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The Dog ATE my Economics Homework!

Estimates of the Average Effect of Treating Hawaii's Public High School Students with Economics

BY

Kimberly Burnett and Sumner La Croix

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UNIVERSITY OF HAWAIʻI AT MANOA
2424 MAILE WAY, ROOM 540 • HONOLULU, HAWAIʻI 96822
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The Dog ATE my Economics Homework! Estimates of the Average Effect of Treating Hawaii's Public High School Students with Economics*

Kimberly Burnett
University of Hawaii Economic Research Organization
University of Hawaii-Manoa

and

Sumner La Croix
Department of Economics
University of Hawaii-Manoa

Abstract

Hawaii is one of 27 states that do not require testing of public high school students regarding their understanding of economics. We report results for the first economics test administered to a large sample of students in Hawaii public high schools during the Spring 2004 semester. Our analysis focuses on evaluating the impact of a semester-long course in economics on student scores on a 20-question, multiple-choice economics test. We specify and estimate a regression analysis of exam scores that controls for other factors that could influence student performance on the exam. While student scores on the economics exam are relatively low, completion of an economics course and participation in a stock market simulation game each add about one point to student scores.

Keywords: economic education, high school economics, stock market simulation
JEL Codes: A20, A21, I21

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I. Introduction

Over the last 50 years, U.S. public and private high schools have increasingly incorporated economics courses into their curriculums. For the 2004-2005 academic year, the *High School Transcript Study* (2007) reported that 45.8 percent of high school graduates had completed an economics course.[1] Standardized tests of nationwide samples of high school seniors have been conducted since the early 1970s to measure understanding of key economic concepts and ability to apply them to particular problems. While average student scores have been relatively low, completion of an economics course has substantially raised student performance (Walsted and Rebeck 2000, 2001). In 2006, the National Center of Education Statistics conducted its first assessment of economics knowledge for the National Assessment of Educational Progress (NAEP) by testing 11,500 twelfth-grade students from 590 public and private high schools. Walstad and Buckles (2008) report cross tabulations from the 2006 NAEP assessment that suggest important demographic, socioeconomic, instructional, and aptitude-related determinants of exam performance.[2]

Twenty-three states require high school students to be tested on their knowledge of economics.[3] There appears to be little systematic reporting of results from the states requiring testing, while statewide tests in economics are almost never conducted in the states without required testing. Hawaii is one of the states in which economics is well established in the public high school curriculum and which has never administered a standardized economics exam to its public high schools students or to students who complete an economics class. The lack of testing is somewhat surprising, as over 90 percent of Hawaii public high schools typically offer a full-semester economics course and 27 percent of high school seniors completed a semester course in economics in both the 2004-2005 and 2006-2007 academic years.[4] Test results for students within a particular state and at particular high schools could, however, help administrators and policymakers to assess the overall understanding of economics by high school graduates and evaluate the impact of an economics course on a student's economic knowledge.

We report results for the first economics test administered to a large sample of students in Hawaii public high schools during the Spring 2004 semester. Our analysis

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[1] The National Center for Education Statistics (2007) reported that 66 percent of high school seniors in 2006 had taken either a general economics course or an advanced placement economics course.

[2] The NAEP does not release state-by-state breakdowns due to the small number of students taking the exam in some states.

[3] Grimes et al. (2008) suggest that the increases in economics exam scores are smaller for students taking a mandated economics course than for students taking the course as an elective.

[4] Hawaii public high school students are required to complete four credits (8 semesters) of social studies courses. Since 3 credits are taken up by required social studies courses, students complete their one elective social studies credit with two semester-length courses chosen from social studies electives offered by their high schools, e.g. psychology, geography, economics, consumer education, or European history.

focuses on evaluating the impact of a semester-long course in economics on student scores on a 20-question, multiple-choice economics test. We specify and estimate a regression analysis of exam scores that controls for other factors that could influence student performance on the exam. As we discuss below, the State of Hawaii placed severe restrictions on the quantity and type of questions that we could ask high school students regarding their personal and family characteristics. As a consequence, some variables that affect student's selection of an economics elective and their performance on our test could not be included in the regression analysis. Despite these limitations, we are able to draw some conclusions from our regression results regarding the impact of an economics course on student performance on our economics test.

II. Exam Methodology

We analyze results from a 20-question multiple-choice test on basic economics administered to over 500 students enrolled in 19 public high schools in Hawaii during the Spring 2004 semester. The 19 high schools were drawn from Hawaii's 38 public high schools based on the willingness of an individual teacher at each high school to administer the exam to the teacher's class. The exam was administered at high schools in each of Oahu's four school districts and from the neighbor islands of Hawaii, Maui, Molokai, and Kauai. The exams were conducted in a high-school class but not in an economics or a consumer education class. The exam did not count towards a student's grade in the class. No compensation was paid to students either for completion of the exam or performance on the exam. Each class had some students who had completed an economics course and some who had not.[5]

The 20-question multiple-choice exam was designed by the National Council for Economic Education, an umbrella organization of state council of education. The questions cover such topics as exchange, supply and demand, price controls, inflation, national income accounting, and international trade. Each question had three possible answers.

We asked the Hawaii State Department of Education ("Hawaii DOE") for permission to ask students 20 questions regarding their personal and family backgrounds. The Hawaii DOE did not allow us to ask any questions pertaining to their family (e.g. number of siblings, lives with both parents, each parent's occupation, high school GPA, ethnicity, and whether English was their native language or spoken at home. In fact, the Hawaii DOE allowed us to ask just four questions pertaining to their personal characteristics: (1) gender; (2) plans to attend a two-year college; (3) plans to attend a four-year college; and (4) plans to take more economics after high school. The Hawaii DOE denied permission to ask students for their high school GPA, ethnicity, and whether English was their native language.[6]

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[5] In one high school, we learned after the test had been conducted that all students who took the economics exam had completed an economics class. We dropped this high school from our sample.

[6] The Hawaii Dept. of Education routinely allows such information to be provided to national testing agencies.

We also asked students whether they had completed (1) a semester-length course in economics; (2) a partial course in economics; (3) a consumer education course; and (4) the Hawaii Stock Market Simulation. We asked specifically about these two courses and classroom exercises because each may teach some concepts and provide some information that could improve performance on an economics exam.[7] After reviewing student responses for partial courses in economics, we found that the only students who responded that they had completed a partial course in economics were students who had also completed a semester-length course in economics. We conclude that students were confused by this question and have not included this variable in our regression analyses.

The Hawaii Stock Market Simulation (SMS), administered by the Hawaii Council on Economic Education, is an interactive educational program that teaches high school students about U.S. securities markets. Student teams invest a hypothetical $100,000 in stocks, bonds, and mutual funds over a 10-week period. Team winners are publicized in the Hawaii media.[8] The intent of the program is to encourage students to think about real life investment and financial issues such as setting investment goals, their tolerance to risk, and the trade-offs that must be considered as they determine how to save for their future.

IV. Sample Properties and Summary Statistics

We examined all test forms and identified 25 with particularly low scores that were likely due to a lack of effort on the exam. A large number of questions were left blank on some exams; others exhibited a pattern of answers inconsistent with efforts to honestly answer each question. Three high schools each had four students with questionable exams. Only 20 percent of these students had taken an economics course, and only 8 percent (2 students) had participated in a stock market simulation. These students were also more likely to be male (56 percent) and were less likely to have plans to attend a four-year college. We decided to drop these exams from our regression analysis. After dropping these exams, we find that student scores on the economics test are normally distributed with no discernable heaping at the tails.

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[7] Our review of consumer education courses in Hawaii shows them to be focused on such issues such as consumer budgeting, checkbook balancing, credit management, consumer protection, and personal saving and investment.

[8] Two 10-week sessions are offered each school year. Students participate in divisions based on their investor profile: Income Growth, Growth, and Aggressive Growth. Each division requires that students maintain a certain asset allocation of stocks and bonds. For example, a student participating in the Income Growth Division would build a portfolio that contains 50 percent common stock and/or equity mutual funds and 50 percent bonds and/or bond funds. At the end of the simulation, the Hawaii Council on Economic Education reviews each portfolio (based on the division in which the team is participating) and compares its performance to an investor profile benchmark (i.e. Growth & Income) representing the proper asset allocation of the 10 year treasury bond and the S&P500.

We compute summary statistics for (1) the entire sample of students; (2) students without a full economics course; and (3) students with a full economics course. Thirty-seven percent of students had completed a semester-length economics; 24 percent had participated in the Stock Market Simulation; and 19 percent had completed a semester-length class in consumer education. The summary statistics show that the students who selected an economics class were somewhat different than the students who did not. They were more likely to be male (53 percent vs. 42 percent), more likely to plan to attend a four-year college (62 percent vs. 51 percent), less likely to attend a two-year college (18 percent v. 26 percent) and more likely to have participated in the Stock Market Simulation (42 percent vs. 14 percent). The difference in characteristics between the two groups of students clearly indicates that students are self-selecting into the class, and that we cannot view an economics class as a randomly assigned treatment.[9]

IV. Econometric Methodology

Our goal in estimating regressions on student test scores is to isolate the effect of an economics course and a stock market simulation on student understanding of economics. Since students are clustered within specific high schools ("strata" in the econometrics literature), our econometric analysis uses a specific form of this more general strata regression:

(1)
$$SCORE_{is} = \alpha + \beta_1 ECON\_COURSE_{is} + \beta_2 STOCK\_MKT\_SIM_{is} + \gamma IC_{is} + \kappa SC_s + q_s + e_{is}$$

where $SCORE_{is}$ is the number of questions correct on the economics test by student i at school s, α_s is a school-specific intercept, and $ECON\_COURSE_{is}$ and $STOCK\_MKT\_SIM_{is}$ are the two treatment variables, IC_{is} is a vector of student-specific control variables, SC_s is a vector of strata-specific control variables, q_s is an unobserved stratum effect, and e_{is} is the error term for student i at school s.

Wooldridge (p. 133) noted that "the presence of the unobservable q_s induces correlation in the composite error term $\mu_{is} = q_s + \varepsilon_{is}$ within each stratum." Estimating individual and stratum effects in one regression leads to unbiased estimators for β, γ, and κ but consistency and asymptotic normality cannot be demonstrated. Moulton (1992) demonstrated that within-group correlation leads to upward biased standard errors for $\hat{\beta}$ and $\hat{\gamma}$. However, since our analysis focuses on estimated coefficients for individual rather than strata characteristics, adding a set of strata dummies to the regression provides a simple solution to the error correlation problem.[10] This yields a more specific form of strata regression:

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[9] Peterson (1992) presented evidence that failing to account for the self-selection bias will understate the potential gain attributable to a course in economics.

[10] Once strata dummies are added to the regression, adding additional variables covering strata characteristics to the regression do not improve the efficiency of estimates for variables covering student characteristics.

$$(2)\quad SCORE_{is} = \alpha_s + \beta_1 ECON\_CLASS_{is} + \beta_2 STOCK\_SIM_{is} + \gamma IC_{is} + e_{is}$$

where α_s is a stratum-specific intercept.

The dependent variable in all regression specifications—the student's score on the multiple choice exam, $SCORE_{is}$—is count data, with a minimum value of 0 and a maximum of 20. Estimated coefficients from a regression with a count-data dependent variable often have superior properties when a Poisson or a negative binomial estimator is used rather than OLS (Wooldridge, ch. 19). Standard goodness of fit tests indicated that the negative binomial model was more appropriate than the Poisson model. Thus, we estimate all regression specifications using both OLS and negative binomial estimators.

The severe restrictions imposed by the Hawaii Department of Education on the amount of personal data that could be gathered from each student has the potential to bias estimated coefficients on both treatment variables due to the usual problems stemming from omitted control variables. If data were available, we would have included high school GPA, ethnicity, and whether English was their native language as control variables in each regression specification. The small number of student characteristic variables also limits our ability to control for selection problems with the two non-randomly assigned treatment variables.

Each regression includes three controls for student characteristics—gender, plans to attend a two-year college, and plans to attend a four-year college. Our basic regression specification follows:

$$(3)\quad \begin{aligned} SCORE_{is} &= \alpha_s + \beta_1 ECON\_COURSE_{is} + \beta_2 STOCK\_MKT\_SIM_{is} + \gamma_1 GENDER_{is} \\ &+ \gamma_2 TWO\_YR\_COLLEGE_{is} + \gamma_3 FOUR\_YR\_COLLEGE_{is} + e_{is} \end{aligned}$$

Finally, the students who took an economics class or participated in a stock market simulation were not randomly assigned to these treatments but rather self-selected into them. If more information on student (and their family's) characteristics were available, it might be possible for to use instrumental variable or matching estimation techniques to address this problem. In lieu of this information, we construct a second data set that only includes groups of students with identical characteristics (gender, post-secondary education plans, and high school) and with at least one student with a different value for the ECON_COURSE treatment variable. All other observations are dropped. By dropping non-comparable observations from the data set, there is the potential for selection bias to be reduced. We estimate the following regression using OLS and negative binomial estimators with the common support data set:

$$(4)\quad SCORE_{is} = \alpha_g + \beta_1 ECON\_COURSE_{ig} + \beta_2 STOCK\_MKT\_SIM_{ig} + e_{ig}$$

where α_g is a group-specific intercept. Results from regressions with the common support data set need to be considered cautiously, as a matching analysis will only perform well if selection is solely on observables (Imbens and Wooldridge 2009). This

condition is clearly not met in our analysis, as we have strong priors that other variables (e.g. family income, student GPA) are likely to affect student selection of an economics class or a class with a stock market simulation.

Our econometric analysis begins (Table 2) with OLS estimates of specification (3) and considers whether results are affected by adding an additional treatment variable (CONS_ED) and an additional control variable (PLAN_ ECON). Next, we run the same regression specifications with a negative binomial estimator because the dependent variable ($SCORE_{is}$) is count data (Table 3). Finally, we repeat both the OLS and negative binomial estimations using the matched data set described above (Table 4).

V. Results

Our empirical analysis of student test scores begins with an examination of results from four different regression specifications estimated using ordinary least squares. In each of the four specifications (Table 2, columns 1-4), control variables performed as expected. Estimated coefficients on GENDER range between .73 and .75 and are statistically significant at the five percent level in all specifications. These results are not surprising, as they mirror those found in earlier national studies of performance of high students on economics tests, in particular the recent NAEP assessment in 2006. Estimated coefficients on TWO_YR_COLLEGE are positive, ranging from .42 to .44, but are not statistically significant at the ten percent level in all specifications. Estimated coefficients on FOUR_YR_COLLEGE are also positive, ranging from 1.33 to 1.35, and are statistically significant at the five percent level. Both variables are measured against the baseline of the group of students who have no plans for further education beyond high school. These results support the finding by Walstad and Buckles (2008) that students with higher post-high school aspirations are likely more academically inclined than otherwise, and therefore perform better on the exam.

All OLS specifications were run with dummy variables for each student's high school to control for stratum effects.[11] None of the estimated coefficients are statistically significant at the ten percent level. This is a somewhat surprising finding, as our priors indicate that the quality of instruction varied substantially across high schools, a factor that should have produced a positive impact on test scores at these schools.

Two more OLS specifications (Table 2, columns 2 and 4) were run using an additional control variable, PLAN_ ECON. Estimated coefficients on PLAN_ ECON range from .06 to .14, but are not statistically significant at the ten percent level.

Since the control variables generally performed as expected (or were statistically insignificant), we turn our focus to estimates of the effects of the two treatment variables, ECON_COURSE and STOCK_MKT_SIM. Estimated coefficients on ECON_COURSE range from 1.02 to 1.09, and are statistically significant at the five percent level in all four specifications. We note that the mean of the four conditional estimates of the effect of an

[11] One school dummy was omitted to prevent perfect collinearity.

economics course on a student's score (1.05) is less than the difference in unconditional means (1.50). Estimated coefficients on the second treatment variable, STOCK_MKT_SIM ranged from .96 to 1.04, and are statistically significant at the five percent level in all four specifications. Together, the two treatments raised student test scores by just over two points. These results support findings by Walstad and Buckles (2008) that participation in a stock market simulation reinforces economic concepts and therefore improves performance on the test.

Estimated coefficients on a third treatment administered to some students, CONS_ED, are negative (Table 2, columns 3 and 4). This is somewhat surprising as one might expect some of the knowledge acquired in a consumer education course to be useful on a test of economics knowledge.[12] The estimates are, however, not statistically significant at the ten percent level.

Student test scores on the economics test are count data, and OLS estimates with count data could be biased. We experimented with a Poisson regression model, but ran into issues with overdispersion, i.e., greater variance than might be expected in this type of distribution, resulting in failures of standard goodness-of-fit tests.[13] We followed the Poisson model with a negative binomial regression, as it is often more appropriate when there is overdispersion. A likelihood ratio test conducted on the negative binomial regression results reinforces our earlier finding that the assumption of a Poisson distribution is inappropriate for our data set. Table 3 reports marginal effects of treatment and control variables on student score for the same four specifications used in the OLS estimates. Inspection quickly reveals that results from the negative binomial regressions are virtually identical to those from the OLS regressions.

We also run OLS and negative binomial regressions on two specifications (with and without CONS_ED) with our matched data set (Table 4). Estimated coefficients for ECON_COURSE range from 1.01 to 1.08 and are statistically significant at the five percent level. These results are just about the same as those obtained from earlier OLS and negative binomial regressions using the full data set. Estimated coefficients for STOCK_MKT_SIM range from 1.03 to 1.11 and are statistically significant at the five percent level. These results are slightly (.08 to .10) higher than those obtained from earlier OLS and negative binomial regressions using the full data set.

VI. Conclusion

Our empirical results for the effects of the stock market game and completion of an economics course are robust across two different estimation methodologies (OLS and negative binomial regression), estimation with matched and unmatched data, and

[12] Walstad and Buckles (2008) find a similar result regarding the negative relationship between participating in Junior Achievement and test scores.

[13] A significant ($p<0.05$) test statistic from the goodness-of-fit test indicates that the Poisson model is inappropriate. The large value for chi-square in our goodness-of-fit test was another indicator that the Poisson distribution was not an adequate functional form.

inclusion of a third treatment variable. In sum, they indicate that the Hawaii public high school students in our sample who completed an economics course scored about one point higher on the twenty-question exam and that students who participated in the stock market simulation also scored about one point higher on the exam.

Participation in the stock market game produced almost as much improvement on the student test as completion of an economics course. This is somewhat surprising, as the amount of student and teacher time devoted to this activity is far less than the semester-long economics course.

How do our results inform us with respect to the impact of a course in economics on a Hawaii public high school student? On the one hand, scores of Hawaii public school students on our economics test mirror nationwide results on standardized economics tests: they are not particularly high. Students who completed an economics course still averaged just 59 percent on the exam. On the other hand, Walstad (2001) suggests that the best opportunity for improving the economic understanding of youth occurs in high school, and our empirical results show non-trivial improvement, as the course in economics added about five percent of the total points possible to student scores. While the effect is not large, it nonetheless shows that foundations are present in the Hawaii public high school curriculum to improve student understanding further. Finally, our analysis emphasizes contemporaneous effects, but there could also be (unmeasured) effects on future performance, as Myatt and Waddell (1990) found that completion of a high school economics course enhances performance in university-level economics.

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Table 1: Summary Statistics: Student Test Scores and Characteristics

A. All Students Taking the Exam

	Unmatched Sample		Matched Sample	
Variable	Mean	S.D.	Mean	S.D.
SCORE	10.88	3.67	10.95	3.77
ECON_COURSE	.37	.48	.42	.49
PART-ECON-COURSE	.20	.40	.23	.42
STOCK_MKT_SIM	.24	.43	.23	.42
CONS_ED_COURSE	.19	.40	.17	.38
GENDER	.46	.50	.44	.50
TWO-YR_COLL	.23	.42	.19	.39
FOUR-YR_COLL	.55	.50	.60	.49
PLAN_MORE_ECON	.20	.40	.19	.39
Observations	468		305	

B. Students Taking Exam with Economics Course

	Unmatched Sample		Matched Sample	
SCORE	11.83	3.69	11.69	3.81
ECON_COURSE	1.00	.00	1.00	.00
PART_ ECON	.53	.50	.53	.50
STOCK_MKT_SIM	.42	.50	.32	.47
COMBINATION	.47	.50	.36	.48
GENDER	.53	.50	.53	.50
TWO_YR_COLLEGE	.18	.39	.18	.38
FOUR_YR_COLLEGE	.62	.49	.58	.50
PLAN_ ECON	.22	.42	.20	.40
Observations	172		129	

C. Students Taking Exam without Economics Course

	Unmatched Sample		Matched Sample	
SCORE	10.33	3.55	10.41	3.65
ECON_COURSE	.00	.00	.00	.00
PART_ ECON	.00	.00	.00	.00
STOCK_MKT_SIM	.14	.35	.16	.37
COMBINATION	.04	.19	.03	.18
GENDER	.42	.49	.38	.49
TWO_YR_COLLEGE	.26	.44	.20	.40
FOUR_YR_COLLEGE	.51	.50	.62	.49
PLAN_ ECON	.19	.39	.18	.39
Observations	296		176	

Table 2: OLS Regressions on Student Test Scores:
Full Sample with School Dummy Variables

Variable	(1)	(2)	(3)	(4)
ECON_COURSE	1.09**	1.09**	1.03**	1.02**
	(.44)	(.44)	(.44)	(.44)
STOCK_MKT_SIM	.96**	.96**	1.04**	1.04**
	(.43)	(.43)	(.44)	(.44)
CONS_ED			-.59	-.61
			(.46)	(.46)
GENDER	.73**	.73**	.75**	.75**
	(.33)	(.33)	(.33)	(.33)
TWO_YR_COLLEGE	.43	.42	.44	.43
	(.49)	(.49)	(.49)	(.49)
FOUR_YR_COLLEGE	1.35**	1.34**	1.36**	1.33**
	(.42)	(.43)	(.42)	(.43)
PLAN_ ECON		.06		.14
		(.42)		(.42)
School Dummies	yes	yes	yes	yes
Adj. R^2	.11	.11	.11	.11
Observations	468	468	468	468
F-Statistic	3.67	3.50	3.59	3.43

Table 3: Negative Binomial Regressions for Student Test Scores: Full Sample with School Dummy Variables

Variable	(1)	(2)	(3)	(4)
ECON_COURSE	1.11**	1.11**	1.05**	1.04**
	(.43)	(.43)	(.44)	(.44)
STOCK_MKT_SIM	.94**	.93**	1.03**	1.02**
	(.43)	(.43)	(.44)	(.44)
CONS_ED			-.60	-.62
			(.45)	(.45)
GENDER	.72**	.72**	.74**	.74**
	(.32)	(.32)	(.32)	(.32)
TWO_YR_COLLEGE	.46	.45	.47	.46
	(.51)	(.51)	(.51)	(.51)
FOUR_YR_COLLEGE	1.38**	1.36**	1.39**	1.35**
	(.42)	(.43)	(.42)	(.42)
PLAN_ ECON		.08		.16
		(.41)		(.41)
School Dummies	yes	yes	yes	yes
Observations	468	468	468	468
Pseudo R^2	.03	.03	.03	.03
Log Likelihood	1241.3	1241.2	1240.4	1240.3
LR $\chi 2(23)$	76.94	76.98	76.73	78.88

Note:

Table 4: OLS and Negative Binomial Regressions for Student Test Scores: Matched Sample

Variable	OLS	OLS	NB	NB
ECON_COURSE	1.08**	1.02**	1.08**	1.01**
	(.47)	(.47)	(.44)	(.44)
STOCK_MKT_SIM	1.05**	1.11**	1.03**	1.11**
	(.54)	(.54)	(.51)	(.51)
CONS_ED		-.76		-.77
		(.58)		(.54)
School Dummies	no	no	no	no
Match Dummies	yes	yes	yes	yes
Observations	305	305	305	305
Adj. R^2	.09	.11		
F-Statistic	1.80	3.50		
Pseudo R^2			.04	.04
Log Likelihood			-807.06	-806.04
LR $\chi 2(23)$			68.43	70.47

Note: ** indicates statistical significance at the five percent level.