Measuring Human Capital: A Comparative Analysis of PISA Background Factors

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This paper examines the impact of academic selection processes, socioeconomic factors, and school resources on the distribution and level of knowledge and skills of 15-year old students in countries that participated in the 2000 cycle of the OECD's Program for International Student Assessment (PISA). It does so by estimating a parsimonious model of educational performance at the country-level and expands on the findings with an analysis of subnational results in Germany and Canada. Academic selection processes segregate students into separate and distinct programs that are often closely linked to labor markets. If post-secondary selection processes are in place, a broader group of 15-year olds appears to do better in terms of knowledge and skills than students from differentiated systems. The subnational analysis questions these findings.

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Economists have documented that education and economic growth are related. Their findings have become the accepted wisdom among international organizations and governments worldwide and have directed the focus of national and international actors towards improving educational performance at all levels of the education system and beyond. In fact, as Crouch has pointed out (Crouch, Finegold and Sako 1999), the economic realities of globalization, i.e. the loss of low-level jobs and the increasing demand for higher-skilled workers, have encouraged governments to turn to education as a key component of human capital formation in their quest for solutions to rising social welfare costs. I explore the broad context of educational performance, relating schooling not only to the economy in the form of human capital, but also acknowledging political implications. "Education is increasingly seen as something the State owes to its citizens, and it is the State's responsibility to ensure it provides and equitable education for all. As a consequence, ensuring a fair and equitable education system has political as well as social implications" (Gorard and Smith 2004, 16). Therefore, when the unexpected outcomes of international testing suggest that human capital is in danger in countries where we might least expect it, questions arise as to the quality of education provided by the state and whether the education system is indeed fair and equitable.

This paper argues that the performance variations across the countries that participated in the 2000 Program for International Student Assessment (PISA) can be partially explained by the macro-level institutional environment that education is embedded in.[1] It focuses in particular on the rules developed over time to accommodate

[1] PISA tests the reading, mathematical, and scientific literacy skills of 15-year old students at the end of compulsory education in order to assess their readiness for participating fully in society. The Organisation for Economic Cooperation and Development (OECD) initiated the first cycle of the Programme for International Student Assessment (PISA) in 2000. The second cycle occurred in 2003, with the third

different economic and educational goals by segregating students into distinct and separate programs and examines how these arrangements, together with the influence of other factors, affect educational performance and ultimately human capital.

I define educational performance in terms of both quality and equity. Quality captures how well a system prepares its students, that is the knowledge and skills students acquire. Equity refers to the fair distribution of educational resources: do all students have equal access to education, regardless of family background or socioeconomic barriers? Both are important for the successful development of human capital.[2] Specifically, this paper asks whether the structure of national education systems makes a difference for the quality of education, for equity, or both. By extending the analysis to the subnational level in two countries (Germany and Canada) with contrasting institutional arrangements, the research adds a new comparative perspective to extant analyses (Hanushek and Woessmann 2005; OECD 2005).

The research question will be answered in two steps: (i) First I will conduct a cross-country analysis that explores the effect of macro-level factors on educational performance. (ii) Next I will deepen the cross-country research by a comparative analysis of Germany's states (Laender) and Canada's provinces. The subnational study focuses on how the factors identified as significant in the cross-country analysis affect quality and equity at the state/province level. The two countries were chosen as cases because (i) the subnational entities in both countries decide education policy, (ii) their PISA performance and education system are different and, (iii) secondary subnational data is available for both. [3] Germany's national PISA 2000 score ranked below the OECD mean, while Canada placed near the top. The subnational results reflect the significantly different outcomes: Canada's lowest-scoring province (New Brunswick) and Germany's top scoring state (Land), Bayern, performed at approximately the same level. As Baumert et al. cogently argue, while macro-level institutional factors shape the environment in which educational performance happens, the multitude of influences makes interpretation of results difficult, since not all causal factors can be captured in one model (Baumert, Carstensen and Siegle 2005, 325ff). Therefore, the subnational comparison will be critical for establishing the reliability of the entire nested analysis (Lieberman 2005). Overall, results at both levels are interpreted solely as signals that relationships may need to be analyzed in greater depth, and not as definitive causal explanations.

The data I use for my model is drawn from secondary sources, for example the OECD's international report (OECD 2003a) (OECD 2001; OECD 2003b), an OECD

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scheduled for 2006. 43 countries participated in PISA 2000, 41 in 2003, and 57 will take part this year. The OECD countries are joined by Latin American nations (e.g. Argentina, Chile, Uruguay), Eastern European (e.g. Latvia, Bulgaria, Romania), Middle Eastern (Israel, Tunisia) and Asian (e.g. Thailand, Indonesia, Hong-Kong China)

[2] Economies based on high skills and a high wage equilibrium, what Streeck calls "diversified quality production" Kozo Yamamura and Wolfgang Streeck, *The End of Diversity? Prospects for German and Japanese Capitalism* (Ithaca, NY, Cornell University Press, 2003), require that countries meet both goals, but they are also important for maintaining the economic prosperity of countries where low-skilled, well-paid factory jobs have been replaced by low-paid service jobs. On the other hand, developing countries may be more concerned about providing jobs to current graduates and less about broadening access.

[3] It is important to note that the OECD is only responsible for conducting country-level testing. Subnational testing is a voluntary option and the responsibility of the respective country. The U.S., for example, took part only in the national test. However, testing is organized in such a manner that national and subnational results are comparable.

follow-up study (OECD 2005) and country/subnational reports for Germany (PISA-Konsortium 2002) and Canada (Education 2001). Data generated from PISA includes not only the actual student level test results, but a vast array of self-reported student and school-level information that have allowed analysts to report how the quality of education, as defined by average PISA scores, is influenced by self-reported family- and school environment factors.

Using secondary data is a necessity, because subnational data has remained confidential in both Canada and Germany. Consequently, the number of observations is limited to the number of countries participating in PISA 2000 and the number of subnational entities in Canada (10) and Germany (14), which restricts the number of explanatory variables that can be used for estimation purposes.[4]

The research uses three indicators to measure the two components of the dependent variable, educational performance. The first indicator is *education quality*, measured as the average national and subnational PISA scores, which reflect the students' aggregate knowledge and skills. The second indicator addresses *education equity*, which can be measured as the Between-School-Variance as a percent of total variance. It provides a measure of how the quality of education differs between schools, i.e. it assesses whether by virtue of attending a different school, educational performance, on average, is likely to improve or decline. At the subnational level, I use the Range, which measures the performance difference between the highest and lowest performing 5% of students (95% - 5%), because the Between-School-Variance is not available for the Canadian provinces. These data address the span of the overall performance rather than performance differences between schools and are therefore less effective in measuring equity.

The following independent variables are used to explain education quality and equity: (1) school system differentiation, as indicated by the age at which students are separated into schools with distinct and unique programs (e.g. vocational, general, technical etc.), (2) school resources, as measured by Teacher-Student ratios, (3) the level of a country's overall economic resources, as indicated by its Gross Domestic Product, and (4) the level of school funding. These factors represent a broad spectrum of influences on education, they vary substantially across the countries and they are known to influence education (OECD 2005), both at the national and the subnational level.

The extant literature on the educational performance reported via PISA results has focused attention on the student characteristics, family background, and school factors reported by the OECD (Fertig 2003; Fertig and Schmidt 2002; Fuchs and Woessmann 2004; OECD 2004b; OECD 2005). Without question, school and home environments are extremely important. That should not blind us to the fact that education is also subject to macro-level factors, which structure the educational experience of *all* students, regardless of personal characteristics, socioeconomic background or school environment. In other words, I argue that while macro-level factors cannot explain *individual student* performance (ecological fallacy), they structure learning environments and expectations which are difficult to change (Streeck and Thelen 2005) and prepare the stage for the educational performance of all students. Together with the long-term horizon that accompanies any changes in education, the impact of macro-level factors can restrict

[4] Germany has 16 states (Laender), however, in Hamburg and Berlin the participation rate of students was below the level needed for statistical reliability, therefore results were not published.

educational opportunities at subnational and national levels, and affect the development of a nation's human capital and economic growth for a long time.

The Dynamics of System Differentiation

To understand why some countries differentiate their students into distinct programs or schools and others don't, a brief look at the historical context can help. In the advanced industrialized countries, the rules and norms that make up what I call "system differentiation" have evolved over time and, in some instances, survived through enormous changes.[5] Governments have traditionally found it politically expedient to segregate students based on various criteria, race, religion, gender, and ability being the most frequent ones in order to accommodate religious concerns or historical traditions and most frequently to link education systems with labor markets. [6] Academic selection, that is differentiation by ability, has historically been practiced in some form in almost every country, but does not always mean the permanent segregation of students into different schools. [7] The earlier a country differentiates its student population into, for example, general, vocational, or technical programs, the closer the education is linked into the labor market. There are three reasons for this: A differentiated system (i) prepares students for a certain career level (e.g. professional vs. blue-collar) with the appropriate skills, (ii) students can obtain school-leaving certificates that have recognized value in the labor market rather than become school drop-outs with no documented skills and (iii) signals to employers which graduates are likely to have acquired the skill level they are seeking in new employees. Overall, differentiated education systems support general and specific skills programs that have been found to mesh well with the requirements of a certain kind of labor market, labeled "coordinated" or "organized" (Hall and Soskice 2001).[8] In coordinated economies, employers, unions and the government coordinate the vocational training of young people and encourage investments in industry-specific skills (Estevez-Abe, Iversen and Soskice 2001).

If a close link to the labor market and a comparatively smooth transition from school to work gives differentiated system a distinct advantage (Allmendinger 1989),

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[5] For example, after World War II leaders of the American occupation forces demanded that Germany should establish an undifferentiated education system similar to the American system within each Land. The demand fell on deaf ears among German state officials, who decided to restore the Weimar Republic's education system structure - the current three-tiered system Arthur Hearnden, *Education, culture, and politics in West Germany* (Oxford, New York, Pergamon Press, 1976), .

[6] Germany's public primary schools were differentiated by religion (Catholic/Protestant) until after World War II and, although Belgian parents have their choice of schools, segregation by religion still affects 33% of students Stephen Gorard and Emma Smith, 'An international comparison of equity in education systems' *Comparative Education*, 40, 1, (2004), In a28 15-, Feb. 2004, . In Israel, the public school system exists next to a completely independent religious school system. Frequently, religious differentiation aligns with gender segregation, as it does in Ireland, where 44% of students attend single-sex schools Stephen Gorard and Emma Smith, 'An international comparison of equity in education systems' *Comparative Education*, 40, 1, (2004), In a28 15-, Feb. 2004, .

[7] Academic selection ranges from allowing students to take advanced placements courses within comprehensive schools (U.S.A., Canada) to the highly selective, tiered systems operating in the German-speaking countries (Germany, Austria, Switzerland) and the Netherlands.

[8] For an in-depth discussion of this subject see Margarita Estevez-Abe, et al., 'Social Protection and Formation of Skills: A Reinterpretation of the Welfare State', In *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage*, Hall and Soskice, *(*Oxford, Oxford University Press, 2001), 145-183,

selection processes can be problematic, particularly when schools draw from specific communities, or attract students from specific socioeconomic backgrounds. Students from disadvantaged backgrounds may be placed in academically less challenging programs than their cohorts from advantaged families (Willms 2003, 46). The more systematic this type of exclusion is practiced, the more the labor market and the economy will be deprived of much-needed human capital.

Undifferentiated education systems, on the other hand, provide a general education for all students, with differentiation occurring after graduation from secondary school. According to Estevez-Abe et al. the acquisition of general, portable skills aligns with competitive labor market institutions, where employers do not participate in the training of young people due to collective action problems (Estevez-Abe, Iversen et al. 2001). When selection processes are deferred to the post-secondary phase of education, students retain the opportunity to attend a variety of secondary school classes at their academic level without socioeconomic barriers. Differentiated and undifferentiated education systems share the goal of providing the best education possible. The PISA data can help us establish whether they have succeeded.

This paper argues that, although the stated goal of differentiated education systems is to provide equivalent basic knowledge and skills across separate and distinct programs, differentiated education system produce disparities in educational performance. Within countries, i.e. Germany and Canada, the research will examine how subnational PISA results and macro-level factors linked to educational outcomes are clustered, confirming or disconfirming the country-level argument.

Educational Performance Model

This study explains educational performance through a nested analysis (Lieberman 2005). The first step is a country-level regression model using the PISA 2000 participating nations, followed by an analysis of whether or how influences found to be significant at the national level continue or abate at the subnational level in Germany and Canada. This two-stage approach provides strong advantages, particularly by subjecting the parsimonious national model to a second test at the subnational level. Because Germany and Canada represent opposite system differentiation philosophies, comparing the subnational entities (i) shows whether or how the variables that influence PISA scores and Between-School-Variances at the national level covary at the subnational level when the System Differentiation variable has been removed, and (ii) helps explain the impact of differences and similarities between Germany and Canada on both the quality of education and the opportunity to benefit from it. The comparison between national and subnational results gives evidence of the extent to which institutionalized selection procedures supersede other influences. The subnational comparison alerts us to potential explanations for the significant performance differences between Canada and Germany.

Measuring Educational performance

Educational performance is measured by using two indicators, quality and equity.

Quality: This research adopts a country's PISA 2000 score for Reading Literacy as a measure of educational quality, defined as the knowledge and skills students acquire,. Reading Literacy, rather than a combined Reading, Mathematics, and Science score, was chosen because PISA 2000 focuses on this competency. In fact, while the composite score is useful for ranking countries, more detailed analyses are possible only for each literacy component. Analyzing the mathematical and scientific results in addition to

reading, however, exceeds the scope of this paper. The original intention of merging 2000 and 2003 Reading Literacy scores was abandoned, because of the different competency foci, which might skew results if PISA-derived data were averaged between the 2000 and 2003 scores. Since the PISA 2000 scores are available for the German Laender and Canadian provinces, this approach allows all available data to be incorporated and thus the broadest application of the model.

Equity: Equity is defined as the fair distribution of educational resources and can be measured in several ways. The range of performance measures the spread between the highest and lowest score of a distribution, or as in the national and subnational PISA reports, the difference between the highest and lowest performing 5% of students. A small range indicates relative homogeneity in performance. A large range, on the other hand, points to large variations, which I argue are at least partially explainable by system differentiation. However, alternative explanations, for example student characteristics, family background or school factors cannot be ruled out. The OECD itself promotes the average performance difference between schools as indicator of equity (OECD 2005). The value of the indicator is based on the theory that, in the absence of institutional, socioeconomic or other barriers, student characteristics determine performance variations. Thus, in the best of all worlds, the within-school variance should exceed the between-school-variance in a given country. If within-school variations are small and between school variations large, then schools may deliver efficiency, selective quality, but not equity. If between-school-variances are small students receive a similar education regardless of the school they attend. The OECD reports for PISA 2000 (OECD 2001; OECD 2003a) provide the Between-school-Variance for all countries except Romania and France, but these data are not available at the subnational level. [9] As a consequence, the less effective range will be used to measure equity at the subnational level.

Determinants of Educational Performance

Education System Differentiation: Macro-level institutional arrangements influence educational performance because they maintain the stable framework within which schools educate and students learn. This paper focuses on education system differentiation, that is the age at which school systems select students into distinct and unique programs (e.g. vocational, general, technical etc.) as the key institutional determinant. At age 15, the age at which the PISA test is administered, some school systems (for example Germany, Austria and Switzerland as well as the Netherlands) have already made selections, other countries wait until age 15/16, and many defer differentiation until after graduation from secondary school. Two dummy variables capture the three system differentiation values: Age16 reflects systems that segregate students at ages 15 or 16, and Pre-Age16 captures those that differentiate earlier. [10]

[9] Romania delivered its data too late to be incorporated into the OECD report and in France these data are not calculated. Romania's separate report does not contain the figures either. See OECD, *Literacy Skills for the World of Tomorrow: Further Results from PISA 2000. Addendum for Romania*, (2003, www.pisa.oecd.org).

[10] The indicator values are: Age16: 1 = differentiation at age 15 or 16, 0 = all others, Pre-Age16: 1 = differentiation prior to age 15/16, 0 = all others. This approach treats undifferentiated systems as the baseline. Source: OECD, *School Factors Related to Quality and Equity: Results from PISA 2000*, (Paris, France, April 2005, 2005), and www.lmu.edu/gobaled/wwcu/background/XX.rtf where XX is replaced with the country abbreviation.

The selection process clearly separates students by academic criteria in order to prepare them more efficiently for their specific career choices. This approach makes possible Germany's traditional, dual system of school and work via an apprenticeship program and generally eases students' transition into the work life (Allmendinger 1989). Two crucial questions emerge: (i) which of the three selection types supports best the acquisition of the knowledge and skills needed in the future, i.e. which helps improve the quality of a country's human capital, and (ii) which system supports best the widest distribution of that knowledge and skills? I expect to confirm the OECD findings (OECD 2005) that differentiation by age and academic selection reduces the quality and equity of performance at the national level. At the subnational level, the hypothesized link between system differentiation and socioeconomic status will follow the national results: strong for Germany and weak for Canada.

Teacher-Student Ratio: Students learn in school environments that differ in many respects, whether by fixed characteristics like location (rural, urban, suburban), or by modifiable factors like the number of teachers employed. Some researchers accept the thesis that smaller classes enhance learning (Wenglinsky 1997). Kozol has documented the "savage inequalities" that affect educational performance in New York City and its suburbs, referring, for example, to the effects of different class sizes on students' ability to learn (Kozol 1991). Fuchs and Woessman, on the other hand, find no effect of smaller class sizes on PISA results (Fuchs and Woessmann 2004). Generally, the inconsistency of performance data has made reliable conclusions difficult (Smith and Meier 1995). Using PISA data eliminates the problems of how to measure educational outcomes, therefore we can test whether lower student-teacher ratios will lead to higher PISA scores.

The Level of School Funding: Schools cannot perform without adequate funding. A country's level of school expenditures measures both the 'willingness and ability of a country/subnational entity to spend on education (Verner 1979). The number and quality of teachers a government can attract and employ, the maintenance and building of adequate facilities, the availability of books, materials and other teaching resources all contribute to the level of educational performance (Fuchs and Woessmann 2004; OECD 2005) (PISA-Konsortium 2005). Countries, that allocate a larger than average share of their assets to education can be expected to perform better than others. For example, Germany's system of "cooperative federalism" allows the federal government to distribute funds for education to the states (Laender), but severely restricts its capacity to fund its own, federal education programs (Muench 1999). Since the Basic Law (*Grundgesetz*) requires the federal government to ensure comparable living conditions for all citizens, a negotiated percentage of revenues from "wealthy" Laender is redistributed to "poor" states to even out financial resources. The redistributive principle of *Finanzausgleich* (equalization of funding), reaffirmed in 2001, takes into account structural Laender differences (Finanzministerium 2001). In Canada, school funding is decided entirely by the provincial governments, hence school expenditures are more directly correlated to the state of the provincial economy. Here, I test the hypothesis that differences in school funding affect performance: the higher school funding is in a country or state/province, the higher the PISA scores. Conversely, funding can be thought of as a way to ensure equality of educational opportunity: the higher the funding, the smaller the differences between schools.

The actual indicators used here differ between the national and subnational analyses. The Education Statistics published by the Worldbank (www.worldbank.org) provide data on expenditures by student as a percent of Gross Domestic Product for nearly all countries in the world, while the UNESCO Education Statistics supply per student expenditures. Since the Worldbank data has the fewest missing values, those are the data used in the study.[11] At the state/province level, however, per student expenditures are readily available for both Canada and Germany.

GDP: This indicator broadly subsumes the results of macro-level efforts to manage the national or subnational economy, as well as their impact on the economic well-being of individual families. Both perspectives are important factors for education. The overall economic climate affects tax revenues available for education financing and it enhances or impairs the ability to maintain school facilities. The Gross Domestic Product (GDP) shows enormous variations across the PISA participating countries, as reported by the World Bank in U.S. dollars and at market prices (www.worldbank.org).[12] The huge economic disparities (see Table 2) point to significantly different standards of living that create different learning opportunities for children. As the PISA analyses have pointed out, a family background rich in cultural and material possessions (books, computers) enhances learning (OECD 2003a; OECD 2004a; PISA-Konsortium 2005). The higher the GDP, the higher the PISA scores can be expected to be. The impact on equity is expected to be the reverse - a higher GDP should reduce Between-School-Variances by ensuring that the broadest spectrum of students is well educated. These hypotheses are expected to apply to the subnational level as well.

Socioeconomic Status: Regardless of different perspectives on or interpretations of educational performance, analysts universally accept the notion that family background crucially affects students' educational performance.[13] Low income families, for example, usually lack the financial or educational resources, or the experience, to provide their children with the same learning opportunities as middle class or higher income parents do. Kozol has vividly documented how the clustering of low versus high income families in metropolitan New York disadvantages students from poor families (Kozol 1991). In PISA 2000, students reported on a variety of family characteristics, among them their parents' occupational status and educational attainment (OECD 2003a). This study expects educational performance to rise when the students' socioeconomic status increases. Conversely, differences in performance between schools should decline with improvements in income levels and educational attainment. This study adopts the International Socioeconomic Index of Occupational Status (ISEI) reported by PISA to relate the students' literacy performance to their family background or socioeconomic

[11] Data is missing for Luxembourg and the Russian Federation.

[12] In fact, international studies analyzing school factors and student characteristics often use GDP to control for differences in economic power. See Ludger Woessmann,*Schooling Resources, Educational Institutions, and Student Performance: The International Evidence* Institute for Economic Research (IFO), University of Munich, 2000), National data is available from the World Bank at www.worldbank.org. Per capita GDP for the German Laender is available from Statistische Aemter des Bundes und der Laender, *Volkswirtschaftliche Gesamtrechnungen der Laender: Gross Domestic Product at Current Prices, 1991-2003*, (2005, For Canada's provinces, see Francis Nault, *Summary public school indicators for he provinces and territories, 1996-1997 to 2002-2003*, (2006, www.statcan.ca) for the per capita GDP indicator.

[13] I use "socioeconomic status" synonymously with "family background".

status. The index ranges from 0 to 90 and "captures the attributes of occupation that convert parents' occupation into income" at the country-level (OECD 2003a, 233). [14]

Table 1 displays the mean values of all variables in the national model, Table 2 and 3 report those values for Germany and Canada respectively.

Table 1: Educational Performance Model - All Countries[15]

Country	PISA Score	Between-School-Variation	Education System Differentiation Age 16	Education System Differentiation Pre-Age 16	GDP (in $US)	School Funding	Teacher-student ratio	Socioeconomic Status (SES)
Albania	349	40	1	0	3445	12	16	27.7
Argentina	418	49.8	1	0	283523	15	12	37.5
Australia	527	20.3	0	0	403895	17	12.7	43
Austria	499	60.1	0	1	209955	33	10	39
Belgium	507	60	0	1	251133	25	12	52
Brazil	400	46.8	0	0	529476	14	22	35
Bulgaria	430	57.7	1	0	12955	18	12	39.1
Canada	531	20.7	0	0	651216	21	19	32
Chile	410	55.8	1	0	73046	15	29	39.1
Czech Republic	491	54	0	1	58999	20	13	55
Denmark	495	15.7	0	0	173124	38	10	40
Finland	545	7.7	0	0	127834	27	17	29.5
France	501	m	1	0	1443748	25	12	40.5
Germany	488	59.4	0	1	2108033	22	15	50.5
Greece	473	50.2	1	0	120058	18	10	37
Hongkong-China	518	47.8	0	0	160636	21	19	29
Hungary	481	65.5	0	1	48011	21	10	57.5
Iceland	500	8.2	0	0	8425	22	12	26
Indonesia	377	44.2	0	0	140001	6	16	20.5
Ireland	521	18	1	0	95476	16	22	35.5
Israel	452	45.2	0	1	103852	23	10	34.2
Italy	482	54.5	1	0	1180475	25	11	29.5
Japan	510	46.5	1	0	4452977	19	14	46
Korea	525	37.9	1	0	445168	15	22	36.5
Latvia	475	30.2	1	0	7221	23	11	31
Luxembourg	460	m	0	1	19964	m	11	33.5
Macedonia, FYR	373	44.5	1	0	3673	15	16	32.6
Mexico	411	53.4	0	1	481094	15	17	29.5
Netherlands	513	52	0	1	398540	22	13	40.5
New Zealand	526	16.1	0	0	54457	26	16	43

[14] For the methodology behind the ISEI see H.B.G. Ganzeboom, et al., 'A standard international socio-economic index of occupational status' *Social Science Research*, 21, 1, (1992), 1-56, Low values indicate low socioeconomic status, and high values represent high socioeconomic status.

[15] Data Sources: PISA score, Standard Deviation, Between-School-Variation: OECD, *Literacy Skills for the World of Tomorrow - Further Results from PISA 2000*, (Paris, 2003, 2003a), ; System Differentiation: OECD, *School Factors Related to Quality and Equity: Results from PISA 2000*, (Paris, France, April 2005, 2005), and www.worldbank.org; GDP, School Funding, Teacher-Student ratio: www.worldbank.org; Family Background: OECD, *Literacy Skills for the World of Tomorrow - Further Results from PISA 2000*, (Paris, 2003, 2003a),

Country	PISA Score	Between-School-Variation	Education System Differentiation	Education System Differentiation	GDP (in $US)	School Funding	Teacher-student ratio	Socioeconomic Status (SES)
Norway	503	9.1	0	0	158098	28	9	39
Peru	327	60.7	1	0	51597	9	19	35.9
Poland	488	62.7	1	0	164466	19	13	44.5
Portugal	474	37.3	1	0	115097	26	10	31.5
Romania	428	m	1	0	35592	16	13	45.5
Russian Federation	462	36.9	1	0	195906	m	11	38
Spain	487	21.2	0	0	602407	22	11	33
Sweden	515	8.8	0	0	251322	29	14	40
Switzerland	497	41	1	0	264874	29	10	45.5
Thailand	426	31.7	1	0	122338	17	25	26.5
UK	500	29	0	0	1462328	17	18	42
US	523	29.6	0	0	9216200	22	15	47.5

Table 2: Educational Performance Model - Germany[16]

Land	PISA 2000 Score	Range (distance between the lowest and highest 5%)	GDP, Per Capita	School Funding, per Student	Teacher-Student Ratio	Socioeconomic Status (SES)
Baden-Wuerttemberg	500	368	27402	3795	16.47	45.7
Bayern	510	339	27864	3856	16.53	45.1
Brandenburg	459	338	16180	3397	15.29	41.5
Bremen	448	377	31890	5030	15.54	43.4
Hessen	476	365	29460	3684	17.23	45.1
Mecklenburg-Vorpommern	467	350	16080	3675	15.96	40
Niedersachsen	474	374	21901	3704	16.99	43.5
Nordrhein-Westfalen	482	384	24500	3838	17.23	44.5
Rheinland-Pfalz	485	357	21774	3530	17.26	43.2
Saarland	484	352	22069	3491	17.87	45.1
Sachsen	491	347	16232	3660	15.23	41.7
Sachsen-Anhalt	455	354	15561	4010	14.45	40
Schleswig-Holstein	478	365	22406	3867	17.01	45.8
Thueringen	482	344	15846	4085	14.06	40.8

Table 3: Educational performance Model - Canada[17]

[16] Data sources: PISA score, Between-School-Variance, Range, family Background: Deutsches PISA-Konsortium, *PISA 2000 - Die Laender der Bundesrepublik Deutschland im Vergleich* (Opladen, Leske & Budrich, 2002), ; GDP, School Funding, Teacher-Student ratio ; Staendige Konferenz der Kultusminister der Laender der Bundesrepublik Deutschland,*Schueler, Klassen, Lehrer und Absolventen; 1993 - 2003* (Bonn, Germany, KMK, Bonn, Germany, 2004), .

[17] Data sources: PISA score, Range, Family Background: Council of Ministers of Education,*Measuring Up: The performance of Canada's youth in reading, mathematics, and science* (Ottawa, Toronto, Council of Ministers of Education, 2001), ; GDP, School Funding, Teacher Student Ratio: Francis Nault, *Summary public school indicators for he provinces and territories, 1996-1997 to 2002-2003*, (2006, www.statcan.ca).

Provinces	PISA 2000 Score	Range (Difference between lowest 5% and highest 5%)	GDP, Per capita	School Funding, per Student	Teacher-Student ratio	Socioeconomic Status (SES)
Alberta	550	321	43830	7210	18.02	54
British Columbia	538	314	31293	7421	16.59	53.3
Manitoba	529	316	28881	7350	15.37	50.3
New Brunswick	501	321	26118	7283	16.77	50
Newfoundland	517	320	24487	6076	14.29	47.5
Nova Scotia	521	316	25586	6059	16.46	51.6
Ontario	533	317	36693	7261	16.62	54.1
Prince Edward Island	517	316	23846	5859	16.62	49.6
Quebec	536	302	29700	6818	14.8	51.5
Saskatchewan	529	299	31879	6705	16.2	51

Estimating the Educational Performance Model for all Countries

The PISA 2000 cycle has demonstrated significant differences in educational performance across participating countries. To explain the impact of institutionalized selection rules, with socioeconomic and school factors controlling for spurious results, I estimate the model with PISA scores first and then Between-School-Variance as dependent variables for all countries. The small number of observations at the subnational level makes a descriptive analytic approach more reliable, albeit without the explanatory power of the estimation model. The purpose of this step-by-step process is to determine whether the factors that are significant at the national level still retain significance when the system differentiation variable is removed. By comparing the German and Canadian results I can better assess the extent to which selection rules constrain or enhance educational performance.

Table 4: Effects of Educational Model on Quality

Variable	All Countries
System Differentiation - Age 16	-27.26* (14.47)
System Differentiation - Pre-Age 16	-33.85** (13.99)
Socioeconomic Status	1.65*** (.588)
Teacher-Student Ratio	1.44 (1.878)
GDP	.00000038 (.0000002)
School Funding	5.11*** (1.45)
Constant	298.374*** (51.71)
Adjusted R^2	.5519
F (5, 34)	5.97***
N	39

Note: Entries are unstandardized regression coefficients. Robust standard errors are in parentheses. * = p < .10; ** = p < .05; ***p < .01

Despite its extremely parsimonious nature, the national model still explains 55% of the total variance (R^2 = .55). [18] All variables except Teacher-Student Ratio and GDP are statistically significant, including both institutional dummy variables, and we can cautiously say that they seem to influence the national level of performance. The average PISA score for an undifferentiated system would be 298, which occurs when both system differentiation indicators have a value of zero. Countries with educations systems that select students into distinctly different programs at age 15/16 (Age 16 indicator = 1) on average are doing less well (minus 27 points on the PISA scale) than countries that do not differentiate at all. An even earlier selection process, e.g. at age 10 to 14 (Pre-Age 16 = 1), is likely to decrease average scores for the group by a total of 33 points. Socioeconomic status and school funding variables point in the same direction: higher levels are associated with better PISA scores. These data confirm the hypotheses and findings by other analysts (OECD 2003a).

When we estimate the same parsimonious model for the differences between schools, a slightly different, but illuminating picture emerges. This model explains an even greater percentage of the variation in Between-School-Variances (R^2 = .64).[19] The institutional component is also more influential: the significance levels for the Age 16 and the Pre-Age 16 indicator are at α = < .01.

Table 5: Effect of Educational Model on Equity [20]

Variable	All Countries
System Differentiation - Age 16	18.04*** (4.93)
System Differentiation - Pre-Age 16	30.53*** (5.49)
Socioeconomic Status	.3157 (.267)
Teacher-Student Ratio	- .29 (.5421)
GDP	- .00000004 (.00000006)
School Funding	- 1.0024*** (.3487)
Constant	38.12** (15.29)
Adjusted R^2	.6487
F (5, 32)	15.12***
N	37

Note: Entries are unstandardized regression coefficients. Robust standard errors are in parentheses. * = p < .10; ** = p < .05; ***p < .01

[18] Diagnostic tests ruled out problems with multicollinearity, all Variance Inflation factors had values below 2.

[19] Diagnostic tests ruled out problems with multicollinearity, all Variance Inflation factors had values below 2.

[20] France and Romania have not reported Between-School-Variance data for PISA 2000.

With increases in school funding, the Between-School-Variance decreases. In other words, countries that are able to fund schools at higher levels on average reduce the differences between schools. As before, the GDP has a miniscule and non-significant impact. Interestingly, the socioeconomic status variable loses its significance when the model explains variations between schools. It seems that the problematic aspects of system differentiation mentioned above, namely that schools draw preferentially from specific socioeconomic neighborhoods, may be intensified by institutionalized, academic selection mechanisms to such an extent that system differentiation and socioeconomic status overlap, and perhaps even stand in for each other. The Between-School-Variance as a percent of the total variance increases by 18 percentage points for education systems that differentiate at age 15/16, and 30 percentage points for those that segregate students prior to the end of compulsory education.

The results seem quite clear with respect to the negative effect of age-related academic selection processes on educational performance. Knowledge and skills on average are significantly lower under institutionalized selection processes and different schools provide surprisingly different levels of educational quality to their students, jeopardizing the formation and improvement of human capital. Countries can easily end up in a vicious circle, where increased school funding, which improves quality and equity both, depends on economic growth, which in highly industrialized countries depends on a skilled labor force. The cycle deteriorates when the education system fails to deliver the skills.[21] If countries also adhere to an institutional framework that inhibits educational performance, they may - according to these national results - seriously limit their future economic possibilities. To see whether that finding holds at a lower level of detail, I will now analyze the subnational PISA data for Germany and Canada.

Comparison of Subnational Models for Germany and Canada

To compare the small number of German states (16) and Canadian provinces (10) the values of all variables have been normalized to a mean of 100, and a standard deviation of 1. This approach has the advantage of representing all variable values as standard deviations from the mean, allowing for a detailed comparison of cross-national patterns. Its disadvantage is that the relative positioning of the raw scores on the original distribution is lost. For example, Canada's provincial PISA 2000 scores range from a high of 550 for Alberta to a low of 501 for New Brunswick, whereas Germany's Laender spanned a much lower and broader performance range, from a high of 510 for Bayern to a low of 448 for Bremen (PISA-Konsortium 2002). Any subnational analysis must keep the raw performance distribution in mind when comparing states and provinces.

Quality of Education

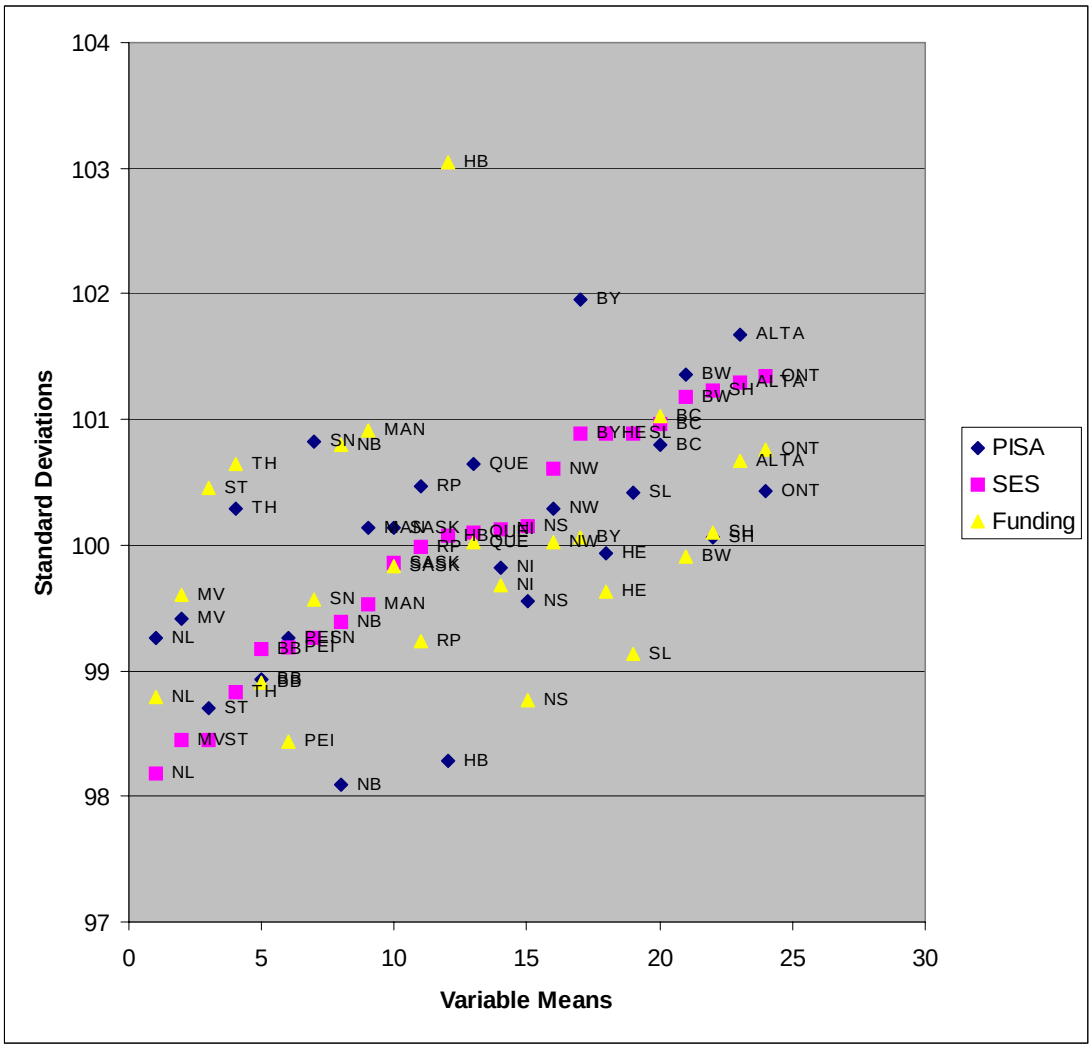
The national comparison disconfirmed teacher-student ratio and GDP as a predictors of either quality or equity and these variables can be dropped from the subnational analysis (Lieberman 2005, 439). A scatterplot (Figure 1) displays the pattern between all statistically significant variables, sorted on socioeconomic status (SES) as the variable most reflective of system differentiation.[22] Contradictory trends immediately become

[21] Other factors can also send the cycle into a downward spiral, e.g. lagging economic growth.

[22] Abbreviations for states/provinces follow national usage. Canada: ALTA (Alberta), BC (British Columbia), MAN (Manitoba), NB (New Brunswick), NL (Newfoundland and Labrador), NS (Nova Scotia), ONT (Ontario), PEI (Prince Edward island), QUE (Quebec), SASK (Saskatchewan). Germany: BW (Baden-Wuerttemberg), BY (Bayern), BB (Brandenburg), HB (Bremen), MV (Mecklenburg-

apparent: (i) as the students' family background improves occupationally and economically, on average, the PISA scores, GDP, and School Funding all increase as well, as predicted by the national results. (ii) The overall picture is punctuated by significant deviations.

Figure 1: PISA 2000 Scores, Socioeconomic Status (SES) and Funding
(normalized, sorted by SES)



Bremen is the extreme outlier among all states and provinces. School funding falls more than three standard deviations higher than the mean of 100, the average socioeconomic status is close to the mean for all Laender, and PISA scores are far below the mean. New Brunswick, Canada's lowest scoring province, exhibits a similar pattern, although less extreme. Clearly, variables not included in the model are significantly affecting the PISA scores in Bremen and New Brunswick. In the German case, the high level of non-German speaking students in the city states is most often blamed for the poor performance despite findings to the contrary (Carle 2002; Fertig 2003). According to the official PISA 2000 analysis (PISA-Konsortium 2002), 40.7% of students in Bremen live

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Vorpommern, NI (Niedersachsen), NW (Nordrhein-Westfalen, RP (Rheinland-Pfalz), SL (Saarland), SN (Sachsen), ST (Sachsen-Anhalt), SH (Schleswig-Holstein), TH (Thueringen).

with at least one foreign-born parent, and 30.6% live with two foreign-born parents. These numbers compare to 22.4% and 14.8% respectively for the PISA "winner", Bayern. When looking at groups, the relative performance of Canada's Atlantic provinces, except for Nova Scotia, combines below average PISA scores with below average socioeconomic status and school funding. According to Willms , no one factor explains these provincial differences, but on average "about 40% of the variation in provincial mean scores is attributable to students' family background" (Willms 2004, 42). A low SES environment places students in jeopardy for low educational performance. Interestingly, four of the East German states with equally low socioeconomic values perform much better on PISA than their socioeconomic status would predict. Overall, the states or provinces whose socio-economic status falls below the mean of their country are clustered in the economically weak regions of their respective countries, East Germany and the Atlantic provinces.

However, differences exist: for the Atlantic provinces, School Funding values and PISA scores all remain relatively the same distance from the average socioeconomic status (excepting New Brunswick), while for East Germany school funding and PISA scores are from one to two standard deviations higher than socioeconomic status, although some are still below the mean. In sum, the analysis of the lowest performing states and provinces shows that the overall much higher raw performance of Canada's students is supported by a macro-level environment that remains relatively constant as the average socioeconomic status increases. Variable values are clustered within one standard deviation of the socioeconomic mean, the only exception being Nova Scotia, whose school funding is below that level. In contrast, for Germany's economically weakest states (based on GDP and socioeconomic status), the macro-level environment seems inconsistent - high school funding is coupled with both high and low PISA scores.

Canada's constant macro-level environment is duplicated in Germany for states whose socioeconomic mean clusters around or above the middle of the SES spectrum. Bremen is the extreme outlier, as mentioned, but all other values remain within one standard deviation of the SES mean. There is a noticeable pattern with regard to school funding, however: school funding for states and provinces with high SES values falls in almost all cases much below the entities' normalized SES value, in the case of Hessen, Baden-Wuerttemberg and Saarland even below the overall normalized SES mean. Alberta and Bayern are outliers: Measured in standard deviations, Alberta's GDP is the highest of all subnational entities, and Bayern's PISA score falls one standard deviation above its high SES and two standard deviations above the overall SES mean.

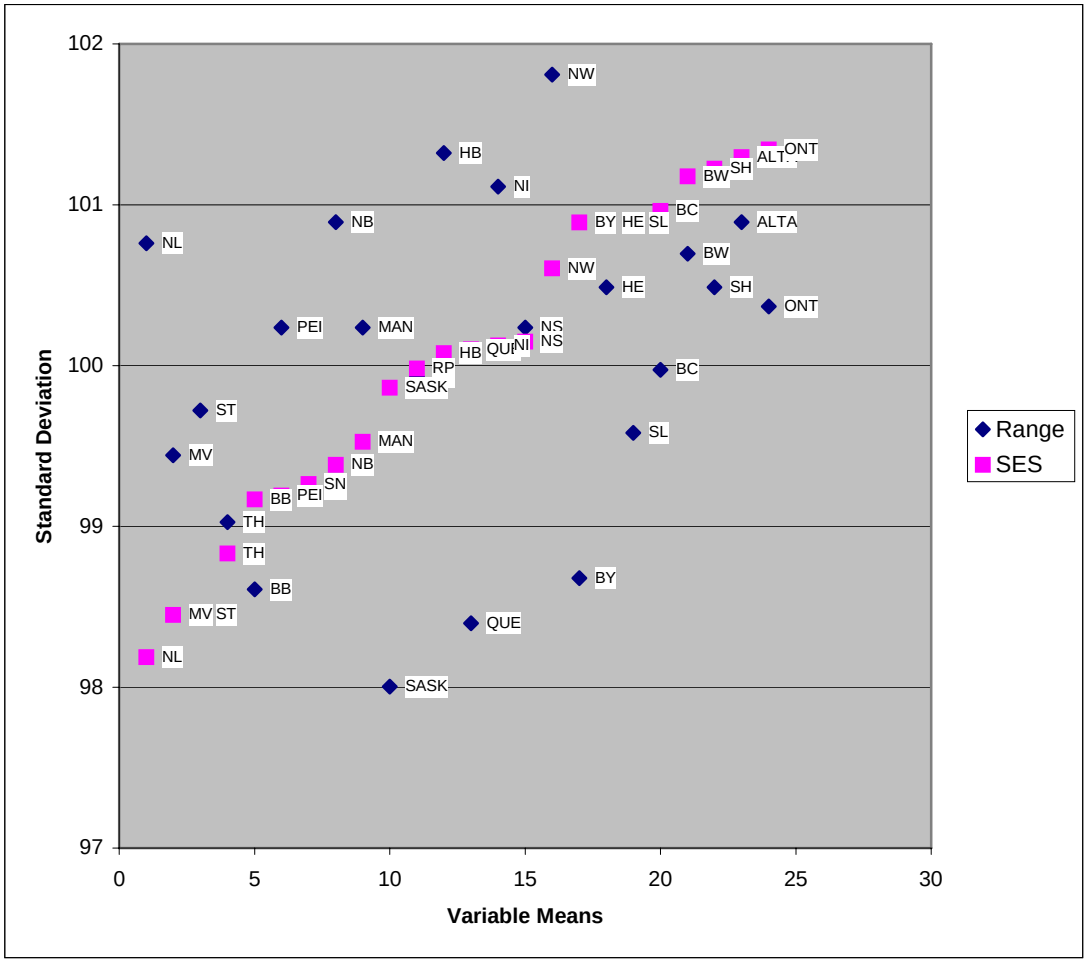
The analysis of subnational patterns confirms the general trend of the national results, but also reveals some important new findings. The positive impact of socioeconomic status and school funding on PISA scores is in evidence, but outliers and contradictory patterns raise questions, because relatively high school funding can produce low educational quality and vice versa. In other words, school funding at Canadian and German levels seems not to matter much. Some states and provinces have a much better quality of education at the same SES level than others. The subnational patterns are more extreme for the German states than for the Canadian provinces. I conclude that Canada, an above-average performing country despite a significant performance spread, benefits from a macro-environment across all provinces that is more constant than Germany's. The PISA scores for Germany's Laender fall below the OECD mean of 500, except for

Bayern, and display much larger and more extreme variations with respect to all variables in the study. These data, however, do not allow the conclusion that system differentiation is the reason why. The clustering and patterns observed simply raise doubts that system differentiation is as powerful an influence on educational performance as alleged (OECD 2005).

Equity of Education

Figure 2 displays the pattern among states and provinces with respect to the range of performance and socioeconomic status. The teacher-student ratio, GDP and school funding variables have been dropped from the scatterplot for clarity's sake. A small range indicates that the performance of students in that state or province is relatively consistent across schools, programs, and population groups. A large range may be a sign that some groups of students do not have access to the same quality of education as higher performing students do. Again, the first impression is one of contradiction: the prior figure already showed that higher socioeconomic status seems linked to higher school funding, but it appears also to be associated with ranges that fall within one standard deviation of the entities' respective socioeconomic mean. The many outliers make a clear picture for equity much harder to discern than for quality of education. All East German states combine low socio-economic status and low GDP with smaller performance ranges than the Western Laender, except for Bayern and Saarland which have a high SES and also a small range. Saskatchewan and Quebec combine an average SES with narrow performance ranges. The widest distribution of scores can be found in five West German states (Bremen, Nordrhein-Westfalen, Baden-Wuerttemberg, Schleswig-Holstein, Niedersachsen), followed by the other West German Laender. Within Germany, equity varies a great deal. Canada's provinces have similar, but less exaggerated patterns.

Figure 2: Range of Performance and Socioeconomic Status
(normalized, sorted by SES)



Newfoundland is the only province to combine a low socioeconomic status (nearly two standard deviations below the mean) with low equity (range is nearly one standard deviation above the mean). The variable values for all other provinces are located within relatively close proximity (no more than one standard deviation away) from each other. It seems counterintuitive, though, that the states and provinces with the highest socioeconomic status also have above average performance ranges, with the exception of Bayern. Do these states and provinces truly combine high educational quality with relatively lower equity? Alternatively, states/provinces with higher socioeconomic status may have attracted a broader range of societal groups (e.g. low income, immigrants) seeking better economic conditions than available in subnational entities with lower socioeconomic status.[23] More research is necessary to explore in greater depth what lies behind this finding. Overall, the pattern is similar to that of the previous graph: variations in the range variable are substantially greater among the German states than the Canadian provinces, Canadian provinces seem more consistent with respect to educational equity than the German Laender.

Conclusion

[23] This phenomenon can be observed in Germany, where residents of the economically weak Eastern Laender seek employment in the economically stronger Laender in the Western part of the country.

This research asks whether macro-level institutional and socioeconomic factors affect educational performance, defined as the level of knowledge and skills and the equal opportunity to receive it. At the national level evidence exists that links education systems with early academic selection to lower educational quality and especially equity. However, when the subnational results for two countries with contrasting system differentiation are examined, patterns emerge that raise doubts about this finding. Canada's undifferentiated education system appears to succeed in producing a high quality of education for a broad spectrum of the student population. The high quality and equity of education, relative to Germany, has emerged from what looks like a more consistent macro-level environment along the SES spectrum than Germany's. The data do not allow a conclusion as to the direction of causality (if such can ever be conclusively determined (PISA-Konsortium 2005)), i.e. does a relatively consistent macro-level environment "cause" high performance, or does the high performance of an undifferentiated education system produce a homogeneous environment? The puzzling aspect of this finding is that Canada's version of federalism emphasizes the independent decision making of the provinces (Scharpf 1985) as opposed to Germany's joint decision making (Muench 1999), which would predict larger variations in Canada than in Germany.

The results for Germany's Laender indicate surprising, large variations with respect to both the quality and equity of education. Since academic selection before age 14 is practiced in all German Laender, the fact that some of them do better than others leads to the conclusion that system differentiation may intensify other, polarizing influences, but it cannot be said to "cause" Germany's dismal results. If system differentiation were the primary cause, I would expect the Laender performance to be less variable. The empirical anomalies point to the influence of not just one other factor, but several different ones. The German states with the largest performance range are very different from each other: Bremen is a city state, Niedersachsen is predominantly rural, and Nordrhein-Westfalen is the most populous Land and highly industrialized. In any event, Manfred Prenzel, the PISA 2003 National Project Manager for Germany seems to have been justified in rejecting the suggestion by the OECD's top PISA leader, Andreas Schleicher, that abolishing Germany's differentiated education system was the only way to improve education overall (spiegel-online 2005).

What are the potential impacts on human capital? In recent decades, shifts in the global economy have focused the attention of policymakers and international organizations on the entire range of educational opportunities, spanning from pre-primary education to continuing education for adults. Unacceptable levels of long-term unemployment and poverty, even in advanced industrialized countries, have raised the salience of education as one avenue to equip a country's future work force long-term with "knowledge and skills for life" (OECD 1997). Education, however, does not provide a straightforward path to success. "High initial levels of educational attainment certainly help in today's changing world but are no guarantee of security" (OECD 1997, 23). Crouch echoes the OECD's sobering thought by emphasizing that education is a two steps forward, one step back kind of process. Workers with more education have better chances at finding jobs, yet having an overall more highly educated workforce simply moves the competition for jobs to a higher educational level (Crouch, Finegold et al. 1999).

To the extent that the PISA test scores summarize the contribution of education towards the formation of human capital, and the range reflects how well diverse societal groups are integrated into the educational process, human capital development appears to benefit when institutions and other macro-level factors reflect consistency with each other, i.e. relatively small variations. When institutions foster differentiation, it is much easier for human capital formation to suffer, because "separate" with respect to education may or may not be "equal". In the end it is ironic that Germany, which mandates "equal living conditions" in the Grundgesetz (Basic Law) and has established cooperation among the states ("cooperative federalism" (Muench 1999)) has created such diverse education performance outcomes across the Laender, while the more independent Canadian provinces overall vary less.

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