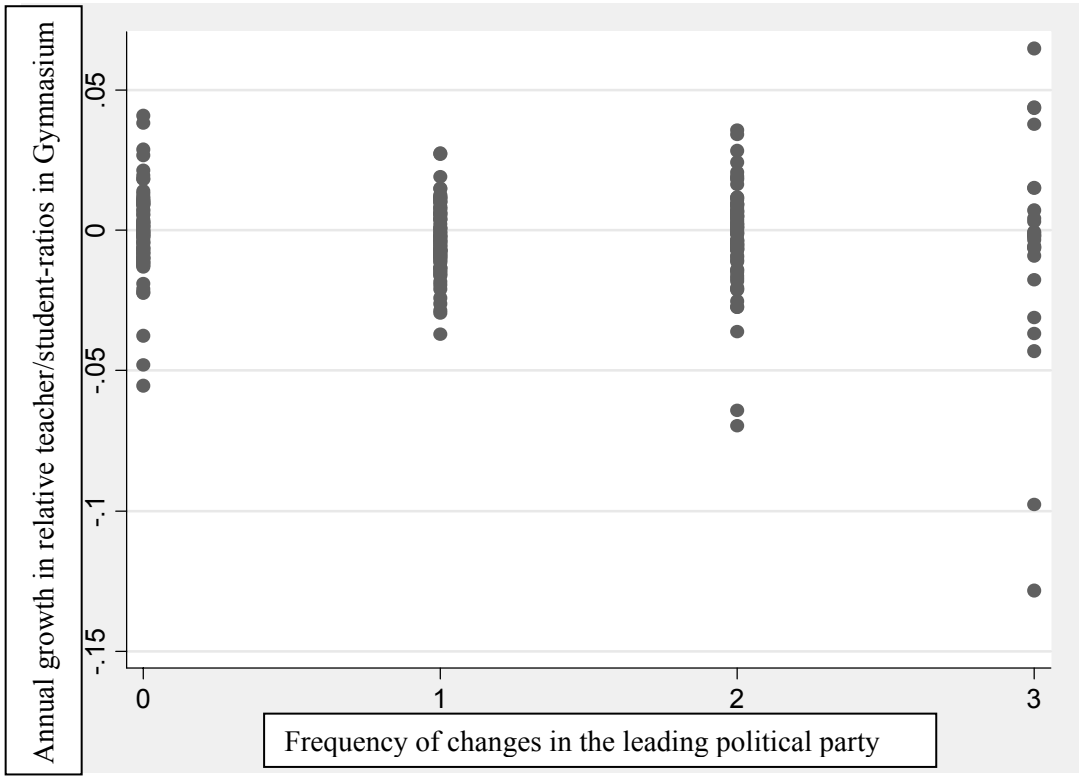



Data source: Standing Conference of German Länder Education Ministers.

Figure 4.5 takes a closer look at the latter evidence by plotting the frequency of government changes against the annual change in relative resource endowments in

Gymnasium. A government change is defined as a change in the leading party, i.e. a change in the political couleur of the Länder prime minister. The presented evidence suggests that the variance of the change in relative resource endowments is considerably higher in swing states, i.e. in the Länder with a higher frequency of changes in governments.

Figure 4.5 The frequency of changes in the leading political party over the 1981-2006 period (X-axis) and the annual change in relative resource endowments in Gymnasium (Y-axis)




Data source: Standing Conference of German Länder Education Ministers.

*4.5.1.2 Some correlations*

Table 4.18 reports simple correlations of the time in office of the political parties with relative resource endowments in Gymnasium, $(T/St^{GYM})/(T/St^{TOTAL})$. SPD and FDP years in office are negatively associated with the relative resource endowments of Gymnasium while CDU's and the Green Party's times in office are positively correlated with relative teacher/student-ratios in Gymnasium. Thus, the correlations are in accordance with the hypotheses derived from partisan theory with the exception of FDP correlations. Note, however, that the correlation coefficients are considerably lower than those reported for the intensity of ability-tracking, and the significance level is below the 5% level for virtually all correlation coefficients (Section 4.4.1).

Table 4.18 Correlations of relative resource allocation in Gymnasium with political parties' years in office (10 West German Länder, 1981-2006)

| | SPD | CDU | FDP | Green | Other |
|---|---|---|---|---|---|
| $(T/St)^{GYM}/(T/St)^{TOTAL}$ | -0.082 | 0.015 | -0.100 | 0.111 | -0.205* |
| $\Delta((T/St)^{GYM}/(T/St)^{TOTAL})$ | -0.033 | 0.001 | -0.070 | 0.085 | -0.016 |

Note: * denotes significance at the 5% level.

### 4.5.2 Stationarity

Similar to Section 4.4.2, stationarity of relative resource endowments in Gymnasium, Hauptschule and joint schools is checked to make sure that the regression coefficients are not spurious. The unit root tests are similar to those described in Section 4.4.2. Tables 4.19(a), 4.19(b) and 4.19(c) present the tests on the relative resource endowments in Gymnasium, Hauptschule and joint schools, respectively. The results suggest quite clearly that the sample of relative teacher/student-ratios in Gymnasium and Hauptschule contain a unit root and have to be considered non-stationary panels. This applies irrespective of whether the tests contain individual linear time trends (Statistic II) or not (Statistic I). The evidence for teacher/student-ratios in joint schools is less conclusive. In particular, if Länder-specific time trends are included (Table 4.19c, Statistic II), the tests assuming individual unit root processes suggest that the panel is stationary while the tests assuming a common unit root process indicate the presence of a unit root.

As in Section 4.4.2 this result may not be entirely intuitive, however, one can argue that the sample period is a period in which enrolment in Gymnasium (Hauptschule) increases (decreases) relative to enrolment in other tracks. If the Länder do not adjust the resources accordingly, this will cause the tests to indicate non-stationarity. The tests which are run on first-differenced data quite clearly indicate that the differenced panels are stationary (see A.4.5.2). Given the result that relative resource endowments in Gymnasium and Hauptschule are nonstationary variables, the following econometric models are based on differenced data.

Table 4.19 Panel unit root tests (10 West German Länder, 1981-2006)

(a) $((T/St)^{GYM}/(T/St)^{TOTAL})$

| Test | Statistic I | p-value | Unit root? | Statistic II | p-value | Unit root? |
|---|---|---|---|---|---|---|
| Levin, Lin and Chu | 0.025 | 0.510 | yes | 0.280 | 0.610 | yes |
| Breitung | - | - | | 2.742 | 0.997 | yes |
| Im, Pesaran and Shin | -0.403 | 0.343 | yes | 0.938 | 0.826 | yes |
| ADF – Fisher | 22.596 | 0.309 | yes | 16.609 | 0.678 | yes |
| PP – Fisher | 17.808 | 0.600 | yes | 15.276 | 0.760 | yes |
| Hadri | 6.612 | 0.000 | yes | 5.325 | 0.000 | yes |

Note: Unit root/No unit root is based on p<0.05. Statistic I includes individual Länder effects; statistic II includes individual Länder effects and individual linear time trends. Tests (1) – (5) are based on the null hypothesis of the existence of a unit root. Test (6) is based on the null hypothesis of no unit root. Tests (1), (2) and (6) assume a common unit root process for all 10 Länder time series; tests (3) – (5) allow for the possibility of individual unit roots in the 10 Länder time series. Lag length is selected based on Schwarz Information Criterion. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

(b) $((T/St)^{HAUPT}/(T/St)^{TOTAL})$

| Test | Statistic I | p-value | Unit root? | Statistic II | p-value | Unit root? |
|---|---|---|---|---|---|---|
| Levin, Lin and Chu | 3.516 | 0.999 | yes | -0.177 | 0.430 | yes |
| Breitung | - | - | | 5.399 | 1.000 | yes |
| Im, Pesaran and Shin | 4.343 | 1.000 | yes | 1.594 | 0.945 | yes |
| ADF – Fisher | 11.435 | 0.934 | yes | 27.689 | 0.117 | yes |
| PP – Fisher | 5.819 | 0.999 | yes | 13.585 | 0.851 | yes |
| Hadri | 8.738 | 0.000 | yes | 5.852 | 0.000 | yes |

Note: Unit root/No unit root is based on p<0.05. Statistic I includes individual Länder effects; statistic II includes individual Länder effects and individual linear time trends. Tests (1) – (5) are based on the null hypothesis of the existence of a unit root. Test (6) is based on the null hypothesis of no unit root. Tests (1), (2) and (6) assume a common unit root process for all 10 Länder time series; tests (3) – (5) allow for the possibility of individual unit roots in the 10 Länder time series. Lag length is selected based on Schwarz Information Criterion. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

(c) $((T/St)^{JOINT}/(T/St)^{TOTAL})$

| Test | Statistic I | p-value | Unit root? | Statistic II | p-value | Unit root? |
|---|---|---|---|---|---|---|
| Levin, Lin and Chu | -1.778 | 0.038 | no | -0.869 | 0.193 | yes |
| Breitung | - | - | | -0.472 | 0.319 | yes |
| Im, Pesaran and Shin | -1.476 | 0.070 | yes | -2.610 | 0.005 | no |
| ADF – Fisher | 34.104 | 0.025 | no | 38.808 | 0.007 | no |
| PP – Fisher | 33.665 | 0.029 | no | 30.478 | 0.063 | no |
| Hadri | 6.769 | 0.000 | yes | 4.779 | 0.000 | yes |

Note: Unit root/No unit root is based on p<0.05. Statistic I includes individual Länder effects; statistic II includes individual Länder effects and individual linear time trends. Tests (1) – (5) are based on the null hypothesis of the existence of a unit root. Test (6) is based on the null hypothesis of no unit root. Tests (1), (2) and (6) assume a common unit root process for all 10 Länder time series; tests (3) – (5) allow for the possibility of individual unit roots in the 10 Länder time series. Lag length is selected based on Schwarz Information Criterion. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

### 4.5.3 Baseline model

We want to provide to provide econometric evidence about whether political parties when in office engage in concentrating public resources on the ability track/tracks, in which their constituencies' offspring is overrepresented. The corresponding econometric approach is quite similar to Section 4.4.3 (where a detailed discussion of the mode can be found). The main difference is in the endogenous variable, which here is the first difference of the teacher/student-ratio in a specific track relative to the teacher/student-ratio in all lower secondary education. For example, the hypothesis on relative resource endowments in Gymnasium is tested using the following:

$$(4.12)\quad \Delta\left[\frac{(T/St)_{it}^{GYM}}{(T/St)_{it}^{TOTAL}}\right] = POLITICAL_{it}'\beta + \eta_i + \theta_t + v_{it}$$

Similar regressions are run for relative resource endowments in Hauptschule and joint schools. The set of exogenous variables is identical with Section 4.4.3. Specifically, the vector POLITICAL is the same vector of political party dummy variables described in Section 4.4.3. Again, Länder-effects $\eta_i$ are included. Here, these effects control for Länder-specific spending preferences or Länder-specific administration of public schools, which can be assumed to stay constant over time. As in the econometric model in Section 4.4.3, these effects are most likely correlated with the political preferences in the Länder, POLITICAL. The $\eta_i$ are therefore treated as fixed. Note that the Länder fixed effects do not become redundant by the first-differencing of the endogenous variable, because the vector POLITICAL is not differenced. Fixed year effects $\theta_t$ control for economy-wide shocks in education spending. Thus, the coefficients are identified from the variation within Länder that is not explained by country-wide shocks. As in Section 4.4.3, standard errors are estimated robust in the presence of serial correlation and heteroskedasticity (Newey and West, 1987).

The results are presented in Table 4.20. Column (1) reports the results for Gymnasium, Column (2) for Hauptschule and Column (3) for joint schools. Note that all coefficients show the predicted signs: relative to SPD governments, Länder governments under participation of the CDU, FDP or the Green Party spend more public resources on Gymnasium and less on Hauptschule and joint schools. However, only some coefficients are significantly different from zero: The Green Party spends significantly

more (less) resources than the Social Democrats on Gymnasium (joint schools) while the CDU spends significantly less on Hauptschulen, which is in line with the partisan hypotheses. The explanatory power of the regressions is considerably lower than in Section 4.4.3 (see $R^2$), suggesting that the resource channel is obviously less important for political influence than the influence working through the design of the education system itself.

Table 4.20 Political parties' influence on resource allocation across tracks (10 West German Länder, 1981-2006)

| | (1) $\Delta(TSt^{GYM}/TSt^{TOTAL})$ | (2) $\Delta(TSt^{HAUPT}/TSt^{TOTAL})$ | (3) $\Delta(TSt^{JOINT}/TSt^{TOTAL})$ |
|---|---|---|---|
| CDU | 0.006 | -0.013 | -0.010 |
| | (0.004)+ | (0.007)* | (0.007) |
| FDP | 0.005 | -0.007 | -0.017 |
| | (0.006) | (0.009) | (0.013) |
| Green Party | 0.019 | -0.011 | -0.033 |
| | (0.007)*** | (0.012) | (0.014)** |
| Other | 0.011 | 0.016 | -0.047 |
| | (0.008)+ | (0.013) | (0.020)** |
| COALSIZE | -0.009 | 0.016 | 0.026 |
| | (0.007)+ | (0.009) | (0.013)** |
| Länder FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 250 | 250 | 250 |
| Adjusted R-squared | 0.07 | 0.07 | 0.05 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

As in Section 4.4.3, the model is augmented with a standard demand model for public education:

$$(4.13)\quad \Delta\left[\frac{(T/St)_{it}^{GYM}}{(T/St)_{it}^{TOTAL}}\right] = POLITICAL_{it}'\beta + \Delta X_{it}' + \eta_i + \theta_t + v_{it}$$

Specifically, Equation (4.13) incorporates $\Delta X_{it}$, the vector of control variables, which is defined similarly as in Section 4.4.3 and which contains $\Delta$ ln(PR), $\Delta$ ln(PD), $\Delta$UR, and $\Delta$o60. Moreover, it incorporates a measure of the relative student demand for a specific track of education. For example, in the case of relative resource endowments in Gymnasium, the change in the number of students in Gymnasium relative to the number

of students in lower secondary education is included, $\Delta(St^{GYM}/St^{TOTAL})$. Table 4.21 presents the results. As in Table 4.20, the models in Columns (1), (2) and (3) differ in the endogenous variables and in the corresponding exogenous student variable.

Table 4.21 Political parties' influence on resource allocation across tracks including control variables (10 West German Länder, 1981-2006)

| | (1) $\Delta(TSt^{GYM}/TSt^{TOTAL})$ | (2) $\Delta(TSt^{HAUPT}/TSt^{TOTAL})$ | (3) $\Delta(TSt^{JOINT}/TSt^{TOTAL})$ |
|---|---|---|---|
| CDU | 0.007 | -0.011 | -0.019 |
| | (0.004)* | (0.008)+ | (0.006)*** |
| FDP | 0.003 | -0.009 | -0.021 |
| | (0.007) | (0.010) | (0.011)* |
| Green Party | 0.016 | -0.011 | -0.037 |
| | (0.007)** | (0.012) | (0.012)*** |
| Other | 0.007 | 0.017 | -0.045 |
| | (0.009) | (0.012)+ | (0.018)** |
| COALSIZE | -0.007 | 0.017 | 0.025 |
| | (0.007) | (0.010)* | (0.011)** |
| $\Delta(St^{GYM}/St^{TOTAL})$ | -0.440 | | |
| | (0.087)*** | | |
| $\Delta(St^{HAUPT}/St^{TOTAL})$ | | -0.330 | |
| | | (0.375) | |
| $\Delta(St^{JOINT}/St^{TOTAL})$ | | | -0.889 |
| | | | (0.055)*** |
| Δ ln (PR) | 0.006 | 0.066 | -0.021 |
| | (0.030) | (0.058) | (0.047) |
| Δ ln (PD) | 0.413 | 0.610 | -0.635 |
| | (0.419) | (0.417)+ | (0.656) |
| Δ UR | 0.349 | -0.405 | 0.334 |
| | (0.267)+ | (0.612) | (0.542) |
| Δ o60 | 2.084 | -1.827 | -2.424 |
| | (1.854) | (2.963) | (2.834) |
| Länder FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 250 | 250 | 250 |
| Adjusted R-squared | 0.11 | 0.07 | 0.29 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

Compared to the model without control variables (Table 4.20), all coefficients keep the signs, in line with the partisan hypotheses. The results suggest that Länder governments under participation of the CDU, FDP or the Green Party increase the growth of the

teacher/student-ratio in Gymnasium relative to other tracks (Column 1) and relative to SPD governments. As predicted, these parties relative to SPD also decrease the growth of relative teacher/student-ratios in Hauptschule or joint schools (Columns 2 and 3). The introduction of the control variables changes the significance level of some coefficients. Table 4.21 suggests that relative to SPD, Länder governments under participation of the CDU and the Green Party significantly decrease relative resource use in joint schools (significant at 1% for both political parties) while they increase relative resource endowments in Gymnasium (significant at 10% for the CDU and at 5% for the Green Party). FDP participation in Länder governments appears to have only a significant effect for relative resource endowments in joint schools.

The magnitude of the parties' effect on the growth of relative resource endowments across tracks is considerable. For example, according to the baseline model with control variables, a shift of government from SPD to CDU increases the growth of teacher/student-ratios in Gymnasium relative to overall teacher/student-ratios by 0.7%, which is about 1/3 standard deviation. Evaluated at the sample mean, this implies a change from -0.3% to +0.4% in the growth of relative teacher/student-ratios in Gymnasium. The effect is even stronger for joint schools. Here, the shift of government from SPD to CDU involves a 1.9% decrease from average -0.3% to -2.2% in the growth rate of relative teacher/student-ratios in joint schools, which is equivalent to about a half standard deviation. The effects estimated for the Green Party are more pronounced than for the CDU. Taken literally, the coefficients suggest that relative to SPD the Green Party decreases (increases) relative resource use in joint schools (Gymnasium) by -3.7% (+1.6%), or about one standard deviation, respectively. In the case of joint schools, this implies that the Green Party decreases relative teacher/student-ratios from an average -0.3% to about -4% in one year, which appears unrealistically high. However, recall that the coefficients have to be interpreted ceteris paribus: in real policy outcomes, coalitions of SPD-Green and SPD-CDU involve important moderating forces. The estimation results also suggest that the frequent coalition constellation CDU-FDP has a strong negative impact on the change in relative resource endowments in joint schools, which will be checked in the next section.

Regarding the control variables, the coefficients estimated for student demand (ranging from -0.3 to -0.9) in Columns (1) to (3) fit into estimates by previous studies (see the

literature survey in Section 3.2.1). The estimated coefficients suggest that there is some sluggishness in the adjustment of resources in a specific track in response to changing student numbers. Larger student cohorts suffer from lower teacher/student-ratios, at least in the short run. The coefficient estimated for the relative number of students is highly significant in Column (3): -0.9, which suggests that rising student numbers in joint schools (Schulen mit mehreren Bildungsgängen, Gesamtschulen and Orientierungsstufe) have not been accompanied by a corresponding increase in total resources. In Gymnasium, the number of teachers has been increased in response to rising enrolment to a higher degree (elasticity of about -0.5). In Hauptschule, the downward trend in relative enrolment has been accompanied by the most pronounced resource adjustment (-0.3 in the point estimate), which is not significantly different from zero. As in Section 4.4.3, the remaining control variables have virtually no influence on the allocation of resources across tracks.

### 4.5.4 Robustness checks

*4.5.4.1 Endogenous student demand*

An immediate concern with the regressions shown in Table 4.21 is that the number of students in an educational track may well be determined by the resource endowments in this track and has therefore to be considered as a potentially endogenous regressor. Since an appropriate instrument is hard to find and since the number of students is not the key exogenous variable in this study, Table 4.20 may already be considered as a first check that the exclusion of the number of students leaves the key results (i.e. POLITICAL) unchanged. The goal of this short section is to provide another robustness check, which is given in Table 4.22. Here, the control variables (vector $\Delta X_{it}$) are included in the regression but relative enrolment in the tracks has been suppressed.

The exclusion of the relative student variable leaves the signs of all coefficients unchanged. However, whereas the significance level of the coefficients estimated for the Green Party are unchanged, the significance of the coefficients estimated for CDU in the regression of Gymnasium and joint schools drops below the 10% level (those effects are significant in Table 4.22 at about 12%, respectively). The reason for the declining significance levels are smaller point estimates. Thus, this robustness check may indicate that the true effects are somewhat smaller than suggested by the baseline model; i.e. the effect of CDU on the share of students enroled in joint schools is 1.1% in

Table 4.22 and not -1.9%. For the case of Hauptschule, the effect estimated for CDU turns significant at about 6% in Table 4.22.

Table 4.22 Political parties' influence on resource allocation across tracks absent student cohort size (10 West German Länder, 1981-2006)

| | (1) $\Delta(TSt^{GYM}/TSt^{TOTAL})$ | (2) $\Delta(TSt^{HAUPT}/TSt^{TOTAL})$ | (3) $\Delta(TSt^{JOINT}/TSt^{TOTAL})$ |
|---|---|---|---|
| CDU | 0.006 | -0.013 | -0.011 |
| | (0.004)+ | (0.007)* | (0.007)+ |
| FDP | 0.006 | -0.011 | -0.019 |
| | (0.006) | (0.010) | (0.013)+ |
| Green Party | 0.021 | -0.015 | -0.035 |
| | (0.007)*** | (0.011)+ | (0.013)*** |
| Other | 0.009 | 0.015 | -0.048 |
| | (0.009) | (0.012) | (0.020)** |
| COALSIZE | -0.011 | 0.019 | 0.029 |
| | (0.006)* | (0.009)** | (0.013)** |
| Δ ln (PR) | 0.006 | 0.074 | -0.021 |
| | (0.030) | (0.058) | (0.061) |
| Δ ln (PD) | 0.342 | 0.657 | -0.505 |
| | (0.413) | (0.419)+ | (0.685) |
| Δ UR | 0.231 | -0.475 | 0.874 |
| | (0.260) | (0.615) | (0.789) |
| Δ o60 | 2.314 | -1.202 | -3.639 |
| | (1.844) | (3.008) | (2.981) |
| Länder FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 250 | 250 | 250 |
| Adjusted R-squared | 0.06 | 0.07 | 0.05 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

*4.5.4.2 An alternative measure for POLITICAL: the coalition pattern*

Here, we want to test whether the main results hold if an alternative definition of POLITICAL is used (as in Section 4.4.4.2), i.e. each coalition combination is modelled using a separate dummy variable. Table 4.23 presents the results. Based on the evidence in the previous section, the student control variable has been suppressed.[60] The results support some of the findings from the baseline model. *First*, the alternative definition of POLITICAL confirms that single-party CDU governments spend significantly more

[60] When the student variable is included, similar results are obtained (see A.4.5.4.2).

(less) public resources per student on Gymnasium (joint schools) than SPD governments. Moreover, although Table 4.23 does not include the student variable, the magnitude of the coefficients is similar to the baseline model, confirming the original effects from Table 4.21.[61] *Second*, Table 4.23 suggests that the Green Party exerts the predicted influence on relative resource endowments in Gymnasium. Green Party coalitions with SPD and with SPD-FDP spend significantly more resources on the highest track. Partisan influence of the Green Party seems, however, somewhat restricted to the Gymnasium; Green Party coalitions do not seem to spend significantly less resources on joint schools or Hauptschulen. This may be one channel through which the moderation of coalition governments works. A second channel is the magnitude of the partisan effect. SPD-Green Party coalitions spend significantly more resources per student on Gymnasium, but this effect amounts only to about 50% of the coefficient estimated for the Green Party in the baseline model. *Third*, as suggested by the baseline model, coalitions with the participation of the FDP pursue an educational policy that is often not significantly different from SPD governments. Specifically, SPD-FDP coalitions and also CDU-FDP coalitions do *not* seem to pursue the predicted partisan policy. The FDP appears to spend significantly more resources on Gymnasium only within the SPD-FDP-Green Party-coalition. *Fourth*, two coalitions in Hamburg, the SPD-Statt (see SPD-Other in Table 4.23) and the CDU-FDP-Schill-Partei (see CDU-FDP-Other in Table 4.23) seem to allocate comparatively many teachers per student to Hauptschulen.

[61] Those magnitudes are also reproduced when the student variable is included (see A.4.5.4.2).

Table 4.23 Political parties' influence on resource allocation across tracks, Coalition patterns (10 West German Länder, 1981-2006)

| | (1) $\Delta(TSt^{GYM}/TSt^{TOTAL})$ | (2) $\Delta(TSt^{HAUPT}/TSt^{TOTAL})$ | (3) $\Delta(TSt^{JOINT}/TSt^{TOTAL})$ |
|---|---|---|---|
| SPD-FDP | 0.001 | 0.009 | -0.013 |
| | (0.005) | (0.010) | (0.011) |
| SPD-Green Party | 0.008 | 0.008 | -0.011 |
| | (0.004)* | (0.010) | (0.007)+ |
| SPD-FDP-Green P. | 0.021 | -0.026 | 0.019 |
| | (0.010)** | (0.017)+ | (0.016) |
| SPD-Other | 0.002 | 0.025 | -0.015 |
| | (0.007) | (0.010)** | (0.020) |
| CDU | 0.010 | -0.014 | -0.021 |
| | (0.005)** | (0.010)+ | (0.008)*** |
| CDU-FDP | -0.001 | -0.002 | -0.002 |
| | (0.006) | (0.008) | (0.011) |
| CDU-FDP-Other | -0.004 | 0.046 | -0.044 |
| | (0.009) | (0.016)*** | (0.012)*** |
| Grand Coalition | -0.003 | 0.002 | 0.019 |
| | (0.006) | (0.008) | (0.011)+ |
| Δ ln (PR) | -0.001 | 0.087 | -0.022 |
| | (0.033) | (0.058)+ | (0.061) |
| Δ ln (PD) | 0.426 | 0.409 | -0.300 |
| | (0.407) | (0.437) | (0.627) |
| Δ UR | 0.231 | -0.497 | 0.918 |
| | (0.261) | (0.618) | (0.786) |
| Δ o60 | 3.060 | -1.424 | -5.795 |
| | (1.913)+ | (3.261) | (3.202)* |
| Länder FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 250 | 250 | 250 |
| Adjusted R-squared | 0.07 | 0.07 | 0.05 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

Generally, the results of the different models are quite stable compared to the baseline model. Table 4.23 confirms that there is virtually no effect from the control variables (PR, UR, PD) on relative resource use in the ability-tracks. Also the variable capturing relative student demand yields similar coefficients as the baseline model (see A.4.5.4.2). The differenced share of the elderly population, Δo60, shows a larger negative coefficient in the model estimated for joint schools compared to the baseline model, which results in a significant effect. However, the elderly share may capture some of the

variation in the (omitted) student variable because this effect disappears when the student variable is included (see A.4.5.4.2).

*4.5.4.3 Another measure for POLITICAL: the Länder education ministers*

As in Section 4.4.4.3, an alternative definition of POLITICAL, which relies on the party membership of the education minister, is tested in this section. For the rest, the models are identical to the baseline model, but suppress the relative student variable for the reasons discussed in Section 4.5.4.1.[62] The results reported in Table 4.24 confirm the findings from the baseline model with respect to the differences between SPD and CDU; in particular, the results suggest that CDU education ministers spend significantly less resources per student on Hauptschulen. The coefficients for relative resource use in Gymnasium and joint schools also accord with the baseline model but are not significantly different from zero.

Table 4.24 Effect of education ministers' party affiliation on resource allocation across tracks (10 West German Länder, 1981-2006)

| | (1) $\Delta(TSt^{GYM}/TSt^{TOTAL})$ | (2) $\Delta(TSt^{HAUPT}/TSt^{TOTAL})$ | (3) $\Delta(TSt^{JOINT}/TSt^{TOTAL})$ |
|---|---|---|---|
| Education Minister CDU | 0.003 | -0.013 | -0.001 |
| | (0.005) | (0.008)* | (0.008) |
| Education Minister FDP | -0.007 | 0.036 | -0.037 |
| | (0.008) | (0.013)*** | (0.011)*** |
| Δ ln (PR) | 0.017 | 0.070 | -0.043 |
| | (0.027) | (0.056) | (0.058) |
| Δ ln (PD) | 0.415 | 0.551 | -0.359 |
| | (0.416) | (0.402)+ | (0.699) |
| Δ UR | 0.234 | -0.420 | 0.820 |
| | (0.262) | (0.619) | (0.800) |
| Δ o60 | 1.898 | -0.346 | -1.870 |
| | (1.809) | (2.789) | (2.860) |
| Länder FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 250 | 250 | 250 |
| Adjusted R-squared | 0.03 | 0.07 | 0.04 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

[62] The model including the student variable is reported in A.4.5.4.3.

The education minister is an FDP member only in a single case (Hamburg, October 2001 through April 2004), which coincides with the CDU-FDP-Other coalition in Hamburg. Thus, it is difficult to identify the source of the educational policy (FDP education minister or CDU-FDP-Other). The FDP education minister in the CDU-FDP-Other coalition apparently distributes resources in accordance with the partisan predictions for CDU and FDP *only* with respect to joint schooling. The effect estimated for relative resource use in Hauptschule is highly significant and positive whereas partisan theory would predict a negative coefficient. The coefficient estimated for relative resource endowments in Gymnasium is – against the prediction from partisan theory – negative, but not significantly different from zero. However, after all, the findings for the FDP education minister in Table 4.24 rely on a single realisation. Note that the explanatory power of the regressions presented in Table 4.24 is somewhat lower than in the models from the previous sections. In particular, the Green Party dummy seems to be an important explanatory variable which is missing here.

*4.5.4.4 Reverse causality: from resource allocation to election outcomes?*

Similar to Section 4.4.4.6, an important objection against a causal interpretation of the coefficients presented to this point is that there may be reverse causality such that election outcomes are determined by relative resource endowments in lower secondary education. Thus, we discuss these concerns and provide some robustness checks.

One may consider the scope of the reverse causality concern to be limited here as well (see Section 4.4.4.6), i.e. public education is not the only issue in Länder election campaigns and only lower secondary education is considered here. Moreover, note that the endogenous variable is *relative* resource endowments in Gymnasium, Hauptschule or joint schools, i.e. a somewhat artificial variable, which is generally not discussed in election campaigns. It is also true that an endogeneity concern of relative resource endowments on contemporaneous election outcomes can *only* apply to election years such that the strategy of disentangling exogenous from potentially endogenous variation in POLITICAL seems a valid approach here as well. The econometric model is therefore re-specified in the spirit of equation (4.11):

$$\Delta \frac{TSt_{it}^{GYMNASIUM}}{TSt_{it}^{TOTAL}} = \left(ELECT_{it} * POLITICAL_{it}\right)' \beta$$

$$+\left(NONELECT_{it} * POLITICAL_{it}\right)' \chi \tag{4.14}$$

$$+\delta Other_{it} + \phi COALSIZE_{it} + \Delta X_{it}' \gamma + \eta_i + \theta_t + v_{it}$$

Equation (4.14) is a variant of Equation (4.13), which distinguishes between POLITICAL in election years (ELECT, potentially endogenous) and non-election years (NONELECT, considered as exogenous). See Sections 4.4.4.6 and 4.5.3 for more detailed discussions of the other features of the model. Table 4.25 presents the results. The potentially endogenous student variable is again suppressed (the results including the student variables are provided in A.4.5.4.4). All coefficients of the interactions of POLITICAL with ELECT and NONELECT must be interpreted relative to SPD in nonelection years. Columns (1) to (3) in Table 4.25 confirm most findings from the baseline model. The effects estimated for the CDU and the Green Party in non-election years (interpreted as exogenous variation in POLITICAL) suggest that Länder governments under participation of the CDU and the Green Party support higher resource use in Gymnasium relative to SPD in non-election years. The magnitude of the CDU*NONELECT and Green Party*NONELECT interactions are very close to what the baseline model suggests. Green Party and FDP government participations appear to decrease relative resource endowments per student in joint schools; again the magnitudes of the coefficients are very similar to the baseline model.

The interactions of POLITICAL with the potentially endogenous election years suggest that the depressing effect of CDU governments on resource endowments in joint schools may indeed be subject to reverse causality, because this effect only shows up in election years (CDU*ELECT). The interactions between Green Party and election years show similar estimates compared to the interactions with non-election years. In summary, the interactions of POLITICAL with the potentially endogenous variation in election years show some differences compared to the estimates that are based on non-election years. Thus, there may be some reverse causality in election years, especially in the effect of the CDU on joint schools. However, the interactions of POLITICAL with the (exogenous) non-election years confirm the robustness of the baseline results (see the limitations in footnote 59).

Table 4.25 Separation of exogenous and potentially endogenous political variation: Political parties' influence on resource allocations across tracks (10 West German Länder, 1981-2006)

| | (1) $\Delta(TSt^{GYM}/TSt^{TOTAL})$ | (2) $\Delta(TSt^{HAUPT}/TSt^{TOTAL})$ | (3) $\Delta(TSt^{JOINT}/TSt^{TOTAL})$ |
|---|---|---|---|
| CDU*NONELECT | 0.008 | -0.013 | -0.010 |
| | (0.004)** | (0.008)+ | (0.007)+ |
| FDP*NONELECT | 0.010 | -0.012 | -0.028 |
| | (0.006)+ | (0.011) | (0.013)** |
| Green P.*NONELECT | 0.020 | -0.014 | -0.038 |
| | (0.007)*** | (0.013) | (0.014)*** |
| SPD*ELECT | 0.003 | 0.000 | -0.007 |
| | (0.005) | (0.006) | (0.010) |
| CDU*ELECT | 0.002 | -0.012 | -0.019 |
| | (0.005) | (0.010) | (0.010)* |
| FDP*ELECT | -0.006 | -0.003 | -0.001 |
| | (0.011) | (0.012) | (0.017) |
| Green P.*ELECT | 0.019 | -0.014 | -0.029 |
| | (0.008)** | (0.012) | (0.016)* |
| Other | 0.008 | 0.016 | -0.050 |
| | (0.009) | (0.013) | (0.021)** |
| COALSIZE | -0.012 | 0.018 | 0.031 |
| | (0.006)* | (0.010)* | (0.012)** |
| Δ ln (PR) | 0.011 | 0.072 | -0.017 |
| | (0.032) | (0.058) | (0.062) |
| Δ ln (PD) | 0.431 | 0.593 | -0.715 |
| | (0.424) | (0.452)+ | (0.739) |
| Δ UR | 0.203 | -0.479 | 0.824 |
| | (0.259) | (0.617) | (0.796) |
| Δ o60 | 2.516 | -1.317 | -4.112 |
| | (1.898)+ | (3.077) | (3.075)+ |
| Länder FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 250 | 250 | 250 |
| Adjusted R-squared | 0.10 | 0.05 | 0.05 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

### 4.5.5 Summary

The data provides some support for the partisan hypotheses described in Section 4.2.2.2. It is a notable result that the signs of the coefficients estimated for the CDU, FDP and the Green Party are in accordance with what partisan theory predicts in virtually every model that has been estimated. The significance levels of the coefficients are, however, somewhat mixed: FDP government participation seems to have only very limited partisan effects on resource allocation across tracks. In particular, there is only evidence for a significant negative effect on the growth of relative resources per student in joint schools. In contrast, there is rather robust evidence suggesting that CDU governments increase relative resource endowments in Gymnasium and decrease relative resource endowments in Hauptschulen. Government participation by the Green Party is found to have significant and positive (negative) effects on the change of relative resources per students in Gymnasium (joint schools).

## 4.6. Conclusions

Ability-tracking is practised throughout the world in varying intensities. The traditional (West) German education system is widely considered to practise comparatively early tracking. Generally, students are grouped according to their ability from the age of 10. Recent empirical evidence suggests that ability-tracking increases educational inequality and – at least some researchers make this point – tracking may also reduce the efficiency of the education system. It is therefore reasonable to explain the practise of ability-tracking with distributional conflicts; in particular, this chapter suggests partisan theory as a political-economic rationale for systems of ability tracking. The partisan hypotheses rely on the observation that in Germany, students' track choices are highly correlated with students' parental background in terms of income, education or social status. Thus, political parties representing high-education households may advocate spending on the higher tracks while politicians representing low-education households may support higher spending on the low-ability tracks. Testable hypotheses are derived for German political parties' educational policy.

Panel data for 10 West German Länder over the 1979-2006 period suggest that German political parties directly influence the education systems along the lines that partisan theory predicts. Social Democrats support comprehensive schools whereas the CDU and the Green Party oppose comprehensive schooling. While the effect estimated for the CDU is not surprising, the effects estimated for the Green Party contradict their electoral manifestos, yet are consistent with partisan theory. The effects estimated for FDP are often not significantly different from zero, which contradicts the partisan hypotheses. When in office the political parties also distribute public resources across tracks in accordance with the predictions from partisan theory. The estimated coefficients suggest that the effects from the political parties are virtually always in the direction predicted by partisan theory, although the estimated confidence intervals are somewhat large in some specifications; in particular the results are more robust for the CDU and the Green Party than for the FDP.

The concern that there is reverse causality from education policy to election outcomes is valid. Some evidence from a separation of the variation between election and non-election years, however, suggests that the main results are robust even if the coefficients

are only identified from non-election years. In non-election years, the political dummies are exogenous from any change in contemporaneous educational policy by definition. It is true that the political dummy variables may still depend on lags of relative resource endowments and that the selection between election and non-election years is not entirely selective. However, the robustness analysis does not provide too much support for this endogeneity concern since – as stated above – the main conclusions are virtually unchanged when the political variation is separated into election and non-election years. Note, moreover, that this concern is directed towards an entire literature, which does not address such objections. The econometric model estimated in this chapter may be considered less vulnerable to endogeneity concerns than comparable approaches that consider partisan effects on inflation, unemployment rates or on (total) public budgets.

After all, to some extent, the results may explain the high persistence of the German system of ability-tracking. The implementation of comprehensive schooling at large scale would imply important redistributions of the benefits from public education and therefore faces resistance from a rather broad alliance of socioeconomic groups ranging from the middle class to the elites. An open question is to which point the empirical analysis can provide support to partisan theory. The findings show that we cannot easily reject partisan theory in the German system of public education. As a matter of course, the results may also accord with other theoretical explanations. For example, the simple ideological differences between the CDU and SPD may have little or nothing to do with partisan theory. The results for the Green Party do, however, suggest that there is no easy explanation along ideological differences. Partisan theory can explain the finding for the Green Party. However, the results for the FDP suggest that partisan theory may not be the only driving force. Given the structure of FDP party members and electoral constituencies, the party's educational policy should be as partisan as the educational policy of the Green Party.

From a welfare view, the cyclical changes in the education system and in education spending across tracks that are associated with the partisan effects may well reduce economic efficiency. In Bremen, the CDU and SPD agreed not to alter the education system (i.e. the number of tracks, etc.) for ten years beginning in 2008. Potentially we can interpret this as a piece of anecdotal evidence that frequent changes in the education institutions are indeed perceived as a problem.

In principle, similar distributional conflicts can exist elsewhere. In some ways partisan cycles may even be more accentuated in nations with majoritarian political systems. However, education systems in the U.S. or elsewhere in Europe are significantly different from Germany in several aspects. For example, where educational finance is local and tracking is less prevalent, the distributional conflicts highlighted in this chapter may be virtually nonexistent. The distributional conflicts, however, may arise along other dimensions. For example, partisan politics may focus on the allocation of public resources across different *levels* of public education. Conflicts may then evolve along the lines sketched by Fernandez and Rogerson (1995) where a partially public education system involves redistributions from low-income individuals to wealthier individuals. Alternatively, conflicts may arise along the spatial distribution of education resources, which is particularly relevant to the U.S. (see e.g., Murray, Evans and Schwab, 1998).

# 5 HIGHER EDUCATION: DETERMINANTS OF GERMAN UNIVERSITIES' COST EFFICIENCY[63]

## 5.1 Introduction

The efficiency of public resource use in higher education receives increasing attention, because the creation of human capital is commonly considered to be a key driver of economic growth. Given that the public sector largely finances higher education in OECD countries (see Chapter 2), today's tight public budgets contribute to the pressure to spend existing financial means efficiently. Therefore, it is useful to identify the environments that contribute to an efficient use of resources.

This chapter focuses on two major factors that may have an effect on the efficiency of spending in public universities: the institutional framework in which universities operate and their regional economic and innovative environments. Evidence reported by Aghion et al. (2008) suggests that university research performance and university efficiency are positively related to the degree of autonomy in the U.S. states. I will look at whether German universities operating in Länder with comparatively liberal legal frameworks are more cost efficient than universities operating under restrictive legal settings. The regional economic and innovative environment of universities may be of importance, too, as suggested by Chaves and Moro (2007). Universities in regions with a significant share of knowledge-intensive production/services may more easily attract private research funding, or conduct productivity-enhancing co-operation with private research units. Thus, the second half of this chapter analyses whether private research activities or a prosperous regional economic environment translates into lower public costs for higher education.

Section 5.2 reviews the extant studies that analyse the determinants of university efficiency. Hypotheses are derived for the link between institutional settings and university efficiency and for the relationship between the regional economic environment of universities and university costs. Section 5.3 reports summary statistics

[63] The analysis concerning the link between university efficiency and Länder university regulation (Hypothesis 1 in Section 5.2 as well as Section 5.4.1) is an extension of Kempkes and Pohl (2008) that additionally controls for universities' history.

while Section 5.4 describes the econometric models and discusses the results. Evidence from a sample of 67 German universities over the 1998-2003 period supports the result by Aghion et al. (2008) for the German Länder, suggesting that liberal university regulation indeed contributes to more efficient use of resources. Furthermore, evidence from 70 German universities over the 1998-2003 period indicates that high regional GDP per capita reduces university costs. Costs in public universities are also negatively correlated with regional patenting activity, but reverse causality cannot be ruled out.

## 5.2 Background: literature review and hypotheses on the determinants of university cost efficiency

The majority of studies analysing university efficiency focus on the measurement of cost efficiency across universities. Recently, however, the literature has begun to investigate the factors contributing to efficient resource use. The following literature review discusses such studies.

Worthington (2001) provides an overview of early studies investigating the determinants of university efficiency. Not surprisingly, *parental socioeconomic background* of a university's student body is found to have a large effect on educational outcomes and on university efficiency. For example, students with highly educated parents may complete their degrees more rapidly. The share of foreign students does not seem to have an effect on university efficiency in English and Welsh universities (Stevens, 2005), but Doucouliagos and Abbott (2007) do find a positive effect on university cost efficiency for Australian universities. They interpret this finding as an effect from strong competition for overseas students among Australian universities (foreign students pay comparatively high fees).[64]

Stevens (2005), who analyses the effects from characteristics of *university staff* on efficiency, finds that the proportion that is non-white, research-active or with professorial (or advanced lecturer) status exerts a positive effect on university efficiency. Conversely, Doucouliagos and Abbott (2007) present evidence for Australian universities which suggests that a higher proportion of senior academic staff has a negative effect on university efficiency. Their analysis also shows a positive effect on efficiency when a higher share of senior administrative staff is employed.

These results should be interpreted with caution, because there may be reverse causality. Take, for example, the share of academic staff that is research active. It would appear reasonable to assume that there is a positive effect on efficiency, because more publications directly increase university outputs, thereby improving efficiency (given

[64] This result does not easily generalise to the German higher education system because a differentiation of fees according to student nationality is not in effect and is not publicly discussed. However, there may be an effect via student exchange programs. Universities could be interested in attracting foreign students, given that more of their own students in turn are admitted to foreign universities.

that research-active staff may be paid similar wages, or that some of the literature measures university inputs by the number of employees without considering wages). On the other hand, more efficient universities may simply choose to employ a higher share of research-active staff, or – alternatively – efficient universities may be more attractive for research-active staff. Thus, one may prefer interpreting these results in terms of correlations.

With respect to *institutional settings*, Aghion et al. (2007 and 2008) and Aghion (2007) report evidence on the link between university autonomy and the efficiency of spending. To capture university autonomy, they construct an index containing information on whether universities can set their own wages and tuition fees, receive lump-sum transfers (contrary to line-item budgeting) and hire their staff autonomously, etc. (see Aghion et al., 2007, 7, Box 2). They find for the U.S. state level that university autonomy is associated with better research performance and more efficient use of funds. Based on these findings, the authors recommend increasing the level of university autonomy in Europe (e.g., develop strategic profiles, select students, determine fee levels, hire staff, determine wages, etc.). Compared to U.S. universities and other European countries, German universities are found to have virtually no wage-setting and budget autonomy, whereas hiring autonomy is quite high (as of 2008, see Aghion et al., 2008, 36; see also footnote 65).

German universities operate within a common institutional framework set by the federal government (Framework Act for Higher Education, "Hochschulrahmengesetz"). However, higher education is a major responsibility of the German Länder which can set the universities' legal framework in detail. In particular, the federal government passed the Framework Act's fourth amendment in 1998, which gives the German Länder more freedom to deregulate university legislation (Stifterverband für die Deutsche Wissenschaft, 2002).[65]

[65] There have been more reforms of the Framework Act for Higher Education following the fourth amendment. In particular, an assistant professor status ("Juniorprofessor") was introduced in 2002 but declared unconstitutional by the Federal Constitutional Court. In connection with the German Federalism Reform (Committee on the Modernisation of Federation-Länder Financial Relations) university regulation continues to be on the reform agenda. From 2007, issues concerning public services law are an exclusive competency of the German Länder. Moreover, the German Bundestag is currently planning to abolish federal framework legislation (Deutscher Bundestag, 2007 and Federal Ministry of Education and Research, 2008).

Thus, in my sample period (1998-2003), Länder governments already have the right to determine a number of issues, such as the allocation of university funds (if universities are allowed to carry over year-end balances, whether they receive lump-sum vs. line-item budgets, and the like), hiring autonomy (whether universities must consult Länder governments before hiring professors), power of decision of university management as opposed to Länder intervention, and universities' autonomy to implement new degree programmes (see Stifterverband für die Deutsche Wissenschaft, 2002). The variation across the Länder makes it possible to link differences in university efficiency to differences in Länder legal frameworks.

The evaluation of Länder regulatory frameworks is, of course, a complex legal exercise beyond the scope of this dissertation. Thus, we make use of a study initiated by an influential think tank in the university landscape, the "Stifterverband für die Deutsche Wissenschaft". In 2000, the Stifterverband created commission of experts to assess the university regulation laws enacted by the Länder after 1998. The assessment was realised with the explicit goal to evaluate the level of autonomy granted to the universities by their respective Länder governments. Several major characteristics of the regulatory frameworks were identified, e.g., legal structure of the university, Länder-university cooperation, budget affairs, labour relations, management, foundation of new universities, establishment of new degree programmes, teaching evaluation, and research. The results are summarised by a classification of Länder university regulations reproduced in Table 5.1.

Table 5.1 Classification of Länder higher education laws by Stifterverband für die Deutsche Wissenschaft

| | |
|---|---|
| "best-law-group" | Baden-Wuerttemberg |
| | Bremen |
| | Hamburg |
| | Hesse |
| | Lower Saxony |
| intermediate group | Bavaria |
| | Brandenburg |
| | Mecklenburg-Vorpomerania |
| | North Rhine Westphalia |
| | Saxony |
| „worst-law-group" | Rhineland-Palatinate |
| | Saarland |
| | Saxony-Anhalt |
| | Schleswig-Holstein |
| | Thuringia |

Source: Stifterverband für die Deutsche Wissenschaft (2002, 28)

The classification divides 15 German Länder into three groups (Berlin is omitted, because its new university regulation had not been completed by 2002). The three classifications shown in Table 5.1 are based on the degree of self-governance and autonomy that is granted by the Länder to "their" universities. In particular, Länder university regulations that are classified as "best-law" are considered to be relatively liberal, thereby contributing to a comparatively high degree of university autonomy. Thus, the classification by Stifterverband für die Deutsche Wissenschaft (2002) provides an indicator for the degree of autonomy under which German universities operate since 1998. In conclusion, given the evidence by Aghion et al. (2007 and 2008) which suggests a beneficial effect from autonomy on university efficiency, I use the classifications shown in Table 5.1 to develop the following hypothesis:

*Hypothesis 1: Universities located in Länder that allow universities more autonomy are more cost efficient than universities operating under a more restrictive regulatory framework.*

Kuo and Ho (2008) investigate the impact of the University Operation Fund (UOF), a reform in 1996 that was intended to improve cost efficiency of Taiwanese public universities. Comparing university efficiency before and after the UOF they conclude that the reform had a negative effect on efficiency.

Given that one prominent category in German Länder higher education regulation is budget autonomy (see Aghion et al., 2007 and 2008; Stifterverband für die Deutsche Wissenschaft, 2002), it appears quite promising to analyse the effects of reforms to funding mechanisms, which have been implemented by some Länder towards the end of the sample period (2003). The goal of these reforms was to some extent to increase budget autonomy for the universities. In principle, one could use a similar setup as presented by Kuo and Ho (2008). However, as pointed out by Orr, Jaeger and Schwarzenberger (2007), "*in many cases, performance-based funding only determines a marginal part of total budget allocations and discretionary, incremental funding dominates*". The effects of these funding reforms cannot be analysed, because implementation started only near the end of my sample period. In addition, the reforms are often relevant only for a very small portion of university budgets.

With regard to the *interaction between universities and their environment* there is substantial literature on spill-over effects of higher education institutions on their regional environment (see e.g., Batria and Licht, 2004; Audretsch, Lehmann and Warning, 2005 or Fritsch and Slavtchev, 2007 for evidence from Germany; Abramovsky, Harrison and Simpson, 2007 for evidence from the UK).[66] These studies show that the presence of universities in a region has a positive impact on the location decisions of private firms, especially private research laboratories and innovations. The evidence presented in Audretsch, Lehmann and Warning (2005) and Fritsch and Slavtchev (2007) suggests that the relationship is dependent on whether or not the university research fields match the innovative activity of private firms. Abramovsky, Harrison and Simpson (2007) indicate that the link between university research and private research investments appears to be particularly strong in pharmaceuticals and chemistry. They also find that for some disciplines it appears highly relevant for the location decision of private research laboratories that the relevant university departments produce high-quality research, while for other disciplines the presence of *any* university research departments seems to be sufficient. There is not much evidence on the underlying economic mechanisms, but Abramovsky, Harrison and Simpson (2007) suggest that the availability of trained students, informal networks, formal collaborations and university spin-outs, science parks, etc. may have significant effects in the transmission of spill-over effects.

[66] In some sense, this literature is related to empirical work analysing the relationship between public capital and private production (see e.g. Seitz, 1995).

However, the spill-over effects are not necessarily unilateral. Chaves and Moro (2007) study the interaction between universities and companies located in the same area. They show that (1) research output of universities is beneficial for private firms, and also that (2) institutions of higher education benefit from innovative companies located in the same region. The reason for this mutual dependence seems to be that firms use basic research results from universities to develop products for the market. Universities, in turn, need to know in which direction basic research should proceed, and private firms' patents may represent an important indicator for their future research activities. Moreover, Kempkes and Pohl (2009) find that universities in wealthier regions are more efficient, likely due to a more favourable infrastructure (e.g., local research institutes, libraries, public transportation, cultural activities, etc.) and a high concentration of the types of private businesses that facilitate the acquisition of third-party funds. Again, I caution that causal effects run in both directions, i.e. from a high GDP per capita towards efficient universities and vice versa.

In conclusion, there is considerable empirical support for a positive correlation of the presence of universities with (1) the location decision of private research activity, and (2) a strong regional economic background. The exact relationship and the direction of causality is, however, still quite unclear (theoretically as well as empirically). In particular, a strong innovative capacity of a region may foster university research and cost efficiency. It may, however, also be true that highly innovative and efficient universities attract private research activity, thereby improving the regional economic situation. Possibly there is indeed a *mutual* benefit by universities and their environment. Thus, the empirical results of such studies may be more adequately interpreted as correlations than in terms of causality (including some of the analyses in this chapter).

From an empirical point of view, I suggest it is proper to consider regional GDP per capita as a proxy for the regional economic background, and for private research activity, the absolute number of patents issued in a region (not normalised by regional population), because in research activity, the sheer size of the regional research sector may be more important than research density. This leads to my second hypothesis:

*Hypothesis 2: The presence of universities positively correlates with GDP per capita and with private patenting activity (outside universities). There may be beneficial effects from regional GDP per capita and patenting activity on university efficiency/costs. But theoretical and empirical research provides support for causal effects in both directions.*

## 5.3 Data and summary statistics

The data set comprises 70 public German universities (higher education, type A, "Universitäten"). Universities of the armed forces, specialised universities and private universities are not included in the sample because these institutes have often different tasks and structures, which make a comparison quite difficult. Universities of applied sciences are not included in the sample because it is not possible to include a control for the quality of university outputs. Thus, a sample, which is restricted to the traditional German universities is preferred to have one common standard for graduating students, which is the degree awarded by traditional universities. As far as the classification of Länder university regulation is concerned (Stifterverband für die Deutsche Wissenschaft, 2002, see above), three Berlin universities have to be excluded from the sample because Berlin university regulation is not classified by Stifterverband für die Deutsche Wissenschaft (2002). Thus, for the econometric study presented in Section 5.4.1, the sample contains 67 German public universities. For 2003, the 67 universities represent about 2/3 of all students in higher education (type A plus type B: including universities of applied sciences, art colleges, conservatoires and theological universities) and about 90% of the students enroled in German "Universitäten". The sample period is 1998-2003. Due to the modification of definitions (e.g., "Gesundheitswissenschaften" was counted as medicine starting in 2004) it is not possible to include pre-1998 and post-2003 years in the sample. The sample size contains therefore 420 (70x6) or 402 (67x6) observations.

The data set is collected from various sources. *First*, data on university costs, outputs and the number of students (total and according to subject) is from the Federal Statistical Office of Germany. Information on regional GDP per capita is from INKAR-CD, which is edited by the Federal Office for Building and Regional Planning. The number of patents is from the German Patent and Trade Mark Office. Note that regional GDP per capita and patenting activity is reported at the level of "Raumordnungsregionen", which are almost equivalent to the NUTS-3 regions, but typically consolidate larger cities ("kreisfreie Städte") and surrounding counties ("Landkreise"). The classification of Länder university regulation is from Stifterverband für die Deutsche Wissenschaft (2002) and universities' years of foundation are taken from the institutions' web pages. Costs and wages (GDP per capita) are deflated using

the government consumption deflator (GDP deflator) from the 2006 Annual Report of the German Council of Economic Experts.

Table 5.2 Summary statistics (70 German universities, 1998-2003)

| Variable | Mean | S.d. | Min | Max |
|---|---|---|---|---|
| (a) University costs and outputs | | | | |
| Costs/Students (C) | 14 275 | 10 350 | 1 339 | 103 776 |
| Third-party funds/Students (TPF) | 2 277 | 1 626 | 95 | 11 799 |
| Graduates/Students (GRA) | 0.092 | 0.026 | 0.019 | 0.185 |
| Wage (w) | 35 311 | 3 974 | 16 277 | 55 804 |
| (b) University faculty structure | | | | |
| Share of students in… | | | | |
| …social sciences (SOC) | 0.574 | 0.219 | 0.000 | 1.000 |
| …medicine (MED) | 0.076 | 0.092 | 0.000 | 0.510 |
| …sciences (SCI) | 0.214 | 0.086 | 0.000 | 0.480 |
| …engineering (ENG) | 0.136 | 0.199 | 0.000 | 0.830 |
| (c) Environmental variables | | | | |
| Regional GDP per capita at the level of Raumordnungsregionen | 24 710 | 6 517 | 14 153 | 44 462 |
| Total number of patents in a region | 525 | 706 | 10 | 3716 |
| Number of patents in a region in | | | | |
| …electricals | 172 | 298 | 2 | 2115 |
| …nuclear physics | 1 | 3 | 0 | 29 |
| …engineering | 238 | 378 | 0 | 2449 |
| …chemicals | 76 | 117 | 0 | 726 |
| …household goods | 22 | 25 | 0 | 125 |
| …nutrition | 6 | 8 | 0 | 44 |
| …mining | 7 | 10 | 0 | 50 |
| …munitions | 2 | 4 | 0 | 39 |
| EAST (Yes = 1, No = 0) | 0.214 | 0.411 | 0.000 | 1.000 |
| FOUND, University founded after WWII? (Yes = 1, No= 0) | 0.457 | 0.499 | 0.000 | 1.000 |
| BESTLAW (Yes = 1, No = 0) | 0.388 | 0.488 | 0.000 | 1.000 |
| MEDLAW (Yes = 1, No = 0) | 0.448 | 0.498 | 0.000 | 1.000 |
| WORSTLAW (Yes = 1, No = 0) | 0.164 | 0.371 | 0.000 | 1.000 |

Note: Monetary variables are reported in 2000 Euros, with deflation across years using the deflator for government consumption/GDP deflator taken from the 2006 Report of the German Council of Economic Experts. Costs are total costs net of third-party funds.

Table 5.2 reports summary statistics. There is a wide range in (annual) costs per student (103.000 Euros vs. 1.300 Euros). This is due to the fact that the structure of universities in the sample is still quite heterogeneous. For example, the university in the sample with highest (lowest) costs per student is a university with a very high share of students enroled in medical/veterinary studies (distance-learning-university). Of course, it would make more sense to calculate costs per student at the level of faculties or departments. Recall, however, that this analysis relies on *universities* as observations and not faculties or departments. Wages are calculated dividing personnel expenditures by total

employees (headcount not full time equivalents). This definition yields only a rough proxy of wages, but is common practise in the empirical analysis of university costs/efficiency (see e.g., Stevens, 2005). The wage proxy suggests an average wage for university employees of 35.000 Euros for the sample period, which is a reasonable proxy. About 60% of students study social science careers (SOC, including economics, languages, legal studies, etc.), about 15% are in engineering (ENG), about 20% of students are in science careers (SCI) and about 10% are in medicine or veterinary studies (MED). FOUND is a dummy variable, which takes the value of 1 if a university is founded after WWII, which is true for about half of the sample. The share of universities located in Länder with university regulations classified as BESTLAW (WORSTLAW) is about 40% (15%). Around 45% of the universities are located in Länder with "intermediate" university regulation (MEDLAW).

EAST is a dummy variable that takes the value of 1 if a university is located in the East German Länder, zero otherwise. Patents are counted as the raw number of patents. Note that only patents *outside* the university are counted. This is due to the goal of the study, which aims at analysing the link between university research and research activity outside universities. Patents are highly concentrated across NUTS-3 regions and also across disciplines. While the lion's share of patents is issued in engineering and electricals, patenting activity is quite rare in disciplines such as nuclear physics or nutrition. GDP per capita is about 24.000 Euros on average with considerable variation across the regions.

## 5.4 Empirical analysis

Section 5.4.1 analyses the effect from Länder regulatory frameworks on university cost efficiency (Hypothesis 1) under the plausible assumption that Länder university regulations are exogenous from university costs and outputs. A university cost function is specified as a stochastic frontier model, which permits simultaneous estimation of university cost efficiency and the effects from university regulation on efficiency. Section 5.4.2 tests the effects from regional GDP per capita and from regional patenting activity outside universities on university costs (Hypothesis 2). As discussed in Section 5.2 we must consider that both regional GDP per capita and regional patenting activity may be endogenous with respect to university costs and outputs. Thus, the analysis in Section 5.4.2 is restricted to the estimation of a standard cost function (no stochastic frontier), which permits the use of instrumental variable techniques.

### 5.4.1 University efficiency and Länder regulatory frameworks

*5.4.1.1 Descriptive evidence*

Table 5.3 reports correlation coefficients of university costs and outputs with the faculty structure of universities (see Panel a), and with the classification of Länder university regulation as published by Stifterverband für die Deutsche Wissenschaft (2002) (see Panel b). It is not surprising that the share of students enroled in medical studies is highly positively correlated with costs per student. The same holds for the share of students in science careers whereas a high share of students in social sciences is negatively correlated with costs per student. The acquisition of third-party funds is positively linked to the share of students in medicine, engineering and science careers whereas the share of students in social sciences is strongly negatively correlated with third-party funds per student. Differences in the correlations of graduates per student, i.e. the "processing time" for the teaching output, with faculty structure are less pronounced.

Table 5.3 Correlation coefficients of university cost and outputs with university faculty structure and Länder university regulation (70 German universities, 1998-2003)

| | Costs/Student (C) | Third-party funds /Student (TPF) | Graduates/Student (GRA) |
|---|---|---|---|
| (a) University faculty structure | | | |
| % of students in… | | | |
| …social sciences (SOC) | -0.3727* | -0.7312* | 0.0218 |
| …medicine (MED) | 0.8096* | 0.3765* | 0.1809* |
| …sciences (SCI) | 0.3862* | 0.5575* | -0.004 |
| …engineering (ENG) | -0.1278* | 0.3914* | -0.1058* |
| (b) Länder university regulation | | | |
| BESTLAW | 0.0511 | 0.1837* | 0.1990* |
| MEDLAW | -0.1264* | -0.1114* | -0.2026* |
| WORSTLAW | 0.1024* | -0.0921 | 0.0102 |
| EAST | 0.1586* | 0.0123 | -0.3264* |
| FOUND | -0.3353* | -0.3614* | -0.0169 |

Note: * denotes significance at the 5% level.

Table 5.3, Panel (b) shows that Länder university regulations which are classified as comparatively liberal (BESTLAW) are associated with universities that produce comparatively more output per student (third-party funds and graduates). At the same time, these universities are virtually uncorrelated with costs per student. By contrast, universities operating under comparatively strict university regulation (WORSTLAW) are positively correlated with costs per student and weakly negatively correlated with third-party funds per student (and not correlated at all with graduates per student). Länder university regulations that have been classified as medium-liberal (MEDLAW) are associated both with lower costs and less output per student. The correlations thus suggest some support for the U.S.-based findings by Aghion et al. (2007). Universities located in BESTLAW Länder appear to produce a relatively high quantity of outputs per student with average costs per student.

The correlations confirm Warning (2005) who finds that the East German universities (EAST) are somewhat less efficient than those in the West German Länder. Moreover, Panel (b) of Table 5.3 shows that universities founded after WWII (FOUND) are negatively correlated both with costs and third-party funds per student. To ensure that effects from university regulation are not confounded with East/West differences or with university history, these variables appear in the econometric study described next.

*5.4.1.2 Evidence from a stochastic frontier*

First, we test Hypothesis 1 via estimating the effect from the degree of autonomy permitted by Länder university regulation on university cost efficiency. The empirical approach presented here is an econometric perspective to efficiency analysis (in contrast to non-parametric efficiency analysis, see e.g., Warning, 2004). Following the usual procedure in the literature, we specify a cost function for universities, which is estimated using a stochastic frontier model (Battese and Coelli, 1995). [67] This model allows estimating university cost efficiency and the influence of environmental variables on university efficiency in a simultaneous estimation procedure. For a more detailed discussion of various methodological approaches to the estimation of the influence of environmental variables on university efficiency see the extensive overview in Kumbhakar and Lovell (2000).

Since there is little empirical evidence on the specific functional form of university cost functions, a flexible functional form, a translog function which takes the following form is used:

$$(5.1)\quad \ln C_{it} = \alpha + \theta t + \sum_{j=1}^{2}\beta_j \ln Q_{jit} + \frac{1}{2}\sum_{j=1}^{2}\sum_{k=1}^{2}\beta_{jk}(\ln Q_{jit} \ln Q_{kit}) + \kappa_1 \ln w_{it} + \kappa_2 \frac{1}{2}(\ln w_{it})^2 + \sum_{j=1}^{2}\kappa_{3j}(\ln w_{it} \ln Q_{jit}) + \sum_{m=1}^{3}\delta_{1m}(FACULTY_{mit}) + u_{it} + v_{it}$$

The cost variable C denotes total university costs minus third-party funds. [68] Thus, it represents *public* costs. As described in Section 5.3, the cost-variable is normalised by the number of students (not graduates) because we do not focus on questions of size or scale economies. Index i represents the 67 public universities in the sample (excluding Berlin) and t denotes the years 1998-2003. α is a constant and t is a linear time trend, which is intended to capture (smooth) technological change over the sample period, as it is standard in the literature. We assume that universities produce j = 2 outputs ($Q_{jit}$),

[67] The cost function approach has become quite popular in empirical analyses of universities (see e.g. Cohn, Rhine and Santos, 1989; de Groot, McMahon and Volkwein, 1991; Glass, McKillop and Hyndman, 1995). The main advantage is that it permits incorporating multiple outputs, which is of particular importance in higher education (research and teaching).

[68] Note that total costs do not include capital expenditures and pension payments for civil servants. Pension payments for civil servants are reported in "Allgemeine Finanzwirtschaft", which is a general function for all public servants irrespective of the function in which they were employed. Thus, it is impossible to determine the pension payments for university employees.

teaching and research. The proxy for the research output is third-party funds and the proxy for the teaching output is the number of graduating students, both also normalised with the number of students, analogous to the cost variable. Given the period (up to 2003), graduating students mainly earn Diplom degrees. There are also some Bachelor and Master degrees, but they are of marginal importance: ~ 1.5%.[69]

Note that two major difficulties with the selection of outputs require a highly cautious interpretation of the results below. *First*, third-party funds that capture a specific type of research skew the research output to science, engineering and medicine research; the analysis would considerably improve by including a second proxy for research outputs, e.g., publications or citations. *Second*, different qualities in the production of research and teaching across the German universities are not considered; including an indicator of the quality of research and teaching would be important, but such data is unavailable at the university level.

Wages are denoted by w. FACULTY is the control for the faculty structure of the university as introduced in Table 5.2, Panel (b). Recall that it consists of m=3 faculty groups, which represent the share of students enroled in

- medical, veterinary and agrarian careers (MED)
- science careers (SCI)
- engineering studies (ENG)

where the share of students in social sciences and languages is the reference share (SOC). Controlling for the faculty structure of universities is important, because the different disciplines have widely varying cost levels.

The residual of the model consists of two error terms. $v_{it}$ denotes an i.i.d. $N(0, \sigma^2_v)$ error term, which is also independent from the $u_{it}$, a non-negative error term that is assumed to capture cost inefficiency in the production of teaching and research (allocative inefficiency plus technical inefficiency). It is assumed to be independently distributed and to follow a truncated normal distribution $N(\mu_{it}, \sigma^2_u)$. The mean $\mu_{it}$ of this error component is assumed to be determined by environmental variables ($Z_{it}$) (see Battese

[69] It is a rather disputed issue in the efficiency analysis of universities whether third-party funds may be viewed as inputs in the production of teaching and research or whether they are more adequately considered a research output (see the overview in Worthington, 2001). I argue that one may interpret third-party funds as a revenue source, which is earned on the market for externally funded research. Universities compete for projects and can charge a price for their research, which makes acquired third-party funds an adequate proxy for the quality (the price the university can charge for its projects) and the quantity (the amount or size of projects) of research activities.

and Coelli, 1995). The effect of Länder university regulation on university efficiency $u_{it}$ is modelled by introducing the classification of Länder university regulation as Z-variables:

$$(5.2) \quad \mu_{it} = \delta_0 + \delta_1 \text{BESTLAW}_{it} + \delta_2 \text{WORSTLAW}_{it} + \delta_3 \text{EAST}_{it} + \delta_4 \text{FOUND}_{it}$$

BESTLAW and WORSTLAW are dummy variables capturing the classification of Länder regulatory frameworks by Stifterverband für die Deutsche Wissenschaft (see Section 5.3). Note that the universities in Länder with medium-ranked university regulation are the reference group. EAST controls for East German universities, which is important given the evidence presented in Warning (2005). The error specification in Equation (5.2) additionally controls whether a university is founded before/after WWII (FOUND). Some universities in Germany were created in medieval age facing a long tradition whereas other universities have been established in the aftermath of World War II. The additional control is introduced to make sure that the Länder classification by Stifterverband für die Deutsche Wissenschaft (2002) does not merely capture differences between young and old universities (e.g., universities in Baden-Württemberg are "older" than universities in North-Rhine Westphalia on average).[70]

The difference of the stochastic frontier approach compared to a standard econometric framework is that the estimated cost function describes the *cost frontier*, i.e. minimum costs of universities (and not averages), which allows us to estimate the efficiency of individual universities' resource use. Universities typically operate with costs *above* the estimated cost function, which is captured by the (positive) $u_{it}$. Due to the rather complex stochastic frontier specification of the error term, econometric research has not yet provided techniques to estimate robust standard errors in the simultaneous estimation of Equations (5.1) and (5.2), which suggests a cautious interpretation of the coefficients estimated for the *cost function itself*. The reason is that the stochastic frontiers focus on the measurement of inefficiency (one component of the error term), not on the estimation of the cost function coefficients.

[70] One may also include *student cohort size* of the region or Land surrounding the university in the cost function (the majority of students in German universities are natives of the Land where the university is located). If resource adjustment in response to student cohort size is sluggish (see the discussion in Chapter 3), a smaller cohort size will be associated with lower efficiency and larger cohorts will be associated with higher efficiency. However, note that this phenomenon is inherently based on the time-series variation and my analysis in Chapter 5 relies predominantly on the variation across universities.

Given that university budgets are still mainly allocated as a function of the prior year's budget (see Orr, Jaeger and Schwarzenberger, 2007) we may conclude that the true model is a dynamic cost function, which would require including a lagged cost variable in the set of exogenous variables. However, this is likely to create major econometric problems, because the institutional variables used to explain the variation in the inefficiency error term $u_{it}$ are dummy variables (BESTLAW, WORSTLAW, EAST, FOUND). In this case, the lagged cost variable would be correlated with the invariant part of the error term, which would introduce a source of endogeneity to the set of regressors. Thus, a static model is preferred for this study.

Table 5.4 presents the results from the simultaneous estimation of Equations (5.1) and (5.2). The model is estimated by Maximum Likelihood and the estimation is conducted using Frontier 4.1 (Coelli, 1996).

Table 5.4 SFA-results of the university cost function including environmental variables (67 German universities, 1998-2003)

| | Endogenous variable: Costs/Student (C) |
|---|---|
| Exogenous variables | |
| Linear time trend | -0.021 |
| | (0.008)** |
| Third-party funds (TPF) | 0.257 |
| | (0.889) |
| Graduates (GRA) | -2.470 |
| | (0.833)*** |
| $TPF^2$ | 0.076 |
| | (0.071) |
| $GRA^2$ | -0.226 |
| | (0.724) |
| TPF*GRA | -0.272 |
| | (0.174)+ |
| Wage (w) | 7.973 |
| | (0.628)*** |
| $w^2$ | -1.842 |
| | (0.455)*** |
| TPF*w | -0.160 |
| | (0.283) |
| GRA*w | 0.567 |
| | (0.522) |
| MED | 4.317 |
| | (0.491)*** |
| SCI | 0.548 |
| | (0.636) |
| ENG | -0.139 |
| | (0.075)* |
| Constant | -15.312 |
| | (0.903)*** |
| Environmental variables (Z) | |
| Constant | -0.076 |
| | (0.211) |
| BESTLAW | -0.373 |
| | (0.055)*** |
| WORSTLAW | 0.237 |
| | (0.134)* |
| FOUND | -0.136 |
| | (0.073)* |
| EAST | 0.271 |
| | (0.171)+ |
| $\gamma$ | 0.064 |
| | (0.009)*** |
| Log Likelihood | -40.649 |
| Observations | 402 |

Note: Costs, third-party funds and graduates are normalised by the number of students; see text. ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

The estimation results for the cost function suggest that there is cost-saving technological change over the sample period (about -2% per year). Moreover, it is quite

clear from the results that universities with an important share of students enroled in medical, veterinary and agrarian studies have higher cost levels. Taken at face value, the coefficient estimated for the share of students in medical and veterinary studies suggests that a university with about 10% of students in medicine has on average about 40% higher costs per student compared to a university with no medicine careers. According to the estimation results, a pure medical school should have costs per student that exceed costs per student of a pure social science university by about four times. In contrast, the share of students in science careers is not significantly different from zero in Table 5.4, suggesting that the cost levels of social science and science careers are not significantly different from each other.

Moreover, Table 5.4 suggests that there are economies of scope in the production of teaching and research (see the coefficient of the interaction term between graduates per student and third-party funds per student, which is, however, only significant at the 20% level).

Since we are attempting to determine whether a comparatively liberal university regulation contributes to more efficient spending of public resources in higher education, the estimation results for the Z-variables BESTLAW and WORSTLAW show that this is indeed the case. Universities located in Länder that allow relatively high autonomy are less inefficient than those in Länder with medium liberal university regulation as shown by the negative coefficient of BESTLAW. In contrast, universities operating under comparatively strict university regulation display higher inefficiency compared to universities operating under medium liberal university regulation (see the positive coefficient of WORSTLAW). Additionally, university history is of some importance. The dummy variable capturing whether a university was founded after WWII is significant at the 10% level, suggesting that younger universities are more efficient. Thus, the effect from Länder university regulation on cost efficiency is robust against controlling for university history. Moreover, the results confirm that East German universities are somewhat less efficient than the West German universities over the sample period. However, the East dummy is only significant at the 20% level, which suggests that some of the efficiency advantage of universities in West Germany is due

to their younger age on average.[71] Finally, Table 5.4 reports the statistic γ, defined as the share of deviations from the estimated cost function that are due to inefficiencies. In Equation (5.3), $\sigma^2_u$ is the standard deviation of the inefficiency error term while $\sigma^2_v$ is the standard deviation of the "classical" error term (see also Coelli 1996):

$$\gamma = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2} \tag{5.3}$$

The estimation result for this statistic suggests that about 6.4% of total deviations from the estimated cost function are explained by the model presented in Equation (5.2). Overall, this suggests that Länder university regulation has a significant effect on university efficiency, but the explanatory power is somewhat limited.

### 5.4.2 The link between university costs and the private economic environment

*5.4.2.1 Descriptive evidence*

Table 5.5 reports correlation coefficients of university costs and outputs with GDP per capita and with patenting activity at the level of Raumordnungsregionen. Note that it is now possible to add the three Berlin universities to the sample. As expected, third-party funds per student are significantly and positively correlated with regional GDP per capita and with the number of patents in a region. This also holds for most subgroups of patents (according to the field of research). Unusually, I find no significant correlation of third-party funds per student with patents issued in chemicals, unlike Abramovsky, Harrison and Simpson (2007) who report a strong link between the location of private sector R&D laboratories and university chemistry departments in the UK. The correlations of costs per student with regional GDP per capita or with total patents issued in a region are weaker and often not significantly different from zero. The same holds for graduates per student. This is not too surprising, because the interpretation of positive or negative correlations of graduates per student (and costs per student) with GDP and patenting activity are not as obvious as for third-party funds.

[71] About 50% of the West German universities and 25% of the East German universities were founded after WWII.

Table 5.5 Correlation coefficients of university costs and outputs with universities' private economic environment (70 German universities, 1998-2003)

| | Costs/Student (C) | Third-party funds /Student (TPF) | Graduates /Student (GRA) |
|---|---|---|---|
| Regional GDP per capita | 0.048 | 0.2504* | 0.1149* |
| Total number of patents in a region | 0.0584 | 0.3684* | 0.0905 |
| Number of patents in a region in | | | |
| … electricals | 0.1215* | 0.3867* | 0.1337* |
| … nuclear physics | 0.0555 | 0.1082* | 0.1287* |
| … engineering | 0.0166 | 0.3784* | 0.1091* |
| … chemicals | -0.029 | -0.0622 | -0.1644* |
| … household goods | 0.1124* | 0.2742* | 0.0695 |
| … nutrition | -0.1066* | 0.0007 | 0.0933 |
| … mining | -0.0392 | 0.1334* | -0.1346* |
| … munitions | 0.0886 | 0.1600* | 0.1440* |

Note: * denotes significance at the 5% level.

*5.4.2.2 Econometric evidence on the effect from universities' environment on costs*

As discussed in Section 5.2, we cannot easily assume a unilateral relationship between universities and their environment, and thus GDP per capita and patenting activity are considered potentially endogenous regressors. Since IV techniques within stochastic frontier frameworks are to the best of my knowledge not yet available, I employ more standard econometric approaches that may be used in the presence of potentially endogenous regressors. Note that using a more standard econometric framework implies that it is not possible to investigate the effect from university environment on university *efficiency*. Rather, the effect from the economic environment on the *cost structure* of universities is analysed using a 2SLS approach. The starting point for the analysis is the translog cost function in Equation (5.1):

$$\begin{aligned}(5.4)\quad \ln C_{it} = {} & \alpha + \theta t + \sum_{j=1}^{2}\beta_j \ln Q_{jit} + \frac{1}{2}\sum_{j=1}^{2}\sum_{k=1}^{2}\beta_{jk}(\ln Q_{jit} \ln Q_{kit}) + \kappa_1 \ln w_{it} \\ & + \kappa_2 \frac{1}{2}(\ln w_{it})^2 + \sum_{j=1}^{2}\kappa_{3j}(\ln w_{it} \ln Q_{jit}) + \sum_{m=1}^{3}\delta_{1m}(FACULTY_{mit}) \\ & + EAST_i + FOUND_i + \ln GDPpc_{it} + v_{it}\end{aligned}$$

Unlike the model in Equation (5.1), Equation (5.4) does not contain the one-sided "inefficiency" error term, $u_{it}$. As in Chapters 3 and 4, standard errors are estimated robust in the presence of heteroskedasticity and weak serial correlation using the

correction of the autocovariance matrix presented by Newey and West (1987), which is not possible in the stochastic frontier analysis due to the rather complex specification of the "inefficiency" error term, $u_{it}$. The natural log of real GDP per capita is included to analyse effects from economic activity on the cost level of universities. Given the discussion above, GDP per capita is instrumented since it must be considered a potentially endogenous regressor. Lagged GDP per capita and the lagged number of patents in a region are used as instrumental variables (both as natural logs). This seems a plausible choice since an effect from contemporaneous university spending/third-party funds per student on last year's GDP per capita seems rather implausible. Thus, these lagged values may be considered reasonable instrumental variables.

Table 5.6, Column (1) presents the estimation results for Equation (5.4). The model presented in Column (2) is similar to Column (1), but controls for unobserved university heterogeneity by including university fixed effects, which make it unnecessary to control for EAST and FOUND. The main result from these two models is the effect from regional GDP per capita on university costs. Whereas the pooled OLS model (Column 1) suggests that there is virtually no effect from regional GDP per capita, the model including university fixed effects (Column 2) suggests a significant and cost-reducing effect. The estimated coefficient implies that a 1% increase in regional GDP per capita translates into a 2% reduction in costs per student.

Table 5.6 IV Estimation results of the university cost function including GDP per capita (70 German universities, 1998-2003)

| | Endogenous variable: Costs/Students (C) | |
|---|---|---|
| Exogenous variables | (1) OLS | (2) University FE |
| Linear time trend | -0.006 | -0.007 |
| | (0.010) | (0.003)** |
| Third-party funds (TPF) | 0.714 | 0.541 |
| | (0.703) | (0.298)* |
| Graduates (GRA) | 0.885 | 1.225 |
| | (2.373) | (0.757)+ |
| $TPF^2$ | 0.027 | 0.133 |
| | (0.077) | (0.044)*** |
| $GRA^2$ | 0.109 | 0.317 |
| | (0.337) | (0.150)** |
| TPF*GRA | -0.241 | 0.035 |
| | (0.087)*** | (0.043) |
| Wage (w) | 0.722 | 1.979 |
| | (6.150) | (2.168) |
| $w^2$ | -0.240 | -0.555 |
| | (1.522) | (0.536) |
| TPF*w | -0.273 | -0.067 |
| | (0.187)+ | (0.076) |
| GRA*w | -0.116 | -0.102 |
| | (0.541) | (0.224) |
| MED | 4.237 | 2.021 |
| | (0.431)*** | (0.732)*** |
| SCI | 0.591 | 0.495 |
| | (0.466) | (0.451) |
| ENG | -0.140 | 0.272 |
| | (0.167) | (0.423) |
| EAST | 0.218 | |
| | (0.084)** | |
| FOUND | -0.109 | |
| | (0.064)* | |
| Constant | 1.602 | |
| | (12.635) | |
| ln(GDPpc), instrumented by | 0.001 | -2.047 |
| – $\ln(GDPpc_{t-1})$ | (0.130) | (0.331)*** |
| – $\ln(patents_{t-1})$ | | |
| Anderson-statistic, IV-relevance test, H0: equation is underidentified | 39.760*** | 39.984*** |
| Hansen-J-statistic, Test of overidentifying restrictions, H0: IVs are valid | 0.954 | 0.001 |
| University FE | No | Yes |
| Observations | 350 | 350 |
| Adjusted R-squared | 0.83 | 0.30 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

The Anderson statistic shows that the instrumental variables (lagged GDP per capita and lagged patents) are reasonably correlated with contemporaneous GDP per capita. Hansen's J-Statistic indicates that the instrumental variables are valid instruments, i.e.

uncorrelated with the error term (see also Bauer, Fertig and Schmidt, 2009, 333). Thus, the results support Hypothesis 2: regional GDP per capita reduces university costs per student. The channel by which higher GDP per capita translates into lower costs per student is probably the easier acquisition of third-party funds (see Table 5.5).

Regarding the cost function, there are some differences when comparing the SFA estimation results with the results from the OLS/FE estimations. There is a notable difference between the coefficients estimated for the number of graduates in the SFA and the OLS/FE models. Differences between these two approaches are, however, not too surprising, given that the focus in the stochastic frontier analysis is on measuring efficiency whereas that of the OLS/FE estimation is obtaining consistent, unbiased and efficient estimates of the cost function parameters.
Moreover, the models differ in some important aspects. *First*, due to the standard OLS framework, EAST and FOUND are included in the cost function and not in the inefficiency term (see Equations 5.1 and 5.2). It implies that the OLS model assumes different cost levels between East and West Germany (as an integral element of university technology). In contrast, the SFA model assumes a common technology over East and West Germany, but identifies systematic differences in efficiency between East and West Germany. *Second*, SFA and OLS/FE differ in explanatory/environmental variables (BESTLAW, WORSTLAW, GDP per capita, university fixed effects). *Third*, standard errors in the OLS/FE estimations are corrected whereas this is not possible in the SFA framework.

An alternative to including regional GDP per capita in Equation (5.4) is to include the number of patents issued in the region around the university. Table 5.7 reports the results for these models. Due to the endogeneity concern, the number of patents is instrumented. Lagged GDP per capita and the lagged number of patents are chosen as instruments. Again, Column (1) reports a pooled OLS model which controls for East German universities and for universities founded after WWII (FOUND). Column (2) shows the result for the university fixed effects specification. The errors are estimated robust in the presence of heteroskedasticity and serial correlation using the correction of the autocovariance matrix as suggested by Newey and West (1987).

Table 5.7 IV Estimation results of the university cost function including patenting activity (70 German universities, 1998-2003)

| | Endogenous variable: Costs/Student (C) | |
|---|---|---|
| Exogenous variables | (1) OLS | (2) University FE |
| Linear time trend | -0.006 | -0.008 |
| | (0.010) | (0.003)** |
| Third-party funds (TPF) | 0.726 | 0.684 |
| | (0.705) | (0.354)* |
| Graduates (GRA) | 1.052 | 0.501 |
| | (2.340) | (0.923) |
| $TPF^2$ | 0.040 | 0.150 |
| | (0.077) | (0.050)*** |
| $GRA^2$ | 0.125 | 0.378 |
| | (0.327) | (0.164)** |
| TPF*GRA | -0.241 | -0.024 |
| | (0.085)*** | (0.050) |
| Wage (w) | 1.643 | 4.917 |
| | (6.395) | (2.432)** |
| $w^2$ | -0.518 | -1.194 |
| | (1.574) | (0.610)* |
| TPF*w | -0.274 | -0.150 |
| | (0.188)+ | (0.096)+ |
| GRA*w | -0.156 | 0.141 |
| | (0.540) | (0.264) |
| MED | 4.246 | 1.821 |
| | (0.433)*** | (0.896)** |
| SCI | 0.500 | 0.198 |
| | (0.438) | (0.557) |
| ENG | -0.137 | -0.233 |
| | (0.169) | (0.612) |
| EAST | 0.171 | |
| | (0.079)** | |
| FOUND | -0.128 | |
| | (0.066)* | |
| Constant | 0.273 | |
| | (13.125) | |
| ln(patents), | -0.025 | -0.284 |
| instrumented by | (0.029) | (0.075)*** |
| – $\ln(patents_{i, t-1})$ | | |
| – $\ln(GDPpc_{i, t-1})$ | | |
| Anderson-statistic, IV-relevance test, H0: equation is underidentified | 56.865*** | 40.665*** |
| Hansen-J-statistic, Test of overidentifying restrictions, H0: IVs are valid | 0.294 | 7.929*** |
| University FE? | no | yes |
| Observations | 350 | 350 |
| Adjusted R-squared | 0.83 | 0.14 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

Regional patenting activity appears to have a cost-reducing effect in public universities. Again, for the pooled OLS model, this effect is not significantly different from zero, whereas the FE model suggests a significant effect. An increase of the number of

patents by 1% results in a 0.3% reduction of university costs per student. Thus, the effect appears to be considerably lower than the effect from GDP per capita, which is entirely plausible, given that the number of patents measures only a fragment of GDP per capita. GDP is a much broader variable containing the effects from innovative capacity plus other factors such as business activity.

However, the Hansen-J-Statistic indicates that the endogeneity of patents is still a concern: The null hypothesis that the instrumental variables are uncorrelated with the error term is rejected, which casts doubt on the validity of the instrumental variables and suggests that the lagged GDP and lagged number of patents embody the same endogeneity problems as the contemporaneous number of patents. In other words, the IV estimations are insufficient to handle the reverse causality concerns for patenting activity. It makes sense that reverse causality is more relevant for the number of patents in a region than for GDP per capita (see the discussion above). The endogeneity concern needs more work, possibly using different instrumental variables. The results in Table 5.7 should be viewed as multivariate correlations and *cannot* be interpreted as causal relationships. Future analysis should consider specifications that account for the importance of research clusters in specific fields of research (e.g., chemistry departments in the university collaborate with pharmaceutical firms), as suggested by Abramovsky, Harrison and Simpson (2007).

## 5.5 Conclusions

Identifying the factors which benefit efficient resource use in German public universities is important, because (i) human capital is considered a central driver of economic growth, (ii) universities are of paramount importance for the creation of human capital, (iii) inefficiency in the production of higher education is a serious concern, given that there is no mechanism ensuring efficient resource use in Germany (such as market exit and entry), and (iv) today's public budgets are tightly constrained.

The first part of the empirical analysis in this chapter confirms that liberal university legal frameworks benefit efficient resource use in higher education. This finding is an extension of Kempkes and Pohl (2008), which additionally incorporates a control for university history. Controlling for university history is important, because the classification by Stifterverband für die Deutsche Wissenschaft (2002) may also detect that some of the Länder with older universities are more experienced in academic management and regulation. The results presented here show that this concern does not affect the main results. One channel for transmission of liberal university regulation is that universities located in Länder with a comparatively liberal university framework acquire more third-party funds than universities located elsewhere. It appears straightforward to assume that Länder university regulation is exogenous of university costs, and thus we can conclude that there is some evidence that liberal university regulation indeed translates into more efficient resource use, of course keeping in mind the important limitations of the analysis. One important shortcoming is the absence of more detailed data on university outputs (*no quality* indicator for research and teaching outputs and the *limited scope* of proxies for research and teaching outputs).

The second part of the empirical analysis gives econometric evidence for the link between university costs and the private economic environment of universities. The results show that universities located in regions with high GDP per capita operate on a lower cost level than universities located in less prosperous regions. The results are obtained from a model which includes university fixed effects and which considers that GDP per capita can be endogenous on university spending in a region. Thus, we may interpret this result such that there is indeed a (causal) effect from a high GDP per capita

on public costs per student. The channel of this effect appears to be the same as above: easier acquisition of third-party funds.

Finally, I find evidence for a negative correlation of patents issued in a region with university costs per student. However, this correlation *cannot* be interpreted in terms of a causal effect. The IV estimation, which uses lagged patenting activity and lagged GDP per capita as instruments for contemporaneous patenting activity, does not solve the endogeneity problem. Thus, the negative correlation of university costs per student with regional patenting activity may well indicate that there is also an effect from the presence of a university on patenting activity outside universities.

The econometric model presented here is probably too simple to capture the true relationship between patenting activity and university costs/outputs. More sophisticated models that account for research clusters are needed (e.g., there may be virtually no connection between a university with a focus on social sciences and private R&D labs in engineering). Moreover, the data basis of the analysis has to be broadened. Including indicators for the quality of research and teaching is important and the proxy for the research output of universities has to be extended. Third-party funds have a bias towards certain types of research and towards certain disciplines like engineering and medicine. These shortcomings are still too important to give policy advice.

# 6 CONCLUDING REMARKS

In this thesis I provide an analysis of the German system of public education at the level of primary schools, lower secondary schools and higher education. For each level, of course, different topics dominate the public debate and the research agenda in economics.

The sharp drop in student numbers in primary schools in the East German Länder has led to demonstrations by teachers' unions, parents, and pupils against resource adjustments. The topic is also of significant public finance interest, because East Germany is an ideal laboratory to study public policy in response to rapid demographic changes. My empirical analysis using data for the East German Länder from 1993 to 2006 suggests that resource adjustments are significantly stronger than what has been experienced in demographically stable times. This is true especially for the periods in which student cohorts were actually decreasing. Resource adjustments loosened somewhat in times of stagnating and increasing student numbers. Concerning the nation's future demographic changes, these findings suggest that one should not be too pessimistic about the capability of the public sector to handle demographic challenges. My reading of the results is that the public sector can cope with demographic changes as long as there is awareness of the challenges in the public. Thus, slow and smooth demographic changes may in the end be more difficult to handle than strong shifts, because only rapid or strong changes are accompanied by the level of public debate that can exert the necessary pressure on public authorities to manage the problems.

In lower secondary schools, the practise of ability-tracking is a major issue. Ideological discussions about the practise of tracking have shaped the public debate in West Germany for decades, because the track choice in the transition from primary schools to lower secondary schools is critical for a student's future career, social status and earnings. In Chapter 4, I provide empirical evidence supporting a political-economic explanation for the practise of tracking. Apparently, German political parties support ability-tracking if their members' or electoral constituencies' offspring are predominantly enroled in the higher educational track, and thus profit from ability-tracking. There is also some evidence suggesting that political parties when in office allocate public resources primarily to the track in which their constituencies' offspring

are overrepresented. Both findings suggest that partisan theory offers a political-economic rationale of the German education system, which may aid in understanding Germany's low intergenerational mobility (see e.g., Dustmann, 2004, 211; OECD, 2007, 116). There may, however, also be other theoretical approaches that accord with the empirical evidence.

There is a widespread perception that ideological discussions about education institutions are about to disappear and that German political parties' education policies are converging in the aftermath of the publication of the PISA results. Anecdotal evidence for this argument is found in plans for reforms of the education system in Hamburg and Berlin. Beginning in 2010, both Länder will implement virtually identical education systems (students are tracked after the sixth grade, at the age of 12, into Gymnasium and Stadtteilschule). These reforms will be implemented by very different coalitions: the CDU-Green Party coalition in Hamburg and the SPD-Die Linke coalition in Berlin. However, the specific socioeconomic problems of German city states may also assume a major role.

The Bologna process and the implementation of the Excellence Initiative appear to open up possibilities to re-organise the German system of higher education, such as the formation of research clusters between universities and research institutes, or mergers between universities and universities of applied sciences. Chapter 5 provides preliminary evidence suggesting that universities operate more efficiently under liberal university regulation than under a strict legal framework. Thus, the recent developments towards more liberal university regulation and the abolishment of the Federal Framework Act are a step in the right direction. Moreover, I provide evidence suggesting that (i) universities are operating on lower cost levels when located in prosperous regions, and (ii) there is a negative correlation of private patenting activity with public university costs. The latter finding most probably indicates a mutual benefit between universities and private R&D labs while the direction of causation remains unknown. From a pure efficiency perspective, these results may provide some support for the formation of research clusters. However, the analysis in Chapter 5, more than the preceding chapters, is limited by important shortcomings that mostly reflect data deficiencies and which make policy advice at this stage problematic. I suggest that

future research should exploit the much richer variation in terms of university autonomy, university management, research clusters, etc. among Europe's universities.

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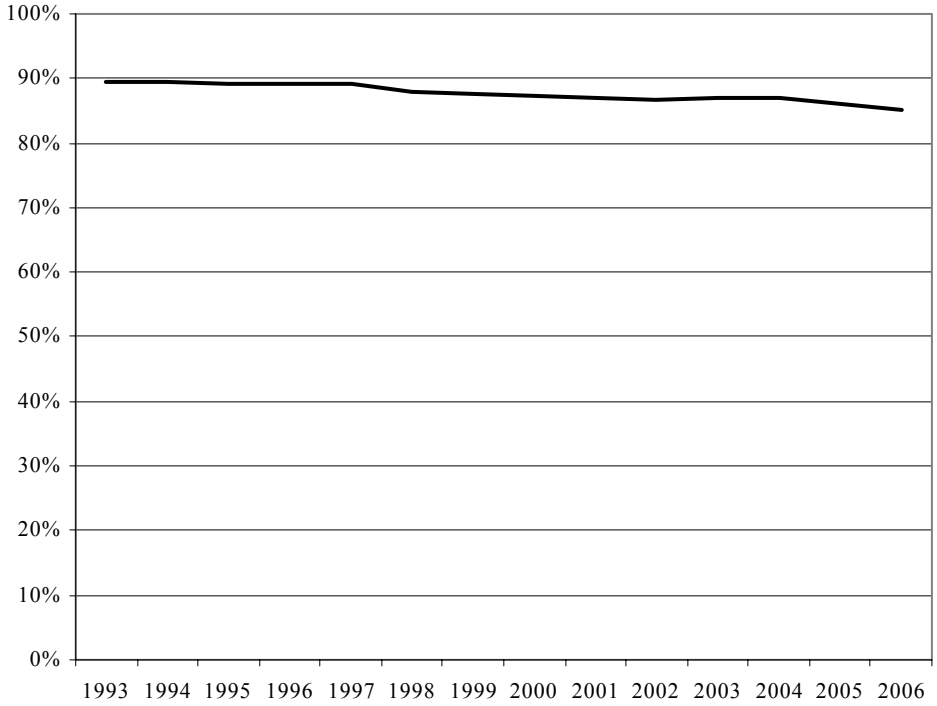
# APPENDIX

A.2.4 Electorates of the political parties with respect to profession in 2002 federal elections

| | SPD | CDU/CSU | Green Party | FDP | PDS |
|---|---|---|---|---|---|
| Blue-collar worker | 42% | 37% | 5%- | 6% | 5% |
| White-collar worker | 39% | 35% | 12% | 8% | 3%- |
| Civil servants | 37%- | 36% | 15% | 8% | 3% |
| Farmer/Self-employed | 21% | 47% | 13% | 15% | 2% |
| Unemployed | 41% | 28% | 9% | 7% | 10% |
| Pensioner | 41% | 43% | 4% | 6% | 5% |
| In training | 39% | 28% | 15% | 10% | 4% |
| ELECTION | 38.5% | 38.5% | 8.6% | 7.4% | 4% |

Source: Graf and Neu (2002)

A.3.4.2 Wage spending as a share of total education spending at the Länder level




Data Source: Federal Statistical Office of Germany.

A 3.4.3.2 (a) Regression results for the East German Länder (1993-2006)

| | (1) Δln(Tt/T) | (2) Δln(St/Cl) | (3) Δln(Tt/Cl) |
|---|---|---|---|
| Δ ln(St) | -0.258 | -0.063 | -0.190 |
| | (0.416) | (0.154) | (0.393) |
| Δ ln(PR) | -0.760 | -0.047 | -0.140 |
| | (0.349)** | (0.083) | (0.265) |
| Δ ln(PD) | 0.861 | 0.870 | -0.084 |
| | (1.429) | (0.366)** | (1.051) |
| Δ UR | 1.885 | -0.044 | -0.154 |
| | (1.089)* | (0.331) | (0.620) |
| Δ FS | 7.947 | 1.452 | 1.346 |
| | (6.036)+ | (1.170) | (4.262) |
| Δ o60 | -0.862 | 1.358 | 1.618 |
| | (5.649) | (1.749) | (4.405) |
| Constant | 0.022 | -0.005 | -0.009 |
| | (0.032) | (0.010) | (0.024) |
| Observations | 65 | 65 | 65 |
| Year FE? | Yes | Yes | Yes |
| F (Year FE) | 1.33 | 2.56** | 0.6 |
| Adjusted R-squared | 0.10 | 0.84 | -0.17 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively. Joint significance of the year fixed effects is tested using an F (12, 46) test.

A.3.4.3.2 (b) Regression results for the West German Länder (1993-2006)

| | Δln(Tt/T) | | Δln(St/Cl) | | Δln(Tt/Cl) | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Δ ln(St) | 0.001 | 0.390 | 0.350 | 0.184 | -0.190 | -0.113 |
| | (0.118) | (0.315) | (0.058)*** | (0.324) | (0.135)+ | (0.449) |
| Δ ln(PR) | 0.026 | 0.053 | -0.021 | -0.025 | 0.034 | 0.036 |
| | (0.050) | (0.069) | (0.032) | (0.038) | (0.051) | (0.052) |
| Δ ln(PD) | 0.529 | -0.157 | -0.978 | -0.735 | -0.068 | 0.135 |
| | (0.510) | (1.088) | (0.719)+ | (0.710) | (0.744) | (1.133) |
| Δ UR | 0.295 | -0.252 | -0.003 | 0.305 | -0.365 | -0.465 |
| | (0.446) | (0.743) | (0.122) | (0.336) | (0.427) | (0.859) |
| Δ FS | -1.238 | -1.154 | -0.312 | -0.569 | -1.628 | -1.452 |
| | (0.632)* | (1.275) | (0.433) | (0.650) | (0.803)** | (1.133) |
| Δ o60 | 1.655 | -0.978 | -0.975 | -0.566 | -1.630 | -0.021 |
| | (1.034)+ | (1.897) | (0.724)+ | (1.523) | (1.125)+ | (2.562) |
| Constant | -0.005 | -0.009 | 0.005 | 0.006 | 0.011 | 0.001 |
| | (0.004) | (0.013) | (0.004) | (0.012) | (0.006)** | (0.015) |
| Observations | 104 | 104 | 104 | 104 | 104 | 104 |
| Year FE? | No | Yes | No | Yes | No | Yes |
| F (Year FE) | - | 1.58+ | - | 0.67 | - | 0.75 |
| Adjusted R-squared | -0.00 | -0.06 | 0.38 | 0.34 | 0.20 | 0.16 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively. Joint significance of the year fixed effects is tested using an F (12, 85) test.

A.4.2 Additional information on partisan theory and related empirical evidence

*Partisan theory: a summary*

Generally, the essence of partisan theory is the assumption that a political party's policies are shaped by ideology and that different parties when in office pursue quite different goals and policies (Hibbs, 1977; Tufte, 1978 and Alesina, 1987). In economics and political science, this assumption is not as commonplace as one might suspect. Very prominent strands of the literature on voting and electoral cycles assume that parties are only engaged in maximising votes and winning elections, thereby leaving little or no room for party ideology (Median voter theorem, Downs, 1957 or opportunistic political cycles (see e.g., Nordhaus, 1975; Rogoff and Sibert, 1988).

As opposed to these "opportunistic" models, partisan theory highlights the ideological motivation of politicians and their parties. As Alesina, Roubini and Cohen (1997, 45) state "opportunistic policymakers choose policies solely to win elections, [whereas] partisan policymakers want to win in order to implement their desired policies". Thus, different parties are assumed to represent specific clienteles in the electorates, and when in office pursue mainly the interests of their core constituencies. Most commonly it is assumed that left-wing parties pursue policies benefiting lower-middle class households, such as lowering unemployment, increasing growth and following less strict inflation policies. In contrast, right-wing governments are usually assumed to focus on containing inflation while being less concerned about unemployment.

Partisan theory dates back to Hibbs (1977) and Tufte (1978) the former being among the most heavily cited in political science (Sigelman, 2006). Alesina (1987) formalises and modifies Hibbs (1977) such that voters and workers, etc., form expectations rationally (rational partisan theory), which limits the governing parties' possibilities to exploit the trade-off between inflation and unemployment stated by the short-run Phillips-curve. Nevertheless, most qualitative predictions of Hibbs's model hold also in Alesina's framework.

The following presentation sketches the basic assumptions and predictions of partisan theory. It is based on Alesina, Roubini and Cohen (1997, chapters 1 and 3), who present traditional and rational partisan theory in a common framework and notation.[72] Both the

[72] See also Blankart (2002) or Mueller (2003).

traditional and the rational partisan hypotheses are based on the assumption that the governing parties can exploit a trade-off between inflation and unemployment as stated by the Phillips-curve (at least in the short run in the case of rational partisan theory; see below). Both frameworks further assume that the timing of elections is exogenously fixed and there are only two parties running for government. Moreover, both theories share the core assumption that the two competing parties represent different ideologies. Based on the preferences of their constituencies and members, right-wing parties choose a combination of relatively lower inflation and higher unemployment compared to left-wing parties.

The two models differ in their assumption concerning voters' formation of expectations. Hibbs's (1977) model implicitly assumes voters to form adaptive or even static expectations. This allows the government to exploit a stable Phillips-curve without causing voters' (and workers') expectations to shift the Phillips-curve to the right. Left- or right-wing governments can therefore permanently choose combinations of higher growth/lower unemployment and higher inflation or vice versa. Alesina (1987) incorporates rational expectations in combination with wage or price rigidities to Hibbs's (1977) model. Due to rational expectations, voters anticipate public policies' intention to exploit the inflation-unemployment trade-off, e.g., in the case of left-wing governments pursuing expansionary policies, wage-contracts and prices will be adjusted to the new inflation rate. This causes the expectations-augmented Phillips-curve to shift to the right.

However, elections introduce an element of uncertainty to the economy, since the election outcome and thus future macroeconomic policies are generally uncertain: therefore, wage contracts and prices are based on the expected election outcome (a weighted average of the anticipated policies of right-wing and left-wing parties weighted by the winning probabilities). As a consequence, prices and wage contracts which are determined in long-term contracts usually lasting for half the electoral period cannot precisely anticipate the pursued macro policy (unless the election outcome was known with certainty), and must be adjusted to the winning party's inflation/unemployment policy. This, however, takes some time, which allows the government to exploit the Phillips-curve trade-off temporarily, usually for about half of the electoral period. After that, voters know which party will be in office and their

expectations have adjusted to the – then known – economic policy, i.e. rational expectations (by adjusted prices and work-contracts) cause a shift of the short-run, expectations-augmented Phillips-curve to the right in post-election years. Consequently real effects in growth and unemployment cease. The shift to the right of the short-run Phillips-curve, however, causes inflation to be permanently higher than under right-wing governments. Obviously, rational expectations limit the scope for partisan policies in the model.

Thus, in summary, Hibbs (1977) predicts permanent differences in inflation and growth/unemployment under right-wing and left-wing governments. Alesina (1987) in turn suggests only temporary unemployment/growth differences between right- and left-wing parties while differences in inflation should be permanent as in Hibbs (1977). Furthermore, both models predict booms and recessions to be more pronounced when differences in ideologies are large. Alesina's model additionally implies that the magnitudes of post-electoral booms/recessions are positively correlated with the degree of surprise in the election result. Thus, political polarisation and electoral surprise imply that the electoral outcome is relatively far from expectations. Conversely, if the election outcome is known with certainty, then under rational partisan theory there is no room for a boom/recession.

*Some empirical evidence*

In empirical tests, party ideology has been tested in its impact on macroeconomic outcomes. However, one can also test for the use of policy instruments such as monetary or fiscal policy, which is more closely related to the discussion in Chapter 4. Few studies have focussed on investigating the ideological differences between political parties in education policy.

*(a) Macroeconomic outcomes*

Party ideology has been widely shown to have effects on growth, unemployment and inflation. This holds for the U.S. and several other OECD countries as well as for panels of OECD countries (Hibbs 1977; Tufte 1978; Frey and Schneider, 1978a and 1978b; Alt, 1985; Hibbs 1987a, 1987b; Alesina and Sachs, 1988; Alesina and Roubini, 1992; Alesina, Roubini and Cohen, 1997 as well as Franzese and Jusko, 2006 and Berlemann and Markwardt, 2007 as well as the literature cited therein).

There is, however, some degree of dissent about whether the data support traditional partisan hypotheses, i.e. sustained differences in macroeconomic outcomes under left- and right-wing governments, or rational partisan theory, i.e. sustained differences only in inflation, whereas differences in growth and unemployment are restricted to the first half of the electoral period. Moreover, the magnitude of booms (left-wing party) or recessions (right-wing party) should, under rational expectations, positively correlate with the degree of electoral surprise.

Post-electoral booms and recessions – at least in the U.S. – appear to be restricted to the beginning of the electoral period and tend to cease towards the end (Alesina, Roubini and Cohen, 1997; Hibbs, 1992; Franzese and Jusko, 2006). Scholars disagree whether this is sufficient evidence to support rational partisan hypotheses; in particular, it is argued that existing studies do not test the heart of rational partisan theory, i.e. the effect of electoral surprise on real macroeconomic outcomes (Hibbs, 1992; Franzese and Jusko, 2006). A recent empirical study overcomes this shortcoming by including polling data on a large sample of OECD countries as a measure of electoral surprise. They find support for rational partisan theory (Berlemann and Markwardt, 2007).

*(b) Fiscal policy*

There is a broad empirical literature testing partisan hypotheses within the context of fiscal policy (e.g., Roubini and Sachs, 1989; de Haan and Sturm, 1997; Alesina, Roubini and Cohen, 1997, chapter 7.5 for OECD countries; Alesina, Roubini and Cohen, 1997, chapter 4.8 for the U.S.; Seitz, 2000 for Germany).[73]

Generally, these studies can be understood as empirical tests on one of the instruments by which governments may try to achieve their macroeconomic policy goals. However, these tests can also be interpreted more generally, i.e. parties try to benefit their core constituencies directly via public spending (Franzese and Jusko, 2006). For example, a

[73] In particular, scholars argue that left-wing governments may be more willing to accept public deficits. However, whereas the literature on the political economy of public debt has proliferated (see Alesina, Roubini and Cohen, 1997, chapter 9.2 for a good overview), partisan hypothesis with respect to public deficits has been questioned on theoretical grounds (Alesina, Roubini and Cohen, 1997, chapters 4 and 7, 103, 202 and 230). Moreover, empirical support for partisan-related hypotheses in public deficits has been rather inconclusive (Roubini and Sachs, 1989; Alesina, Roubini and Cohen, 1997, chapters 4, 7 and 9.3; Jochimsen and Nuscheler, 2007).

left-wing party may engage in expanding public systems of unemployment benefits relying on a progressive tax system.

However, while Hibbs (1977, 1987a) and Tufte (1978) present convincing descriptive evidence on the distributional impact of unemployment/inflation that shows the beneficiaries of this policy, some of the studies hypothesising that leftist governments tend to advocate higher public expenditures do not (see also Alesina, Roubini and Cohen, 1997). Moreover, the distributional effects of marginal increases in public spending (and taxation) are not clear-cut for many subcomponents of public spending/taxation. This holds even less for a broad cross-section of countries when not accounting for differences in political and fiscal institutions (see Schmidt, 1996 and Alesina, Roubini and Cohen, 1997, 247).

It is therefore more promising to focus on subcomponents of public spending for which a theoretical prediction on the influence of party ideology is clear. This is also part of the concept of "context-conditionality" by Franzese (2002, 44): *"In partisan cycles, as in electoral cycles, the incentives for, capacity for, and effects of 'partisaneering' should vary predictably from policy to policy and across contexts characterized by differing international and domestic political-economic institutions, structure, and strategic situation."*

*(c) Public policies in education*

The following review offers an extensive overview of studies reporting evidence on partisan hypotheses in public education spending. Since the education systems across countries are quite heterogeneous, the evidence is grouped accordingly.

Castles (1989) investigates the effect of right-wing governments on public education spending based on a panel of 18 *OECD countries* over the years 1960 and 1980 and finds a significant negative effect. Castles's findings align with the results by Boix (1997), whose estimates suggest a positive effect of leftist governments on education spending for a sample of 20 OECD countries over the 1960-1990 period. Busemeyer (2006 and 2007) exploits a panel data set on 21 OECD countries for the 1980-2001 period and roughly confirms earlier findings. However, in some of his specifications, the positive effect of Social Democratic government participation no longer

significantly differs from zero. He finds some evidence that partisan influence on public education spending may have become weaker in the 1990s compared to earlier periods. Thus, cross-country analyses for OECD countries tend to confirm the hypothesis that left- (right-) wing governments prefer higher (lower) spending on public education.

For the *U.S.*, Fusarelli (2002) reports case-study evidence from the states Florida, New York and Texas. In each state, a Democratic government was followed by a Republican government. No change in educational policy could be observed, which is attributed to increased accountability of educational policy due to reports/tests on the performance of the American educational system, pressure from globalisation and straitened public budgets at the state level. Based on a cross-section of the U.S. states in 2000, Saeki (2005) finds that the number of Democratic-majority chambers in the state legislature between 1994 and 1999 has had a positive impact on the share of state budgets allocated to primary and secondary education. But his estimates also suggest that education spending per pupil is not affected by Democratic majorities. Thus, the state-level evidence for the U.S. is mixed. Whereas Democratic governments seem to give priority to education compared to other government spending, spending per student is apparently not higher in states with Democratic incumbents. However, one must bear in mind that in the U.S. education from primary to high schools are generally the responsibility of local school districts such that the state level is not the appropriate level of government for analysing this question. Based on a cross-section of cities and counties in Virginia, Colburn and Horowitz (2003) find that electorates voting for the Democratic Party in the 1992 presidential election are associated with higher public education expenditures. However, one may argue that voting behaviour in a presidential election may not be the most appropriate variable to capture party affiliation in this question.

Hecock (2006) investigates partisan influence on public expenditures in primary education in 29 *Mexican* states over the 1999-2004 period. Based on a pooled PCSE regression, he finds weak evidence that spending is higher in times/states with left-wing governments than under a right political party.

Evidence by Bilek (2005) suggests that in a 2001 cross-section of *French* local communities the ideological orientation of the local government has no significant

effect on education spending. Moreover, a socialist-oriented electorate is associated with lower education expenditures.

Heinesen (2004) finds for a panel of *Danish* municipalities (1984-1996) that a higher share of Socialists in the council is associated with higher public spending per pupil in primary education.

Falch and Rattsø (1997) find that a stable government and low party fragmentation in the *Norwegian* Parliament (1880-1990) is associated with lower aggregate teacher employment, while a socialist government increases teacher wages and employment. Evidence for high school spending at the level of Norwegian counties over the 1976-1993 period presented in Falch and Rattsø (1999) suggests that a high share of socialists in the council is associated with higher teacher/student-ratio and higher non-wage spending per teacher in high schools. However, this effect is conditional on the county level of per capita revenue, which suggests that partisan influence is somehow limited when public resources are scarce. Moreover, higher resource-use in high schools also seems to reflect socialists' priority for vocational training. Borge and Naper (2006) analyse a sample of lower secondary schools in Norwegian municipalities and find that higher party fragmentation and a high share of socialists in the local council are associated with higher resource-use and less efficient schools. For Norwegian primary education, Borge and Sørensen (2002) present evidence from survey data that does not suggest significant disagreement concerning spending levels (see also Falch and Rattsø, 1996). There is, however, some evidence that socialist politicians have somewhat higher preferences for public spending on kindergarten services. Overall, socialist participation in Norwegian government(s) seems to be associated with higher resources use in all levels of education with the exception of primary schooling. Moreover, socialists give priority to vocational training.

For *Germany*, Galli and Rossi (2002) investigate partisan effects on public expenditures for 11 West German Länder over the 1974-1994 period and do not find significant evidence in support of partisan theory. This finding is confirmed by Potrafke (2006) for the 1974-2004 period (expenditure data, 10 West German Länder) and by Tepe (2007) for the 1992-2004 period (teacher employment data, 16 German Länder). Schmidt et al. (2006) do find a negative effect of Social Democratic Länder governments on public

education spending in a pooled (PCSE) estimation. When they include Länder fixed effects, the coefficient effect becomes insignificant and thus, it could also capture unobserved Länder heterogeneity. For university expenditures the negative effect of SPD governments is also robust to the inclusion of Länder dummies. Coalition governments under participation of the liberal party, FDP, are associated with higher university expenditures. Oberndorfer and Steiner (2006) confirm the negative effect of Social Democratic Länder governments on public university spending based on a panel for 10 West German Länder over the 1985-2002 period. However, at the federal level, Social Democrats seem to have preferences for higher spending on financial support to students (see Potrafke, 2006). In summary, differences between political parties seem to be rather small or nonexistent when analysing overall education spending. For higher education spending there is some evidence pointing to higher spending preferences of liberal and conservative parties while at the federal level Social Democrats seem to prioritise financial support to students.

In conclusion, existing evidence tends to confirm the general partisan hypothesis that leftist governments prefer higher public spending also in the context of public education, although there are quite important differences in the results across countries. Moreover, some of the evidence points to limitations of such generally formulated partisan hypotheses. *First*, partisan influence may be contingent on sufficiently favourable fiscal conditions; specifically the rule of party ideology may not be feasible in times of tight public budgets or in welfare states in the globalised economy (Falch and Rattso, 1999 and Fusarelli, 2002). *Second*, the influence of party ideology may not be fair with respect to the overall level of public education spending, but also regarding specific educational tracks or levels which most benefit the party's electorate. This pattern might be the reason for the evidence found for Germany (higher education spending; financial support for students).

A.4.4.2 Panel unit root tests on the share of students enroled in comprehensive and joint schooling (first differences)

(a) Panel unit root tests on $\Delta(St^{COMPREHENSIVE}/St^{TOTAL})$

| Test | Statistic I | p-value | Unit root? | Statistic II | p-value | Unit root? |
|---|---|---|---|---|---|---|
| (1) Levin, Lin and Chu | -3.411 | 0.000 | no | -2.911 | 0.002 | no |
| (2) Breitung | - | - | | -4.073 | 0.000 | no |
| (3) Im, Pesaran and Shin | -6.636 | 0.000 | no | -5.857 | 0.000 | no |
| (4) ADF – Fisher | 85.160 | 0.000 | no | 73.190 | 0.000 | no |
| (5) PP – Fisher | 65.234 | 0.000 | no | 55.843 | 0.000 | no |
| (6) Hadri | 3.816 | 0.000 | yes | 3.765 | 0.000 | yes |

Note: Unit root/No unit root is based on p<0.05. Statistic I includes individual Länder effects; statistic II includes individual Länder effects and individual linear time trends. Tests (1) – (5) are based on the null hypothesis of the existence of a unit root. Test (6) is based on the null hypothesis of no unit root. Tests (1), (2) and (6) assume a common unit root process for all 10 Länder time series; tests (3) – (5) allow for the possibility of individual unit roots in the 10 Länder time series. Lag length is selected based on Schwartz Information Criterion. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

(b) Panel unit root tests on $\Delta(St^{JOINT}/St^{TOTAL})$

| Test | Statistic I | p-value | Unit root? | Statistic II | p-value | Unit root? |
|---|---|---|---|---|---|---|
| Levin, Lin and Chu | -2.836 | 0.002 | no | -1.269 | 0.102 | yes |
| Breitung | - | - | | -1.110 | 0.134 | yes |
| Im, Pesaran and Shin | -5.455 | 0.000 | no | -5.047 | 0.000 | no |
| ADF – Fisher | 75.158 | 0.000 | no | 71.195 | 0.000 | no |
| PP – Fisher | 72.085 | 0.000 | no | 65.541 | 0.000 | no |
| Hadri | 2.557 | 0.005 | yes | 4.663 | 0.000 | yes |

Note: Unit root/No unit root is based on p<0.05. Statistic I includes individual Länder effects; statistic II includes individual Länder effects and individual linear time trends. Tests (1) – (5) are based on the null hypothesis of the existence of a unit root. Test (6) is based on the null hypothesis of no unit root. Tests (1), (2) and (6) assume a common unit root process for all 10 Länder time series; tests (3) – (5) allow for the possibility of individual unit roots in the 10 Länder time series. Lag length is selected based on Schwartz Information Criterion. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

A.4.5.2 Panel unit root tests on relative teacher/student-ratios (first differences)

(a) $((T/St)^{GYM}/(T/St)^{TOTAL})$

| Test | Statistic I | p-value | Unit root? | Statistic II | p-value | Unit root? |
|---|---|---|---|---|---|---|
| Levin, Lin and Chu | -10.523 | 0.000 | no | -8.713 | 0.000 | no |
| Breitung | - | - | | -7.339 | 0.000 | no |
| Im, Pesaran and Shin | -9.555 | 0.000 | no | -8.209 | 0.000 | no |
| ADF – Fisher | 118.480 | 0.000 | no | 94.478 | 0.000 | no |
| PP – Fisher | 131.835 | 0.000 | no | 126.965 | 0.000 | no |
| Hadri | 0.263 | 0.396 | no | 2.885 | 0.002 | yes |

Note: Unit root/No unit root is based on p<0.05. Statistic I includes individual Länder effects; statistic II includes individual Länder effects and individual linear time trends. Tests (1) – (5) are based on the null hypothesis of the existence of a unit root. Test (6) is based on the null hypothesis of no unit root. Tests (1), (2) and (6) assume a common unit root process for all 10 Länder time series; tests (3) – (5) allow for the possibility of individual unit roots in the 10 Länder time series. Lag length is selected based on Schwarz Information Criterion. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

(b) $((T/St)^{HAUPT}/(T/St)^{TOTAL})$

| Test | Statistic I | p-value | Unit root? | Statistic II | p-value | Unit root? |
|---|---|---|---|---|---|---|
| Levin, Lin and Chu | -5.346 | 0.000 | no | -4.044 | 0.000 | no |
| Breitung | - | - | | -1.969 | 0.025 | no |
| Im, Pesaran and Shin | -7.174 | 0.000 | no | -6.702 | 0.000 | no |
| ADF – Fisher | 91.356 | 0.000 | no | 79.380 | 0.000 | no |
| PP – Fisher | 111.555 | 0.000 | no | 438.868 | 0.000 | no |
| Hadri | 0.654 | 0.257 | no | 1.999 | 0.023 | yes |

Note: Unit root/No unit root is based on p<0.05. Statistic I includes individual Länder effects; statistic II includes individual Länder effects and individual linear time trends. Tests (1) – (5) are based on the null hypothesis of the existence of a unit root. Test (6) is based on the null hypothesis of no unit root. Tests (1), (2) and (6) assume a common unit root process for all 10 Länder time series; tests (3) – (5) allow for the possibility of individual unit roots in the 10 Länder time series. Lag length is selected based on Schwarz Information Criterion. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

(c) $((T/St)^{JOINT}/(T/St)^{TOTAL})$

| Test | Statistic I | p-value | Unit root? | Statistic II | p-value | Unit root? |
|---|---|---|---|---|---|---|
| Levin, Lin and Chu | -10.205 | 0.000 | no | -10.243 | 0.000 | no |
| Breitung | - | - | | -6.129 | 0.000 | no |
| Im, Pesaran and Shin | -10.629 | 0.000 | no | -10.336 | 0.000 | no |
| ADF – Fisher | 135.580 | 0.000 | no | 119.171 | 0.000 | no |
| PP – Fisher | 173.397 | 0.000 | no | 186.984 | 0.000 | no |
| Hadri | 0.716 | 0.237 | no | 5.141 | 0.000 | yes |

Note: Unit root/No unit root is based on p<0.05. Statistic I includes individual Länder effects; statistic II includes individual Länder effects and individual linear time trends. Tests (1) – (5) are based on the null hypothesis of the existence of a unit root. Test (6) is based on the null hypothesis of no unit root. Tests (1), (2) and (6) assume a common unit root process for all 10 Länder time series; tests (3) – (5) allow for the possibility of individual unit roots in the 10 Länder time series. Lag length is selected based on Schwarz Information Criterion. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

A.4.5.4.2 Political parties' influence on resource allocation across tracks (10 West German Länder, 1981-2006)

| | (1) $\Delta(TSt^{GYM}/TSt^{TOTAL})$ | (2) $\Delta(TSt^{HAUPT}/TSt^{TOTAL})$ | (3) $\Delta(TSt^{JOINT}/TSt^{TOTAL})$ |
|---|---|---|---|
| SPD-FDP | -0.000 | 0.008 | -0.010 |
| | (0.005) | (0.010) | (0.011) |
| SPD-Green Party | 0.007 | 0.010 | -0.016 |
| | (0.004)* | (0.010) | (0.007)** |
| SPD-FDP-Green P. | 0.024 | -0.024 | 0.012 |
| | (0.010)** | (0.017)+ | (0.015) |
| SPD-Statt Party | 0.004 | 0.026 | -0.017 |
| | (0.007) | (0.009)*** | (0.017) |
| CDU | 0.009 | -0.012 | -0.025 |
| | (0.004)** | (0.010) | (0.008)*** |
| CDU-FDP | 0.001 | 0.001 | -0.015 |
| | (0.005) | (0.008) | (0.008)* |
| CDU-FDP-Statt P. | -0.004 | 0.047 | -0.050 |
| | (0.008) | (0.016)*** | (0.011)*** |
| Grand Coalition | 0.002 | 0.002 | 0.008 |
| | (0.007) | (0.008) | (0.010) |
| $\Delta(St^{GYM}/St^{TOTAL})$ | -0.440 | | |
| | (0.087)*** | | |
| $\Delta(St^{HAUPT}/St^{TOTAL})$ | | -0.334 | |
| | | (0.369) | |
| $\Delta(St^{JOINT}/St^{TOTAL})$ | | | -0.875 |
| | | | (0.058)*** |
| Δ ln (PR) | -0.001 | 0.079 | -0.026 |
| | (0.032) | (0.058)+ | (0.045) |
| Δ ln (PD) | 0.523 | 0.363 | -0.450 |
| | (0.414) | (0.431) | (0.597) |
| Δ UR | 0.354 | -0.426 | 0.375 |
| | (0.268)+ | (0.616) | (0.545) |
| Δ o60 | 2.597 | -2.080 | -3.841 |
| | (1.933)+ | (3.184) | (3.022) |
| Länder FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 250 | 250 | 250 |
| Adjusted R-squared | 0.11 | 0.07 | 0.29 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

A.4.5.4.3 The effect of education ministers' party affiliation on resource allocation across tracks (10 West German Länder, 1981-2006)

| | (1) $\Delta(TSt^{GYM}/TSt^{TOTAL})$ | (2) $\Delta(TSt^{HAUPT}/TSt^{TOTAL})$ | (3) $\Delta(TSt^{JOINT}/TSt^{TOTAL})$ |
|---|---|---|---|
| Education Minister CDU | 0.004 | -0.011 | -0.010 |
| | (0.004) | (0.009) | (0.007)+ |
| Education Minister FDP | -0.006 | 0.037 | -0.041 |
| | (0.008) | (0.013)*** | (0.011)*** |
| $\Delta(St^{GYM}/St^{TOTAL})$ | -0.480 | | |
| | (0.082)*** | | |
| $\Delta(St^{HAUPT}/St^{TOTAL})$ | | -0.265 | |
| | | (0.388) | |
| $\Delta(St^{JOINT}/St^{TOTAL})$ | | | -0.881 |
| | | | (0.061)*** |
| Δ ln (PR) | 0.012 | 0.065 | -0.038 |
| | (0.026) | (0.057) | (0.042) |
| Δ ln (PD) | 0.511 | 0.532 | -0.596 |
| | (0.423) | (0.404)+ | (0.675) |
| Δ UR | 0.352 | -0.369 | 0.330 |
| | (0.275) | (0.615) | (0.558) |
| Δ o60 | 2.118 | -0.830 | -1.492 |
| | (1.838) | (2.711) | (2.789) |
| Länder FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 250 | 250 | 250 |
| Adjusted R-squared | 0.09 | 0.07 | 0.28 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.

A.4.5.4.4 A separation of exogenous and potentially endogenous political variation: Political parties' influence on resource allocations across tracks (10 West German Länder, 1981-2006)

| | (1) $\Delta(TSt^{GYM}/TSt^{TOTAL})$ | (2) $\Delta(TSt^{HAUPT}/TSt^{TOTAL})$ | (3) $\Delta(TSt^{JOINT}/TSt^{TOTAL})$ |
|---|---|---|---|
| CDU*NONELECT | 0.009 | -0.010 | -0.020 |
| | (0.004)** | (0.009) | (0.007)*** |
| FDP*NONELECT | 0.007 | -0.010 | -0.031 |
| | (0.006) | (0.011) | (0.011)*** |
| Green P*NONELECT | 0.015 | -0.010 | -0.041 |
| | (0.008)* | (0.013) | (0.013)*** |
| SPD*ELECT | 0.003 | 0.001 | -0.010 |
| | (0.005) | (0.006) | (0.009) |
| CDU*ELECT | 0.002 | -0.010 | -0.024 |
| | (0.005) | (0.010) | (0.010)** |
| FDP*ELECT | -0.010 | -0.001 | -0.000 |
| | (0.012) | (0.013) | (0.017) |
| Green P.*ELECT | 0.014 | -0.010 | -0.030 |
| | (0.008)* | (0.013) | (0.014)** |
| Other | 0.004 | 0.019 | -0.047 |
| | (0.010) | (0.013)+ | (0.019)** |
| COALSIZE | -0.007 | 0.016 | 0.028 |
| | (0.006) | (0.010)+ | (0.011)*** |
| $\Delta(St^{GYM}/St^{TOTAL})$ | -0.479 | | |
| | (0.084)*** | | |
| $\Delta(St^{HAUPT}/St^{TOTAL})$ | | -0.333 | |
| | | (0.384) | |
| $\Delta(St^{JOINT}/St^{TOTAL})$ | | | -0.906 |
| | | | (0.054)*** |
| Δ ln (PR) | 0.013 | 0.063 | -0.018 |
| | (0.031) | (0.058) | (0.048) |
| Δ ln (PD) | 0.505 | 0.542 | -0.857 |
| | (0.432) | (0.451) | (0.698) |
| Δ UR | 0.324 | -0.411 | 0.297 |
| | (0.270) | (0.611) | (0.545) |
| Δ o60 | 2.261 | -1.941 | -2.927 |
| | (1.892) | (3.037) | (2.965) |
| Länder FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| Observations | 250 | 250 | 250 |
| Adjusted R-squared | 0.15 | 0.05 | 0.30 |

Note: Robust standard errors are reported in parentheses (Newey and West, 1987). ***, **, * and + denote significance at the 1%, 5%, 10% and at the 20% level, respectively.