THE ALCHIAN-ALLEN EFFECT IN HIGHER EDUCATION REVISITED: STATE LOTTERY IMPACTS ON PUBLIC VERSES PRIVATE ENROLLMENT[1]

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Abstract: The purpose of this paper is to revisit the Alchian-Allen effect in higher education and to examine the impact of state lotteries on the public/private enrollment ratio. The Alchian-Allen effect applies to situations where there is a change in consumption resulting from the change in relative prices due to a fixed cost the consumer must pay regardless of the which product is purchased. Kroncke and Ressler (1993) tested for the Alchian-Allen effect in higher education and concluded the price ratio of public to private education increased with a decrease in the fixed cost of attending higher education, proxied by the unemployment rate, bringing about a decrease in the public to private enrollment ratio. Our results also indicate the unemployment rate does have a significant direct effect on the enrollment ratio (confirming the Alchian-Allen effect); however, the existence of a state lottery tends to decrease the public/private enrollment ratio and therefore reduces impact of the Alchian-Allen effect in higher education enrollment.

JEL classifications: D12, I23

Keywords: Alchian Allen (AA) Effect, Public versus private enrollment in higher education, State lotteries.

1. INTRODUCTION

The Alchian Allen (AA) Effect, coined by Alchian and Allen (1968), has been applied to a plethora of situations where the relative prices of two substitute goods change as a result of a fixed cost that the buyer must pay. The classic example of the AA effect was posited by Borcherding and Silberberg (1978). The question considered was why the better quality apples were shipped out of Washington, leaving the lower quality apples to be consumed within the state. Borcherding and Silberberg answer the question by explaining the existence of shipping costs, a fixed cost, that when applied to the apples, will make the more expensive apple relatively cheaper, and therefore more attractive. Consequently, the better quality apples are a better bargain to the out of state consumers than to in-state consumers.

Kroncke and Ressler (1993) tested the existence of the AA effect in higher education, examining two goods - public and private higher education. Using the unemployment rate as a

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proxy for the opportunity cost of attending post-secondary education, Kroncke and Ressler conclude the relative price of public and private education does change as a result of changes in foregone employment opportunities. Changes in unemployment rates impact the fixed cost, and therefore the full cost, of attending both public and private institutions, hence changing the relative price between the two. When the relative prices change, so will the quantities demanded of each good.

One rather recent development that has impacted higher education is the existence of state lotteries. Currently, forty three states have state lotteries, and fifty percent of these lotteries began after 1986. Lotteries have been marketed by their supporters as the panacea for the lack of education funding provided by the state. With state budgets under constant pressure, lottery tax revenue is a welcome supplement to the state's spending on education, potentially impacting the relative prices of public and private education.

The purpose of this paper is to examine the AA effect that lotteries may have on the U.S. higher education. First, whether the AA effect of unemployment rate still exists in higher education is examined. The model specification developed by Kroncke and Ressler (1993) is the basis for the model utilized in this paper. Second, a new model specification will be estimated utilizing a new variable to control for the existence of state lotteries. By accounting for the existence of lotteries, we examine whether the existence of state lotteries enhances the AA effect, or whether it in fact reduces the AA effect on the public and private enrollment ratio.

2. THE MODEL AND FINDINGS

A basic cross-sectional ordinary least square (OLS) model is utilized to determine if the AA effect exists in higher education. The "fixed cost" workers experience is measured by the state's unemployment rate, which proxies the opportunity cost of attending college. As the unemployment rate increases, the probability of getting a job decreases, and thus the opportunity cost (forgone income) of enrolling in higher education falls. If the AA effect does exist, the unemployment rate will have a positive sign, indicating as the opportunity cost of going to college decreases (higher unemployment rate), then public enrollment (the assumed lower quality good) should increase to a greater degree than the private school enrollment.

The OLS specification of this basic model is:

$$Enrollratio = \gamma + \beta 1 Unemplrate + \beta 2 Income + \beta 3 Finaid + \beta 4 Pop + \beta 5 Tuitionratio$$

where *Enrollratio* = the ratio of public enrollment to private enrollment of each state, γ is the intercept, *Unemplrate* = the unemployment rate of each state, *Income* = the per-capita income of each state, *Finaid* = financial aid distributions of each state, *Pop* = the 18-24 year old population of each state, *Tuitionratio* = state's ratio of public institution tuition to private institution tuition. This variable measures the Department of Education's obligations for student financial assistance. The data consists of an observation for each state for the fiscal years 2004 and 2005. The variables are in their natural logarithmic form, except for the unemployment rate and the tuition ratio.

Table 1: All models

Regressors	Model 1 Coefficient estimate (p-value)	Model 2 Coefficient estimate (p-value)	Model 3 Coefficient estimate (p-value)
γ	21.708 (0.000)	21.499 (0.000)	18.355 (0.001)
Unemplrate	18.336 (0.017)	17.914 (0.011)	15.356 (0.024)
Income	-1.782 (0.001)	-1.779 (0.001)	-1.479 (0.003)
Finaid	-0.139 (0.091)	-0.138 (0.013)	-0.101 (0.062)
Pop	-0.003 (0.980)	-	-
Tuitionratio	-0.426 (0.643)	-	-
Lottery	-	-	-0.628 (0.004)
F	6.470 (0.000)	10.070 (0.000)	11.190 (0.000)
B-P χ^2	10.070 (0.073)	8.170 (0.043)	6.730 (0.151)
p-value of S-W W test	(0.383)	(0.279)	(0.074)
adj-R^2	0.246	0.262	0.327

Note. This table provides the results of this analysis for the three models: Model 1, Model 2, and Model 3. In all models we try to explain average enrollment ratio of public versus private education. The results show that Model 3 explains better the variation in enrollment ratio and it does not suffer from the heteroskedasticity problem.

The second column, labeled as Model 1, of the Table 1 contains the results of this basic model. The existence of the AA effect is evident with a statistically significant, positive coefficient on *Unemplrate*. As the unemployment rate decreases, the ratio of public to private enrollment decreases as well. The $Income$ coefficient is negative and highly significant indicating that as state per-capita income increases, the enrollment ratio declines, either by more students enrolling in private institutions, fewer students enrolling in public institutions, or possibly the increase in private sector enrollment increasing to a greater degree than the public sector enrollment. Another income-related variable, *Finaid*, has a significant negative coefficient. The effect of financial aid assistance seems to have a stronger impact on enrollments in private institutions relative to public institutions. The *Tuitionratio* and *Pop* coefficients are negative, although insignificant. This model specification supports the notion that the unemployment rate has an AA effect on the enrollment ratio in higher education, reaffirming the finding of Kroncke and Ressler (1993).

Given the fact our data are cross-sectional, it is necessary to test for the occurrence of heteroskedasticity in the residuals of the model. The well-known Breusch-Pagan (B-P) test for heteroskedasticity is utilized and the p-value of the B-P χ^2 statistic is reported on the 9th row of Table 1. The results from this test indicate we are unable to reject the null hypothesis of constant variance as the corresponding p-value is 0.07 (> 0.05). Since we are assessing significance of five independent variables by corresponding *t*-tests we also need to check the normality assumption of the residuals of the model. For this purpose the Shapiro-Wilk (S-W) W test is used to test for normality, and the corresponding p-value is 0.38 (> 0.05) indicating we cannot reject the null hypothesis the residual is normally distributed. Thus, it appears Model 1 does not violate any of the standard assumptions of the OLS. However, we cannot be certain without a further analysis of the adequateness of Model 1 specification for explaining the Alchian-Allen effect in higher education enrollment.

A second model is estimated that omits the two insignificant variables in the first model specification: *Tuitionratio* and *Pop*.

$$Enrollratio = \gamma + \beta 1 Unemplrate + \beta 2 Income + \beta 3 Finaid$$

The results of this model are presented in the third column, labeled as Model 2, in Table 1. The adjusted R-squared improves by 6.5% with two fewer explanatory variables, and all three of the explanatory variables are significant at the 5% level. The unemployment rate variable is once again positive, showing the existence of the AA Effect. The Income variable is once again negative, indicating as income increases, consumers of higher education choose to enroll in private institutions to a greater degree than public institutions. The financial aid variable is also inversely related to the enrollment ratio. As with the income variable, it appears the financial assistance has a greater impact on private enrollment relative to public enrollment.

An examination and testing of common OLS assumptions of Model 2 does identify some concerns. The p-value of the B-P χ^2 statistic, reported on the 9th row, third column of Table 1, indicates that the underlying model may suffer from the heteroskedasticity problem, as the corresponding p-value is 0.04 (< 0.05). However, the corresponding p-value of the S-W W test is 0.28 (> 0.05) indicating we cannot reject the null hypothesis that the residual is normally distributed. We also note that t-tests for the three independent variables in the model are highly significant as p-values are less than 0.05 and the VIF's (< 10) are small (see Table 2) indicating insignificant multicollinearity. Therefore, Model 2 does not violate the normality assumption, but may suffer from the heteroskedasticity problem.

Given the heteroskedasticity concern, the residuals of Model 1 and Model 2 specifications are examined to detect if there is any important independent variables omitted from those models. Basic econometric theory states there should not be any pattern apparent in the residuals plot, meaning econometrically meaningful models' residuals should bear only a random pattern. Initially, these residual plots (see left hand side diagram of first two panels of Figure 1) seem to exhibit a rough random pattern, implying that no adjustment to these models can be made to improve these regression equations. However, after careful consideration we noticed an interesting and fairly consistent pattern in the residuals plot of these models: states that do not have a lottery (represented by the dummy variable and is equal to zero) are positive with just one exception (see right hand side of the first two panels of Figure 1). This pattern implies the OLS models under-predicted the enrollment ratio. Thus, it appears we can improve the fit of these models by adding a variable that represents the lottery effect.

2.1. STATE LOTTERY IMPACT ON HIGHER EDUCATION ENROLLMENT

Our results so far have confirmed the existence of the Alchian - Allen Effect in higher education; the unemployment rate in the state has a significant, positive impact on the public/private enrollment ratio. As the unemployment rate declines, the enrollment ratio decreases, meaning private enrollment is increasing to a greater degree than public enrollment. The results from our analysis of the residuals from Model 1 and Model 2 indicate there are strong econometric reasons, in addition to mere economic intuition, to include the lottery variable in our model.

Currently, lotteries are in forty-three states, with Alabama, Alaska, Hawaii, Mississippi, Nevada, Utah, and Wyoming currently not operating state lotteries. Among the forty-three states operating a lottery the appropriation of lottery tax revenue varies. Some states allocate the revenue to the general fund, whereas other states earmark the revenues to public K-12 education, or programs for the elderly, as well as scholarship programs in higher education. For a majority of the states, the revenues are generally split between the state's common fund and public K-12 education. Only a small percentage of states with lotteries explicitly earmark lottery revenue to benefit higher education. Florida and Georgia, among others, use a portion of the lottery tax revenue to fund various merit-based and need-based scholarship programs (Borg and Borg, 2007). Researchers have explored the impact of lottery proceeds on the incidence of the benefits of lottery-funded HOPE scholarships that Georgia residents received (Rubenstein and Scafidi 2002). Dyarski (2000) examined the impact of lottery-funded merit-based scholarships on in-state college attendance rates of middle and upper income students. We contribute to this literature by specifying a model (Model 3) that includes a dummy variable for the lottery. The question we examine here is whether the existence of a lottery in a state has an impact on the public/private enrollment ratio. We also examine the impact the lottery has on the AA effect. We include a dummy variable, *lottery*, which has a value of 1 if the state has a state lottery and 0 if no lottery exists in the state. The lottery variable does not account for how the lottery revenue is apportioned; it simply accounts for the existence of a lottery in the state. The Model 3 is specified as follows:

$$Enrollratio = \gamma + \beta 1 Unemplrate + \beta 2 Income + \beta 3 Finaid + \beta 4 lottery$$

The results of the third model specification are presented in the fourth column, labeled as Model 3, of Table 1. The increase in the adjusted R-square by 25% relative to Model 2 and by 33% relative to Model 1 supports our choice of including the lottery variable in Model 3. The same tests for heteroskedasticity and normality were used in Model 3, and the results indicate that we failed to reject both the null hypotheses of homoscedasticity and normality of the residuals distribution. The lottery variable is significant at the 1% level, and is negatively related to the enrollment ratio. Moreover, we do not find any consistent pattern in the residuals plot of Model 3 (see diagrams of third panel in Figure 1). The results show the existence of a lottery in the state decreases the public to private enrollment ratio. One possibility is the lottery increases private enrollment to a greater degree than public enrollment. It is also possible that public enrollment is declining as the private enrollment is increasing. This result may support the view the public education is an inferior good compared to the private education. In explaining this view, it could be the existence of state lotteries reduce the overall tuition cost the student faces, leading to an increase in effective income. This increase in available income leads to more private education being purchased than public education.

The findings by Rubenstein and Scafidi (2002) may also help us to explain the inverse relationship between the lottery variable and the public/private enrollment ratio. Rubenstein and Scafidi concluded that white, higher-income households receive a disproportionately large number of lottery funded, merit-based scholarships Therefore, it is possible states with lotteries would see more scholarships awarded to higher income households, and these households could be choosing the more selective, “higher quality” private institutions.

Including the lottery variable in Model 3 does affect the size of the Alchian-Allen effect relative to Model 1 and Model 2. The smaller coefficient on the unemployment rate indicates the size of the AA Effect is slightly reduced when the lottery is considered. The coefficients on income and the financial aid variable both decreased to some degree with the inclusion of the lottery variable. It appears the effect the lottery has on the enrollment ratio accounts for a small portion of both the income effects and financial aid effects on the enrollment ratio.

4. CONCLUSION

This paper has tested for and confirmed the existence of the Alchian-Allen effect in higher education. Our results show as the opportunity cost of attending college (proxy by the unemployment rate) changes, the relative full prices of public to private education change, thereby changing the quantity demanded of both goods. The second contribution of this paper is the inclusion and examination of a lottery variable and its impact on the public to private enrollment ratio. The results from the model including the lottery variable confirm that in addition to the unemployment rate having a significant direct effect on the enrollment ratio, the existence of a state lottery has a statistically significant, negative impact on the public to private enrollment ratio, indicating the lottery is associated with a decrease in the public to private enrollment ratio. Specifically, the private enrollment increases to a greater degree than public enrollment in states that have a lottery. Further study on this lottery effect on higher education enrollment could attempt to explain how lottery revenue appropriation plans impact the public to private enrollment ratio.

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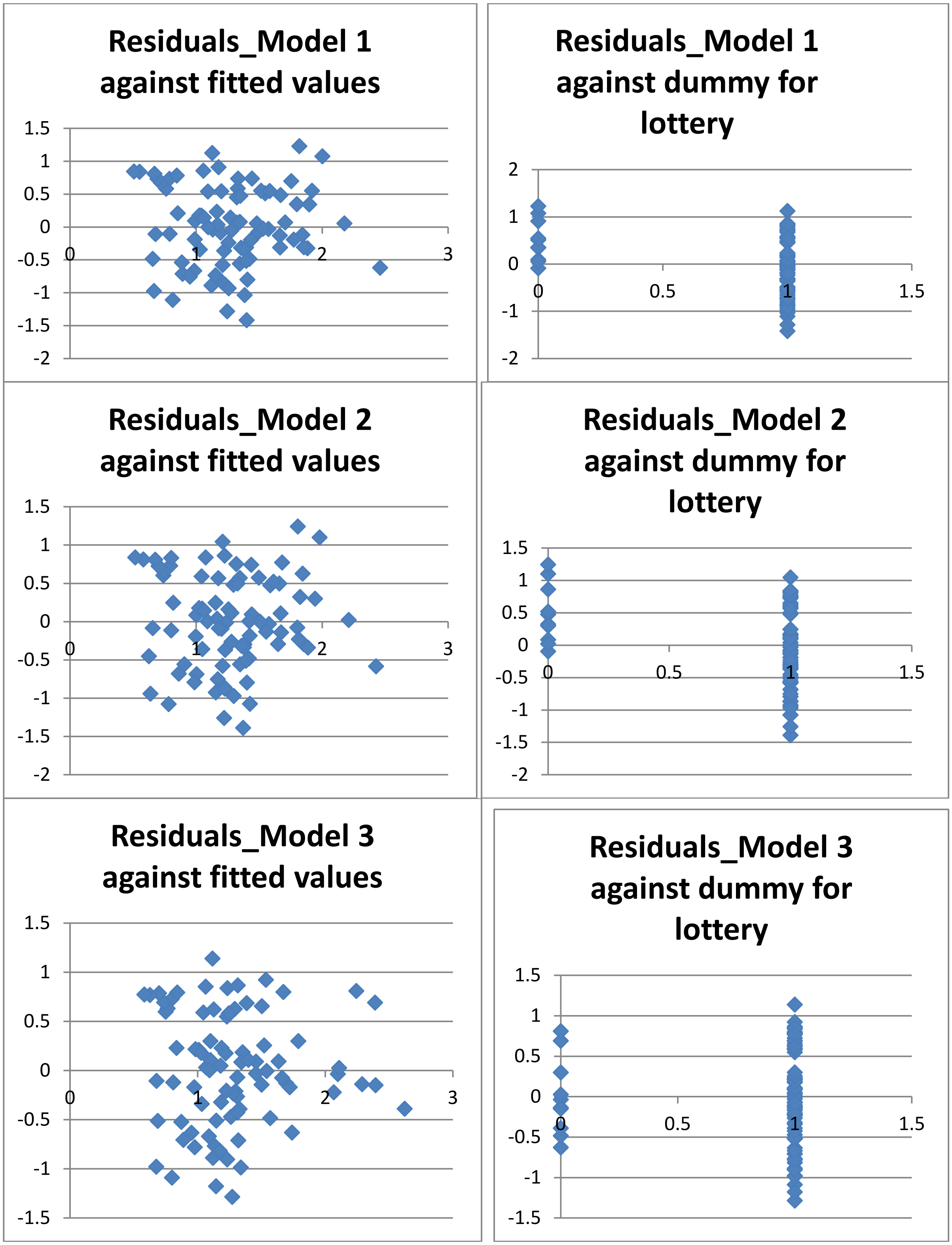
Table 2: Variance Inflation Factor

Variables	Model 1 VIF	Model 2 VIF	Model 3 VIF
Unemplrate	1.31	1.13	1.15
Income	1.17	1.10	1.15
Finaid	2.32	1.06	1.12
Pop	2.73	-	-
Tuitionratio	1.06	-	-
Lottery	-	-	1.14

Note: This table provides the variance inflation factor of all the explanatory variables for the three models: Model 1, Model 2, and Model 3. The results show that none of the models suffer from the multicolinearity problem.

Figure 1


Residuals_Model 1 against fitted values
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
1
2
3
Residuals_Model 1 against dummy for lottery
2
1
0
-1
-2
0
0.5
1
1.5
Residuals_Model 2 against fitted values
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
1
2
3
Residuals_Model 2 against dummy for lottery
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
0.5
1
1.5
Residuals_Model 3 against fitted values
1.5
1
0.5
0
-0.5
-1
-1.5
0
1
2
3
Residuals_Model 3 against dummy for lottery
1.5
1
0.5
0
-0.5
-1
-1.5
0
0.5
1
1.5

RESIDUALS PLOT

This figure plots the residuals of the three models: Model 1, Model 2, and Model 3 on the left hand side of the three panels against fitted values. On the right hand side it plots residuals against the dummy variable for lottery. The diagrams on the right hand side of the first two panels show a fairly consistent and interesting pattern: states those have no lotteries are positive with just one exception whereas the third panel shows that residuals for states with no lotteries have random positive and negative values.