MULTILEVEL MODELLING NEWSLETTER

The Multilevel Models Project:

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Workshop on Three-level Modelling: The course using the *ML3* program package, lectures, seminars and group discussions on 1-4 December 1992 is already full, and the next one is 1-4 March 1993. If you wish to book the next workshop (1-4 March 1993) or to be on the waiting list for further workshops, please contact Min Yang at the project address.

Introductory booklets for ML3 macros: *ML3*'s macro language is a useful instrument for specialist analyses which have not yet been incorporated as efficient routines in the main program, such as logit models for binary response data, multinomial response data, multilevel time series models for repeated measurements and mixed models for both continuous and discrete responses. A booklet with examples for each set of macros is soon available free from the Multilevel Models Project.

Just Published: A new book 'Hierarchical Linear Models' by *Anthony S. Bryk* and *Stephen W. Raudenbush* has just been published by Saga, Newbury Park. It has nine chapters covering basic variance component models, random coefficients, repeated measures models and residual analysis with plenty of worked examples drown mainly from education. This comprehensive introductory text will be useful for student courses and for those who want a detailed introduction to multilevel modelling. We will be carrying a full review of the book in our next issue.

ML3 Clinics in London 1992/93

Free for users of *ML3/ML3-E*

Tuesday December 8
Tuesday January 12
Tuesday February 9
Tuesday March 9
Tuesday May 4
Tuesday June 8

10.30 am - 5.30 pm, Room 683
Institute of Education
20 Bedford Way
London WC1H 0AL
Call *Min Yang* for an appointment
Tel: 071 612 6682

Also In This Issue

The Multilevel Models Project is supported by a grant from the Economic and Social Research Council, U.K.

Book Review

Schools, Classrooms, and Pupils: international studies of schooling from a multilevel perspective, edited by *Stephen W. Raudenbush* and *J. Douglas Willms*. Pp 260. £21. 1991. ISBN 0-12-582910-8 (Academic Press).

This book is based on papers read to the *International Conference on Application of Multilevel Methods in Educational Research* held in August 1989 at the Centre for Educational Sociology, Edinburgh. It aims to make those methods available to a broader audience by offering reasonably nontechnical accounts of substantive studies, which go out of their way to clarify the 'logic-in-use' of the multilevel approach.

There are sections on curriculum coverage and reform, the monitoring of performance, educational interventions and the life of teachers. Canada, England, Israel, the Netherlands, Scotland, the United States and Thailand are represented. The studies are preceded by two introductory chapters, the first describing early attempts to grapple with the hierarchical structure of the educational system and the liberating power of multilevel methods, the second providing a simple introduction to multilevel modelling for the benefit of researchers unfamiliar with the technique. The book, then, represents a real attempt to introduce multilevel methods to the general educational research community by example. It is the first full-length book of this kind and before looking at individual chapters I have to make two criticisms which bear on its overall fitness as such an introduction.

First, it is obvious that a collection of conference papers will tend to contain a degree of overlap as authors strive to make their contributions self-contained. In the present collection the *HLM* formulation of a multilevel model is described in general terms by many of the contributors before they go on to the specifics of their own models. This is both irritating and potentially confusing since contributors are not entirely consistent. The place for such general description is surely Chapter 2, which, although admirably clear as far as it goes, does not describe the *HLM* formulation. In addition to removing redundant repetition the editors could then usefully have gone through each chapter ensuring consistency of notation, terminology and tabulation of results.

The second major general criticism is the number of inaccuracies in the text. These range from the trivial (some three dozen garbled words) to the seriously confusing. In Chapter 5 the models on p60 are inaccurately labelled and therefore not clearly linked with the results in Table 4. In Chapter 6 a mistake in Table 3 leads to confusion about unexplained variance and intra-school correlation. Chapter 14, particularly plagued, appears to assume equal variances at levels 1 and 2 on p205, makes a mistake in subscript notation in equation 3 on p208 and substitutes intra-school correlation for percentage of variance explained on p220. By the time I reached Table 3 in Chapter 15 (p240), which contains a suspiciously large estimate for a quadratic effect of years of experience and variance estimates which do not appear to agree with those in Table 4 on the next page, I gave up trying to understand the implications and assumed that these too were mistakes.

These deficiencies make the book harder to read than it should be and will certainly confuse the nontechnical reader. This is a pity as the studies themselves contain much that is of interest. Many of them deserve a full review to themselves and only a brief résumé can be given here. The chapters are self-contained.

Chapter 2, introducing multilevel ideas and terminology, has already been briefly referred to. It is lucidly written by *Lindsay Paterson*, with a particularly clear explanation of the standard error problem. It is intended for statistically untrained readers: a more sophisticated reader might infer, wrongly, that multilevel modelling was equivalent to regression with dummy variables. Thus the chapter gives more emphasis to sample inferences than to population ones. The book as a whole would have benefited from an extension to this chapter giving *HLM* model formulations and terminology and comparing these with *ML2*.

Chapters 3 to 5 form Section II, **Curriculum Coverage.** *Ruth Zuzowsky* and *Murray Aitkin*'s chapter relates Science achievement of fifth-grade students in Israel to explanatory variables at pupil and school (=class) levels. Unfortunately they leave little space for interpretation of their models: the more interesting model, with pupil SES random, is discussed in a referenced paper. The authors replicate an earlier finding concerning ethnic origin differences in adjusted scores, but they do not test interactions with, for example, initial reading scores which serve as a proxy for ability. Thus we do not know whether the estimated ethnic origin differences are constant across the ability range.

In Chapter 4 *Adam Gamoran* compares 'additive' and 'interactive' models of schooling effects: in the first, learning opportunities at the class level are considered to contribute additively to the achievement of all pupils regardless of their ability or effort, while in the second they are considered to contribute only by interaction with pupils' ability and effort. This distinction finds a fairly natural expression in the *HLM* formulation adopted here, but in *ML2* the second model can be seen to be artificially restricted (*Gamoran* eventually combines the two models). The main interest is in the differences Gamoran finds between his two data sets, one for Maths and one for Literature, which contain different measures of learning opportunities. The first measures quantity of coverage, the second quality of classroom discourse. Increasing the first appears to increase the difference between high- and low-achieving students: increasing the second appears not to.

Ian Plewis links two multilevel models, one for curriculum coverage in Maths and one for progress, by using the residuals of the first in the second. This is done either directly using class-level residuals or via a categorisation based on the residual distribution at pupil level. Like *Gamoran*'s, his findings have important policy implications: progress appears to be related to curricular matching.

Section III, **Performance Indicators,** is a pot-pourri. *Carol Fitz-Gibbon* and *Bosker* and *Guldemond* address issues surrounding the use of residuals from a multilevel analysis as indicators of school performance. *Fitz-Gibbon* is right to point out that different models have advantages for different purposes, but I find her declared preference for OLS residuals in the context of a monitoring system unconvincing. If we accept the use of residuals for this purpose at all, it seems to me that the more stable and conservative shrunken estimates are preferable. Bosker and Guldemond compare residuals from a multilevel analysis with simple aggregate measures such as mean examination success and proportion of pupils dropping out. They find the former to be more stable and informative as a PI, but that a single such indicator is inadequate.

Lindsay Paterson looks at trends in attainment in public examinations in Scotland from 1980 to 1986, a period of relative stability in the Scottish secondary education system. He finds that this attainment, adjusted for pupil's gender, mother's education, father's occupation and school mean of a composite of these measures, varies between schools according to their religious denomination and their history. The value of this study is that it places earlier findings on a firmer foundation by exhibiting their longitudinal, multilevel structure. It is a clear exposition.

Nick Longford's chapter on multivariate outcomes, technically the most demanding in the book, is also very well written. The US testing programme GENED was developed with the intention of exhibiting more than one dimension of the academic achievement of colleges. The test has a 4x3 (skill by content) matrix design and the main issue is whether combinations of test subscores based on rows or columns of this matrix provide useful information for comparison of colleges. This leads Longford to consider a multivariate variance-components model. He defines contrasts of subscores and gives a sufficient condition for the true contrasts for two colleges to differ substantially. He then establishes the test administration size necessary for the observed contrasts to exhibit a statistically significant difference, given that condition. In the short form of the test the only contrast 'observable' in this sense is the total score: all others require administration sizes larger than any in the pilot. Thus the complex design of the test is not justified.

Longford collaborates with *Marlaine Lockheed* in a thorough study of school effects on Mathematics achievement in Thailand. They explicitly tackle the issue of variance heterogeneity, but only at level 2. By incorporating school-level variables they succeed in virtually saturating the between-school variance, but they point out that this fact does not *explain* the processes involved: intervention to change the values of these variables could be expected to change the regression relationship. Thus supplementary information is needed to answer questions about the allocation of resources.

Section IV, entitled **Studying Educational Interventions**, contains two chapters. *David Raffe* assesses the impact of the British Technical and Vocational Education Initiative (TVEI) by comparing TVEI student outcomes from 19 pilot schools in Scotland with those of non-TVEI students in the same schools. He is cautious in his interpretations: for example, there are good reasons why TVEI, despite its name, should have had the small impact that he finds it had on the job prospects of its trainees. *Suzanne Jacobsen* is similarly cautious in her chapter, in which she assesses the relationship between kindergarten screening measures and grade three achievement, and the effect on that relationship of remedial intervention. Both studies are notable for their authors' careful interpretation of the apparent indications of their models: the risks of model mis-specification are emphasized.

The final section, **The Life of Teachers,** draws together three studies based on the High School and Beyond data as supplemented by the Administrator and Teacher Survey. The fact that all three chapters emanate from the United States affects the balance of the book, but between them they provide valuable insight into what it is like to work as a high-school teacher in that country. *Anthony Bryk* and *Ken Frank* study the specialization of teachers' work. Although the purpose of the chapter is primarily illustrative and the results preliminary only, it appears that school features such as size, academic mission and school social class affect teachers' work, but differently for academic and non-academic teachers. A quite complex model is clearly developed and explained.

Brian Rowan, Stephen Raudenbush and *Sang Jin Kang* examine teachers' perceptions of school organization and climate. Five measures of these perceptions are devised, called principal leadership, staff cooperation, teacher control, teacher morale and classroom order. The authors investigate within- and between-school factors affecting the variation of these measures and estimate the reliability of school-level aggregates. The principal purpose of the study is again illustrative but an important substantive finding is that teachers' perceptions of student ability critically affect their perceptions of school climate on each of the five measures, independently of the actual ability of the students.

In the final chapter *Valerie Lee* and *Julia Smith* investigate sex discrimination in teachers' salary. It is one of only two chapters explicitly to contrast the results of OLS regression with those of multilevel modelling. The latter is used to model the operation of a labour market at school district level: the possibility that female teachers are concentrated in low-paying districts is considered a justifiable reason for an overall difference between male and female salaries. The models developed include only factors that can be so justified, for example qualifications, teaching responsibilities, etc. The final, conservative, model suggests that there is a female salary deficit of some $1180, or 5.3% of average teacher salary, which is unexplained by such factors.

The book's index is useful, and clearly the result of a careful reading of the text rather than word tagging. Reliability and measurement error are significant omissions, although it is true that these topics receive little attention in the text.

The editors describe these papers as some of the best of the 'first wave' of substantive multilevel applications in education. The modelling used in most chapters may now appear fairly limited to many readers of this newsletter: very few of the studies mention covariance between random terms, for example, and only one mentions complex level-1 variation, although estimation techniques for each were already well established. In the interest of educating the general researcher, the editors could usefully have commented on such limitations. They should also, I feel, have provided a clear vision of possible directions for the second wave. The papers themselves, as I hope I have shown, are well worth reading.

(*Geoff Woodhouse*, Department of Mathematics, Statistics and Computing, Institute of Education)

Questions and Solutions

Q: We have two versions of the ML3 program, the VAX version ML3-V and PC version ML3-E V2.1. Why were we given the same estimates for both fixed and random parameters but different results for their standard errors when they were used to fit the same model on one data set?

S: There was a bug in V2.1 of ML3-E which appeared when ML3-E was run on machines without a coprocessor. This was due to a bug in the C-Compilor's (Watcom C V7.0) floating point emulation library. As a user of the particular version of ML3-E, if you don't have a coprocessor on your machine, you can simply return your old copy to us, and will be sent a free copy of the latest version.

APPLICATIONS

Class and Party in Britain: Preliminary results with a multilevel Logit model

Dorren Mc Mahon & Anthony Heath
Nuffield College, Oxford

Introduction

In recent years there has been considerable controversy about the extent to which the relationship between class and party in Britain has been changing. For example, there has been a celebrated controversy between Heath and Crewe. Proponents of the Crewe thesis claim that although people used to vote on the basis of habitual party loyalty , that commitment has now declined and they are open to a wider range of influences. Traditional loyalty has given way to rational action. Crewe and his colleagues refer to this process as the "secularisation of party choice" (Crewe, Sarlvik and Alt 1977:185). Heath et al, on the other hand, suggest that electoral volatility has not particularly changed. Voters' behaviour was not much more fickle in the 1980s than it was in the 1960s. Neither do they believe that it is entirely clear that class has declined all that much in causal importance (Heath, Jowell and Curtice 1985; Heath et al 1991).

A particular paradox in the literature lies in the relative importance of contextual effects as an explanation for the changing relationship between class and party. For example, if we use individual level data, we find that the relationship (measured by odds ratios or log linear models) was rather stronger in 1964 and 1966 than it has been subsequently (see Evans et al 1991). However, if we use constituency level data, the relationship appears if anything to have become stronger in the 1970s than it was in the 1960s (see Miller 1978). Thus, Miller found that the variance in the Conservative share of the two-party vote in each constituency explained by the proportion of managers and employers in that constituency (based on Census data) had increased from 0.69 to 0.77 over time (between 1964 and October 1974). To reconcile this paradox, he suggests that contextual effects have increased.(1) That is to say, Miller argued that the class composition of the local political environment was becoming more important while the class position of the individual voter was becoming less important. The two counter-tendencies cancelled out, giving stability at the aggregate level.

The existence let alone the growth of contextual effects has been another matter of considerable debate in political science. Firstly, it is not yet generally agreed that there are constituency-level contextual effects. For example Kelley and McAllister (1985) argue that the apparent contextual effects are due to a failure to control adequately for individual level variables such as income, housing tenure and union membership (See also Hauser 1970, 1974). Furthermore, it is not clear why the contextual effects of class should be increasing. Most theories of class dealignment assume that class solidarity has diminished (for example see Robertson 1984), and so we might expect the contextual effects of neighbourhood class to diminish too. On the other hand, there is substantial evidence of a growing regional divide in voting. Since neighbourhood social class and region will tend to be associated, Miller's findings may be due to his failure to take region into account in his analysis.

Nonetheless, Miller's work does undoubtedly demonstrate at the descriptive level a paradox that needs to be resolved. If we update his work to 1987, we find that the bivariate constituency-level correlation increases from x to y, whereas the association between class and party , measured say by the index of concentration, falls from p to q.

Multilevel Models

The aim of this paper is to explore the changes in the size of the individual-level and contextual level effects over time, using the technique of multi-level modelling. The analysis presented here is the result of our initial use of multilevel models. The multilevel framework is ideally suited to the problem. It was originally developed, or at least applied extensively, to problems in education, for example looking at individual pupils within school classes, within schools, which in turn (before opting out) belong to educational authorities. The crucial point is that the members of a particular form share common experiences, eg the same teacher or the same peer group, that may be expected to make them more similar than they would have been if randomly distributed, and so on.

Similarly, we can think of electors as belonging to local communities, which in turn belong to particular constituencies, and to particular regions. Again, there may be common experiences shared by members of a given group (eg class solidarity as a consequence of interaction with fellow members of one's class analogous to peer group pressure at school) or a common choice of candidate (equivalent to teachers).

We are going to concentrate on a simple two-level model of voter and polling district. Details of the basic model are as follows:

At the first level we postulate:

$$\ln(\pi_{ij}/(1-\pi_{ij})) = b_{0j} + b_1 x_{1ij} + b_2 x_{2ij} + b_3 x_{3ij} + b_4 x_{4ij} \quad (1)$$

where $\pi_{ij} = E(p_{ij})$ and $p_{ij} = 1$ if the subject votes for the specified party and 0 otherwise. X_1 to X_4 are four dummies representing the Salariat, Routine Nonmanual, Petty Bourgeois and Foremen classes respectively. The fifth class, which thus becomes the baseline, is the Working Class. The subscript i represents the individual; the subscript j represents the polling district. In other words, the log odds of the *ith* individual in the *jth* polling district depends on the constant for that constituency and on his individual social class.

At the second level we postulate:

$$b_{0j} = b_0 + a_1 w_{1j} + u_j \quad (2)$$

where w_1 is the percentage of managers and employers in the polling district (the "sal%" variable). In other words we explain the constant for the polling district in terms of the social class composition of that constituency. This is, of course , the contextual effect that Miller referred to. So, there are assumed to be two components to the individual's vote choice: the individual's social class and the constituency social class. If there are two such components, then a single level model will mis-specify the individual level relation, that is, it will exaggerate it. Again, this point was made by Miller.

It should be noted that Przeworski and Soares (1971) developed an interesting theory suggesting that the more working class a neighbourhood is the greater will be the individual level class differences in voting. They suggest that "a high concentration of workers would increase working class consciousness and so make the workers more socialist. But this same high concentration of workers would also make the middle class more class conscious and so make them more antisocialist" (Miller 1978: 266). This hypothesis can be tested through an interaction term between individual and polling district class, that is between X_1 and W_1.

We actually use a logistic regression formulation since we have a binary dependent variable. Our approach is to examine alternative dichotomizations, eg Conservative versus non Conservative, Labour versus non Labour, etc. It should be noted that this is not a fully random model: we allow for the random intercepts but not for random slopes.

The Data

We use the 1964, 1970, February 1974, 1983 and 1987 British election studies. We discard the 1966, October 1974 and 1979 studies as they contain large panel elements from the previous surveys, and therefore the assumption of independent random samples is not met. We are planning to incorparate the panel element later, using a 3-level model. It should be noted that the 1964 and 1970 surveys also contain panel elements from pre-election surveys in 1963 and 1969 respectively.

In most of the surveys a three stage sampling procedure was used. The details of surveys are as follows:

1964	N=1769 drawn from 80 sampling points
1970	N=1843 drawn from 80 sampling points
Feb 1974	N=2462 drawn from 200 sampling points
1983	N=3955 drawn from 250 sampling points
1987	N=3826 drawn from 250 sampling points

Fresh sampling points were chosen in 1963, February 1974, 1983 and 1987. In 1970 the same constituencies were used as in 1963/4 but there is no record whether the same polling districts were used within these constituencies. There may be some overlap in the constituencies selected in the later years, but we should note that there were boundary revisions in 1974 and 1983, making strict comparisons difficult.

At the individual level we measure social class and vote. At a later date in our analysis we will introduce further control variables to deal with Kelley and McAllister's criticism of inadequate control for individual level variables. However, we will begin simply at this stage.

At the polling district level we measure the percentage employers and managers. At the constituency level we measure the political options facing the voter.(2)

Analysis

We begin in Table 1 with an analysis of variance, that is, the proportion in variance of vote associated with the constituencies in which voters live. Miller's hypothesis suggests that the parameters b_1 to b_4 will decline over time while the parameter a_1 will increase.

The results are in line with Miller's predictions. Between polling district variation increased in 1970 and again in 1974. The size of the contextual effect also increased, although whether the change is significant remains to be seen. The large standard errors recorded for the earlier years are the result of fewer sampling points, that is fewer observations. Thus we may not be able to reject the hypothesis that the "sal%" parameter has been constant at 1.70.

The effects are generally larger when we turn to Labour party identification. This largely reflects the similarity of the individual and polling district class position of the Liberal and Conservative identifiers.

Table 1. Percentage of variance in vote between polling districts

	Explanatory Variable : Class				
	1964	1970	1974	1983	1987
Con	5	11	20	23	19
Lab	20	19	23	31	32
	Explanatory Variable: Class/Sal% Constituency				
	1964	1970	1974	1983	1987
Con	3	10	18	21	15
Lab	18	17	21	25	26

Mindful of the criticisms of Kelley and McAllister and Hauser, we will need to go on to control for other individual-level variables. But if our finding is robust, how can we explain it? As outlined above, Crewe's general theory suggests that class solidarity has been declining not increasing. It may be the result of a shift from a national to local basis of class solidarity. The "sal%" could also be acting as a proxy for a political variable, such as the Liberal candidate in constituency/tactical situation.

Following on from the analysis of variance we fitted an basic multi-level model to each of our five samples separately.(3) In this basic model we take the individual's party identification as the dependent variable. We treat this as a binary variable contrasting Conservative identifiers against all others including respondent's with no party identification. We later run these models with Labour identifiers as the binary dependent variable. Conservative identifiers are included with all others.(4) Our two independent variables are the head of household's social class using the five classes described by Heath et al (1991:66-67) and the social class of the polling district as measured by the percentage of respondents in each polling district who were managers or employers (the "sal%" variable). At a later date we hope to use measures, derived from the Census, of the constituency social class composition although these of course will not be contemporary with the sample.

In Tables 2-5 we created dummy variables for the first four classes and used the Working Class as our base category. The constant is the fitted log odds in the baseline. Class estimates are the fitted log odds ratios between the category in question and the baseline category.

In table 2 class is our explanatory variable while our dependent variable is voting Conservative versus some other party. The Working Class are the least likely to vote Conservative , followed by the foremen although these parameters do swing about. The Petit Bourgeoisie are the most likely to vote Conservative. If we look for trends over time we can see that there has been a decline in class voting. Individual class effects were bigger in 1964.

Table 2: Model One: Individual class as an explanatory variable (Conservative, standard errors in parentheses)

	1964	1970	1974	1983	1987
Constant	-1.10(.09)	-.91(.10)	-1.24(.08)	-1.13(.07)	-.97(.07)
Salariat	1.41(.14)	1.04(.14)	1.13(.12)	.95(.10)	.79(.10)
Rnonman	1.12(.16)	.71(.16)	.93(.13)	.75(.10)	.73(.10)
Petb	1.99(.22)	1.33(.20)	1.74(.17)	1.29(.14)	.99(.14)
Foreman	.57(.20)	.44(.19)	.43(.21)	.58(.15)	.27(.16)

In Table 3 we ran a multilevel logit model with class and the percentage salariat in each constituency as explanatory variables. The response variable is voting Conservative versus some other party. The Working Class are even less likely to vote Conservative. Looking at trends over time, it is evident that there is still a decline in class voting. If we look at the "sal%" parameter size we can see that the effect grew between 1964-87 (+.72). This would appear to support Miller's hypothesis that contextual effects have increased.

Table 3: Model Two: Individual class and percentage Salariat in each constituency (Conservative, standard errors in parentheses)

	1964	1970	1974	1983	1987
Constant	-1.31(.12)	-1.16(.14)	-1.53(.10)	-1.50(.10)	-1.47(.10)
Salariat	1.30(.15)	.97(.14)	.92(.13)	.81(.10)	.60(.10)
Rnonman	1.09(.16)	.71(.16)	.88(.13)	.71(.10)	.67(.10)
Petb	1.97(.22)	1.34(.20)	1.69(.17)	1.41(.14)	.95(.14)
Foreman	.56(.20)	.44(.19)	.42(.21)	.55(.15)	.22(.16)
Sal%	1.24(.48)	1.32(.55)	1.63(.35)	1.57(.30)	1.96(.28)

The response variable in Table 4 is voting Labour versus some other party. Class is the only explanatory variable. Between 1964-74 the Working Class are the most likely to vote Labour but in 1983-87 they are less likely to vote Labour. Although the parameter estimates are negative we can still see that there is a marked decline in class vote.

Table 4: Model Three: Individual Class as an explanatory variable (Labour, standard errors in parentheses)

	1964	1970	1974	1983	1987
Constant	+0.34(.09)	+0.23(.09)	+0.16(.08)	-0.15(.07)	-0.31(.07)
Salariat	-1.91(.17)	-1.25(.15)	-1.43(.13)	-1.43(.11)	-1.19(.11)
Rnonman	-1.61(.18)	-0.76(.16)	-1.01(.13)	-1.09(.11)	-0.81(.11)
Petb	-2.02(.27)	-1.61(.24)	-1.57(.20)	-1.29(.17)	-1.22(.17)
Foreman	-0.57(.19)	-0.30(.19)	-0.43(.20)	-0.83(.16)	-0.32(.16)

In table 5 we added the percentage salariat in each constituency as an explanatory variable. When this is added we can see that the Labour log odds for the Working Class remains positive. For the other class estimates we can see that there has been a decline in class voting . If we look at the "sal%" parameter we can see that, as with table 3, there has been a growth in contextual effects

Table 5: Model Four - Individual class and percentage salariat in each constituency (Labour, standard errors in parentheses)

	1964	1970	1974	1983	1987
Constant	+0.64(.14)	+0.60(.15)	+0.44(.09)	+0.38(.10)	+0.35(.11)
Salariat	-1.81(.18)	-1.18(.15)	-1.23(.14)	-1.26(.11)	-0.99(.11)
Rnonman	-1.59(.18)	-0.76(.16)	-0.97(.13)	-1.05(.11)	-0.76(.11)
Petb	-2.00(.27)	-1.64(.24)	-1.54(.20)	-1.27(.17)	-1.20(.17)
Foreman	-0.57(.19)	-0.30(.19)	-0.42(.20)	-0.81(.16)	-0.27(.16)
Sal%	-1.68(.64)	-1.83(.63)	-1.67(.37)	-2.32(.35)	-2.65(.35)

Conclusion

Our preliminary results suggest that there has been a decline in class voting and an increase in the growth of contextual effects on voting behaviour. However, these results are preliminary and we will need to specify more appropriate models. We intend to add extra controls such as tenure , for example, to our models. Its use as an explanatory variable may be unsatisfactory, however, because tenure is likely to be confused with context since housing often comes in blocks of estates. At a later date in our analysis we propose to look at either the percentage council tenants in the polling district or perhaps use travel to work area information. In order to improve the fit of the model further we intend to fit region as a fixed effect in later analysis. Overall, we feel that multilevel modelling offers a useful framework for exploring the changes in the size of the individual level and contextual level effects on voting over time.

Any comments or suggestions will be gratefully received by the authors.

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Notes:

(1) It should be noted that Miller excluded both Scotland and Wales from his analysis because of the nationalist vote.

(2) At a later stage we could also introduce constituency social class and constituency unemployment rate.

(3) In a later stage of this paper we will use a combined analysis of all five samples but initially we will analyse them individually in order that we can examine the parameters for each sample separately.

(4) We intend to run these Labour identifier models again with the Conservatives excluded from the "Other" category.

Bug in SIMUlate command

A bug was found in SIMU command of the ML3/ML3-E V2.2 and V2.201, which may cause the program to crash. Please contact *Min Yang* if you are interested in doing a simulation study using the SIMU command in ML3/ML3-E.

Research at the World Bank

The World Bank (Population and Human Resources Department) is applying multi-level modelling in a variety of education studies. Here are some examples. Further information can be obtained from Dr. Marlaine Lockheed at The World Bank -- 56033, 1818 '1t' Street, NW, Washington, D.C. 20433, USA

<u>School Effects on Achievement in Secondary Mathematics and Portuguese in Brazil.</u> *Lockheed, M. and Bruns, B.*: Determinants of achievement are examined to assess the relative effectiveness of various types of secondary schools in boosting performance and reducing social class differentiation. A stratified random sample of 2,611 students in 62 schools in four cities in Brazil were administered a standardized test of mathematics and Portuguese and a student background questionnaire; a school questionnaire was directed to administrators. While controlling for student-level characteristics, group-level variance in achievement was modelled to explore (1) the percentage of variance attributable to the types of school attended; (2) influence of school-level factors; and (3) within school differences due to the student's socioeconomic status. Students in federal technical schools outperformed those in general secondary, teacher training, and full secondary schools with technical schools outperformed those in general secondary, teacher training, and full secondary schools with technical specializations--in both subject areas. For mathematics only, significant factors included class size (achievement was higher in larger classes) and number of instructional hours. Unrelated variables included teachers' stipends, high tuition fees, enrollment in day-only classes, organizational complexity, and university-educated teachers. For Portuguese, significant factors were the schools' organizational complexity, average student socioeconomic status, and average number of hours students spent in the workplace. Unrelated variables were class size, teacher salaries, school fees, day school, and university-educated teachers. These findings suggest that student selection accounted for much of the observed differences.

<u>A Multi-Level Model of School Effectiveness in a Developing Country.</u> *Lockheed, M and Longford, N.*: This paper uses a multi-level approach to examine determinants of growth in grade 8 mathematics achievement in Thailand. Results of the analysis showed that schools in Thailand differed in their pretest-adjusted grade 8 mathematics scores, but there were no statistically significant differences in the relationships between pretest and post-test across schools. Schools and classrooms contributed 32% of the variance in post-test scores. Higher levels of achievement were associated with a higher proportion of teachers qualified to teach mathematics, an enriched curriculum and frequent use of textbooks by teachers. Individual characteristics contributed 68% of the variance, with achievement higher for boys, younger students, and children with higher educational aspirations, less perceived parental encouragement, higher self-perceptions of ability, greater interest in and perceived relevance of mathematics. The model developed in the paper was able to explain most of the between-school variance, but substantially less of the within-school variance. The implication of these results is that schools in Thailand are much more uniform in their effects than previous research in developing countries would have suggested.

<u>The Empty Opportunity: Local Control of Secondary Schools and Student Achievement in the Philippines</u>. *Lockheed, M and Zhao, Q.*: Lockheed and Zhao use a multilevel model to examine: (1) Differences in achievement and attitudes among grade 9 mathematics and science students in 213 national government, private, and local schools in the Philippines. (2) Differences among these types of schools in social composition, available resources, classroom orderliness, academic emphasis, and school decision-making. (3) Possible reasons for differences in achievement. They found that - holding constant for age, gender, and socioeconomic status - students attending the three types of schools differed significantly. Students in local schools scored lower in achievement (1.25 points lower in science and 1.61 points lower in mathematics) and had less positive attitudes in government schools. Students in private schools outperformed students in government schools (0.88 points higher in mathematics). These differences were attributable largely to the effects of student selection. Lockheed and Zhao found that policies for centrally planned decentralization do not necessarily change what goes on in schools. Local schools were given an empty opportunity: there was nothing for local control to control. Local schools had few resources - fewer of them had

laboratories and their teachers were less educated and experienced than those in private schools. By contrast, managers of private schools had significant resources over which to exercise control. Teachers were better educated and experienced, and planned their instruction. Students were motivated and completed their homework and assignments. Managers of private schools exercised significant control over teaching and school management.

What Causes Differences in Achievement in Zimbabwe's Secondary Schools? *Riddell, A and Nyagura, L.*: This study determines the characteristics of effective and ineffective secondary schools in terms of student achievement on the Zimbabwe Junior Certificate (ZJC) English and Mathematics public examination. Student-, class-, and school-level data were gathered from a stratified random sample of 5,293 pupils in 138 classes in 33 schools. Students in mission, high-fee paying trust, and elite government schools scored higher on ZJC examinations than students in less well-endowed government schools and in district council schools. A greater availability of textbooks and a larger proportion of trained teachers with substantial tenure contributed significantly to this difference. Single-sex boarding schools were also characteristic of high performing schools. A substantial share of variation in student achievement was attributable to prior academic achievement. Failure to control for selection bias into schools tends to overestimate the variation attributable to the school. An appendix specifies student class, and school variables used in this multilevel analysis.

Queries and Responses

Dear Editor,

I refer to Goldstein et al (June 1992) page of Vol.4, No. 2 of the Multilevel Modelling Newsletter. The third sub-table is:

Random-between students

	Intercept	LRT
Intercept	0.55	
LRT	0.046	0

The format of this sub-table suggests that the entries are the variances and covariance of the intercept and slope for the individual student regression lines. Such an interpretation is not valid.

The model and the data do not allow the fitting of individual regression lines to students, and there can not be a non-zero covariance of 0.046 between the intercept and the slope (LRT) when the variance of the slope is zero.

The sub-table is a computational device for estimating the level 1 (between students) component of variance assumed to depend on the covariable LRT; the interpretation is given below the table:

> " The level 1 (between students) variance is thus a linear function of LRT score, given by
> $variance = 0.55 + 0.092 \times LRT$"

I make two pleas -

i) To Software Developers
Please package your software so that the user can model, for example variances, explicitly with input and output that can be taken at face value.

ii) To Software Users
Please don't reproduce misleading output.

Yours sincerely

Mrs J I Galbraith

Harvey Goldstein: Jane Galbraith is right to take us to task for reproducing the table of between-student variation with a zero variance estimate. As she says, the parameters in this table merely enable us to calculate the estimated between-student variance as a linear function of LRT score. It would have been better just to have quoted that in the paper.

As far as the program output is concerned, the 'covariance matrix' format is useful. First, there are many models when the components of this matrix are directly interpretable as variances, for example when modelling separate variances for, say, males and females. Secondly, it generalises in a very straightforward fashion to the case when the level 1 variance is a linear or polynomial function of several explanatory variables. The procedure for forming such functions is explained in the ML3 manual and there is a worked example in the new 'Guide to ML3 for New Users'.

Our experience from running ML3 introductory workshops is that the notion of modelling variances as function of explanatory variables in this way often seems strange, but once it is understood its usefulness is appreciated. A new version of the software is currently being prepared and we are giving careful thought to presentation, and this is one aspect we shall be studying.

Some Recent References to Multilevel Modelling

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PLEASE SEND US ANY MULTILEVEL MODELLING PUBLICATIONS FOR INCLUSION IN THIS SECTION IN FUTURE ISSUES.

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