Is the U.S. Private Education Sector Infected by Baumol's Cost Disease? Evidence from the 50 States

Bates, Laurie and Santerre, Rexford

16 December 2013

Is the U.S. Private Education Sector Infected by Baumol's Cost Disease? Evidence from the 50 States

Laurie J. Bates
Professor of Economics
Department of Economics
Bryant University
Smithfield, RI
Email: lbates@bryant.edu
Telephone: (401) 232-6459
Fax: (401) 232-6319

Rexford E. Santerre*
Professor of Finance and Healthcare Management
Department of Finance
University of Connecticut
School of Business
2100 Hillside Road Unit 1041
Storrs, CT. 06269-1041
Email: rsanterre@business.uconn.edu
Telephone: (860) 486-6422
Fax: (860) 486-0634

December 16, 2013

* Contact author.

Is the U.S. Private Education Sector Infected by Baumol's Cost Disease? Evidence from the 50 States

Abstract

High and rising costs characterize the private education industry in the United States. This paper tests if Baumol's cost disease of the service sector can explain some of the growth of private education spending. An empirical strategy developed by Hartwig (2008) and Colombier (2010) and a panel data set of all U.S. states over the period from 1980 to 2009 are used in the empirical analysis. The empirical results indicate that Baumol's cost disease does infect the private education industry in the United States. The results are reasonably robust with respect to state- and time-fixed effects, two-stage least squares estimation, individual state time trends, and a variety of potentially important covariates.

I. Introduction

Most students receive their education from public institutions because they, or their parents, are attracted by the low marginal costs of a public primary and secondary education resulting from property tax support and/or are drawn to the lower costs of a public college education because of its state-subsidy status. However, a relatively large amount of the population in the United States does depend on private schools for their education. For example, in the fall of 2011, nearly 5.3 million students attended private primary and secondary schools. Another 5.9 million students were enrolled in private postsecondary schools during that same time period.[1]

As many know, a private education is not cheap. Per pupil expenditures on a private primary and secondary education averaged nearly $9 thousand for the academic year 2010-11. In addition, during that same year, tuition, fees, room, and board at a private college equaled about $32 thousand. And both of these costs have been rising significantly over time. Specifically, per pupil costs of a private education, at the primary and secondary levels, rose by over 200 percent, in real terms, since the late 1960s. Moreover, the total cost of a private college education more than doubled over that same time period.[2]

Although these costs have been recognized, few, if any, people understand why expenditures on a private education remain so high and tend to rise over time. In fact, we could not locate any research that has empirically investigated the main drivers behind the high and rising costs of a private education. Baumol (1967), however, offers a theoretical perspective by arguing that the education sector may suffer from a "cost disease" over time.

Specifically, Baumol points out that industrialized economies can be conceptualized as possessing progressive and nonprogressive sectors. The progressive sector, containing industries

[1] Digest of Education Statistics:2011
[2] Authors' estimates based on data from the Digest of Education Statistics: 2011.

such as manufacturing, is capital intensive in nature and subject to many process innovations over time. Such characteristics help to raise labor productivity in the progressive sector. While wages tend to rise, unit costs remain fairly flat in the progressive sector over time because of proportionate increases in labor productivity.

In contrast, Baumol views the nonprogressive sector, including industries such as education and medical care, as being more labor intensive and largely absent of productivity-enhancing innovations that enable labor to produce more output in a given amount of time. Consequently, labor productivity tends to be relatively stagnant in these industries. Baumol points out that wages in the nonprogressive sector tend to increase with higher wages in the progressive sector, and because these wage increases are not matched with parallel increases in productivity, they tend to drive up unit costs. Moreover, because the market demands for services tend to be price inelastic, the rise in unit costs also causes expenditures to increase on a continual basis. Coupled with a price-inelastic demand, Baumol's cost disease model provides a possible supply-side explanation for rising education costs over time.

This paper empirically investigates if Baumol's cost disease model accounts for some of the growth in private education costs over time in the United States using state data for the period between 1980 and 2009. The empirical findings suggest that Baumol cost disease model offers some explanation for rising private education costs over time. In the next section, the empirical model is developed and the sample and data are discussed. Section III reports the empirical findings. The final section summarizes the results.

II. Testing the Baumol Cost Disease Model

From a conceptual and mathematical perspective, Baumol's model is relatively simple, yet powerful in its predictions. Baumol assumes that labor, L, is the only input responsible for producing output, Y, in both the nonprogressive, Y^{NP}, and progressive, Y^{P}, sectors. He also assumes that the production functions at time t can be written something like the following:

$$Y^{NP}(t) = aL_{NP}(t) \tag{1}$$

$$Y^{P}(t) = bL_{P}(t)e^{rt} \quad . \tag{2}$$

Note equation 1 implies that output is proportional to labor in the stagnant sector whereas output in the progressive sector continues to grow at a constant growth rate of r over time. From these two production functions the corresponding marginal productivities of labor, $\frac{dY}{dL}$, at time t can be derived as a and be^{rt}, respectively. Note that the marginal productivity of labor in the stagnant sector remains constant whereas the marginal productivity of labor in the progressive sector rises over time.

Baumol further supposes that wages in the two sectors are equal at each point in time and that wages rise over time in conjunction with productivity improvements in the progressive sector. Thus, the wage in both sectors at each point in time can be expressed as:

$$W(t) = W_0 e^{rt} \quad . \tag{3}$$

Given our single input production functions, it follows that unit costs (C) can be written as the ratio of wages to marginal productivities in the two sectors, or:

$$C^{NP}(t) = W_0 e^{rt}/a \tag{4}$$

$$C^{P}(t) = W_0 e^{rt}/be^{rt} = W_0/b \; . \tag{5}$$

One implication of Baumol's model is that unit costs in the progressive sector remain constant over time (equation 5). Another implication is that unit costs continually rise over time in the stagnant sector based upon the rate of productivity growth in the progressive sector (equation 4). This latter result is referred to as Baumol's cost disease of the service sector.

Recently, Hartwig (2008) offers a novel way of testing Baumol's theory. Given that the prices of services are difficult, at best, to measure (Triplett and Bosworth, 2003; Nordhaus, 2008; Hartwig, 2011), the beauty of Hartwig's approach is that price data are unnecessary for the test. Hartwig shows that Baumol's cost disease model can be tested by examining if unit cost changes in the nonprogressive sector are directly proportional to the excess of wage growth less labor productivity growth in the overall economy, or:[3]

$$\dot{C}^{NP} = \lambda[\dot{W} - \dot{Q}] = \lambda[BV]. \quad (6)$$

The left-hand side variable in equation 6 represents the growth of unit costs in the nonprogressive sector. The expression in brackets is named the Baumol variable (BV) by Hartwig. The variables W and Q measure the economy-wide average wage and output per worker so the expression in brackets captures the difference between overall wage and productivity growth over time. Baumol's basic theory suggests that laborers in both sectors experience similar wage adjustments but the nonprogressive sector is entirely responsible for any productivity shortfalls. Thus, because of this "unbalanced growth", wage increases in excess of productivity fall predominately on unit costs in the nonprogressive sector. Thus, $\lambda = 1$ when the Baumol effect is complete and $\lambda = 0$ when no Baumol effect takes place. Intermediate values for λ between 0 and 1 indicate Baumol's theory partially accounts for the growth of unit costs.

Recently, Colombier (2010) shows mathematically that Hartwig's analysis, as depicted in equation 6, only represents a special case when all labor is allocated to the nonprogressive sector. He shows mathematically that a general formulation of the model can be expressed as:

[3] The derivation of this equation requires that the ratio of outputs in the progressive and nonprogressive sector remains constant, as assumed by Baumol (1967). This would be the case if demand is relatively inelastic or if the government subsidizes the price of the output in the nonprogressive sector.

$$\Delta\log(C^{NP}) = \frac{\beta_1[\Delta\log(W) - \Delta\log(Y)]}{L_{NP}/L_T} \; . \tag{7}$$

The implication of Colombier's model is that Hartwig's λ approaches 1 asymptotically as the nonprogressive sector's share of total labor (L_T) approaches 100 percent over time. In equation 7, a positive value for β_1 provides support for Baumol's cost disease. For empirical purposes, note that equation 7 can be rewritten as:

$$\frac{L_{NP}}{L_T} \cdot \Delta\log(C^{NP}) = \beta_1[\Delta\log(W) - \Delta\log(Y)]. \tag{8}$$

Hartwig (2008) and Colombier (2010) both test if the health care sector has contracted Baumol's cost disease using a panel data set of countries belonging to the Organization for Economic and Cooperative Development. Both studies conclude that the health care industry is affected by Baumol's cost disease. In this study, we test if the private education sector suffers from the cost disease by using a panel data set of U.S. states over the period from 1980 to 2009. Unlike Hartwig and Colombier, we test equation 8 rather than 6 or 7. More specifically, since little is known about the determinants of unit costs in the aggregate private education industry, we begin by assuming the empirical model takes the following basic reduced-form:

$$\left(\frac{L_E}{L_T}\right)_{s,t} \cdot \Delta\log(C^E_{s,t}) = \beta_0 + \beta_1\left[\Delta log(W_{s,t}) - \Delta\log(Y_{s,t})\right] + \beta_2\Delta log(\mathrm{PCY}_{s,t}) + \eta_s + \tau_t + \varepsilon_{s,t} \tag{9}$$

with L_E/L_T representing the share of total labor employed in the private education sector.

Notice that equation 9 bears a close resemblance to equation 8 except now it formally allows for variation in the various variables across states and over time; hence the *s* and *t* subscripts. A covariate, income per capita (PCY), is also specified given that researchers often assume that private education is a normal good. State, η_s, and time, τ_t, fixed effects are also specified in the basic estimation equation. The state-fixed effects help to control for any initial unobservable factors affecting the growth of private education costs, such as the proclivity to adopt new instructional technologies or preference for public education in each state, and thereby help to reduce the bias normally associated with unobservable heterogeneity. The time-fixed effects capture changes common to all states over time such as new educational technologies and general price inflation. The only other variable not yet identified, $\varepsilon_{s,t}$, is the equation's error term.

Data are obtained for all of the variables from the Bureau of Economic Analysis. To measure unit costs, C^E, in the private education sector (NAICS code 61), we rely on equation 4. According to equation 4, in a true "Baumol world", unit cost in a nonprogressive industry, such as education, is simply the wage rate divided by a constant marginal product. Thus, in such a world, it follows that wage and unit cost growth are the same in a nonprogressive industry over time. One may argue that a constant marginal product of labor may not actually hold in the real world even for a nonprogressive industry. However, it is Baumol's cost disease that is being tested so it should not be inappropriate to rely upon his assumption regarding productivity in the nonprogressive sector. To calculate the wage rate in the private education sector, total compensation (including sponsored benefits) is divided by the number of all workers, including the self-employed.

Similarly, the overall wage rate, W, in equation 9, is measured by dividing the total compensation (including sponsored benefits) for all industries by the total number of workers including the self-employed in all industries for each state-year observation. Economy-wide output per worker, Q, is calculated by dividing total real gross state product (GSP) by the total number of workers for each state-year observation. GSP per capita is used as our measure for PCY. Descriptive statistics are shown in Table 1 for all of the variables used in this study.

III. Empirical Results

When estimating the various equations, standard errors are made fully robust against arbitrary heteroskedasticity and serial correlation by clustering them at the state level (Wooldridge, 2002).[4] The ordinary least squares (OLS) technique is used to initially estimate equation 9. The multiple regression findings are reported in Table 2. Notice that roughly 54 percent of the variation in the growth of the average private education wage is explained by the multiple regression equation. Also note that the Baumol variable and growth of income, as captured by GSP per capita, add little to the explanatory power of the equation as their estimated coefficients are not statistically different from zero. Clearly, these OLS results provide no support for the existence of Baumol's cost disease in the U.S. private education industry.

One potential problem with these OLS findings, however, is that the coefficient estimates may be influenced by endogeneity bias. In particular, a shock leading to a change in the amount of GSP produced in the private education sector may affect the Baumol variable through its impact on wages and/or productivity in the overall economy. Alternatively stated, rather than just contracting the Baumol disease, the private education industry may also help to produce or cause the Baumol disease. The direction of the bias from this reverse causation is unclear and depends, in part, on whether the shock-induced activity in the private education sector more greatly impacts overall wage or productivity growth. For example, assume that nonprogressive sector growth only affects overall wages and that education wages actually grow slower than manufacturing wages. If so, the direction of the bias will be negative and therefore the estimated coefficient on the Baumol variable will be understated. Now assume that nonprogressive sector growth only influences overall productivity growth. In this case, the bias will be positive and the

[4] Examining the growth rather than the level of expenditures has an added benefit within a time-series context. Specifying variables in first-difference form is the typical remedy when unit roots exist in the data. Unit roots can lead to spurious correlations among variables (Granger and Newbold, 1974).

coefficient on the Baumol variable will be overstated if labor in the private education sector is actually less productive than in the manufacturing sector.

To identify if a causal relationship holds, the two-stage least squares (2SLS) technique is used to re-estimate equation 9. In the first stage equation predicting the current-year Baumol variable, the nominal housing price growth rate during the previous year is specified as an instrumental variable. Recall that the growth rate of nominal wages per worker shows up as one of the two components making up the Baumol variable. The plausibility of specifying the housing-price growth rate as an instrument rests on the notion that faster growing housing prices lead to a greater cost of living in a state. The greater cost of living, in turn, translates into higher nominal wages because employers are required to offer a compensating wage differential to employees or face the prospect of losing workers to states with slower-growing housing prices. Conditioned on the other covariates, the correlation between the previous-year housing price growth rate and the current-year wage growth rate should offer a suitable identification strategy.[5]

The first-stage of the 2SLS procedure tests if the previous-year housing price growth rate does indeed correlate strongly with the current-year Baumol variable. Average housing price data for each state-year observation come from the Lincoln Land Institute and are described by Davis and Heathcote (2007).[6] The first stage results are reported in the second column of Table 3. As expected, the estimated coefficient is positive and statistically significant on the past growth rate of housing prices. A Wald test, which restricts the coefficient on housing price growth to equal zero, confirms a strong correlation between the previous-year housing-price growth rate and the current-year Baumol variable, producing a F-statistic of 92.7. This F-statistic

[5] Also, to the extent that the growth of housing prices (i.e., a housing bust or boom) reflects increased economic activity and employment growth, overall productivity growth, the other component in the Baumol variable, may be affected.

[6] Data located at Land and Property Values in the U.S., Lincoln Institute of Land Policy http://www.lincolninst.edu/resources/ .

exceeds the threshold value of 10 suggested by Staiger and Stock (1997), for detecting weak instruments given one endogenous regressor. Moreover, Stock and Yogo (2002) point out that this Staiger and Stock rule of thumb remains reasonable in terms of the relative bias of 2SLS and size distortion as long as the number of instruments remains one or two.

Table 3 also reports the second stage results in the third column. The estimated coefficients on the Baumol variable and GSP per capita are now larger in terms of magnitude and statistical significance. Apparently, the reverse causality led to the underestimation of the coefficients and a poor overall fit to the data. Given that β_1 is positive and statistically significant, these 2SLS results provide evidence that Baumol's cost disease does, indeed, infect the private education industry in the United States.

As a robustness check, Table 4 reports the multiple regression findings for some alternative specifications of equation 9. The results in the second column of the table show the 2SLS results when individual state time trends are also specified in the estimation procedure. These individual state time trends allow the private education wage to grow at different rates in different states. They also control for any unobservable variables that may be trended over time and systematically related both to the growth of wages in the private education industry and the Baumol variable. While individual state time trends often swamp the effects of the other independent variables, notice that the estimate of β_1 retains its magnitude and statistical significance.

Finally, the third column of Table 4 shows the multiple regression results when some other covariates: growth of percent elderly, the unemployment rate, the poverty rate, the union coverage rate and population, are added to the specification. These specific variables are chosen because consistent data are available for them across states and over time and because they reflect some important factors potentially affecting private education spending. For example, the unemployment rate controls for the effect of the business cycle and the poverty rate captures the distribution of income. Moreover, union activity may leak into the private education industry and influence cost growth whereas the percentage of the elderly speaks to the age distribution in the state. Figures for the unemployment rates are found at the U.S. Bureau of Labor Statistics. Data for population, the poverty rate, and the percent 65 years of age and older are gathered from the U.S. Bureau of the Census. Union coverage data are obtained from Unionstats.com and are described by Hirsch and Macpherson (2003). Despite the control for these additional covariates, notice that the Baumol effect, as captured by β_1, retains its statistical significance and remains relatively unchanged in magnitude.[7]

IV. Conclusion

About 10 million students and their families rely on private schools for their education. Private education costs have been rising in real terms yet few, if any, people understand the reasons behind its rise. To provide some understanding, this study asks if the private education industry suffers from Baumol's cost disease. The empirical model, which depends on a strategy offered by Hartwig (2008) and Colombier (2010), finds that unbalanced growth in the overall economy did increase the growth of private education costs in the United States over the period from 1980 to 2009.[8] The results are robust with respect to time- and state-fixed effects, other covariates, individual state time trends, and 2SLS estimation.

[7] The positive coefficient on the growth of the percent elderly may reflect that older workers add more to wages than productivity. Given that the growth of GSP is already specified in the equation and may control for the business cycle, the positive coefficient on the growth of percent unemployed may be picking up the effect of structural unemployment growth on wages. Wages may rise to reflect the shortage of skilled workers in the private education industry.

[8] While it would also be interesting to know if Baumol's cost disease also infects public education services, that would be difficult to test because the BEA combines together all services produced in the public sector. Thus, public

But the news of Baumol's cost disease infecting the private education industry should not be interpreted as being as bleak as it might seem at first blush. As Baumol (1992) points out in a *Wall Street Journal* article, a rising tide raises all ships. Although the nonprogressive sector may continue to siphon off an increasing share of GDP over time, people do not necessarily sacrifice in terms of the total amount of goods and services consumed as long as the progressive sector continues to grow. A growing progressive sector not only produces more output directly, but through its technological innovations, frees up resources and thereby indirectly finances the consumption of more services in the nonprogressive industries. The important question then becomes: If we are interested in economic growth and consuming a variety of different goods and services, then how do we continue to ensure that the progressive industries continue to expand over time? That, of course, is a challenging macroeconomic topic clearly beyond the bounds of this aggregate industry study.

---

education services are mixed in with police, fire, sanitation, highway, and other collectively-financed services. However, given our results for private education and their structural similarities, we suspect that the production of public education services is also affected by Baumol's cost disease.

References

Baumol, W.J. (1967) Macroeconomics of unbalanced growth: The anatomy of urban crisis, *American Economic Review*, 57(3), 415-426.

Baumol, W.J. (1992) A Growing Economy Can Pay Its Health Bills, *Wall Street Journal*, May 18:A16.

Columbier, C. (2010) Drivers of health care expenditures: Does Baumol's Cost Disease Loom Large? Paper presented at the 66th Congress of the International Institute of Public Finance in Uppsala, Sweden, August 2010.

Davis, Morris A. and Jonathan Heathcote, 2007, "The Price and Quantity of Residential Land in the United States," *Journal of Monetary Economics*, vol. 54 (8), p. 2595-2620

Digest of Education Statistics, 2011. http://nces.ed.gov/programs/digest/d11/ Accessed July 3, 2012.

Granger C, Newbold P. 1974. Spurious regressions in econometrics. *Journal of Econometrics* 2: 111–120.

Hartwig, J. (2011). Can Baumol's model of unbalanced growth contribute to explaining the secular rise in health care expenditure?: An alternative test. *Applied Economics*, 43(2), pp. 173-184.

Hartwig, J. (2008), What Drives Health Care Expenditure?: Baumol's Model of Unbalanced Growth Revisited, *Journal of Health Economics,* 27, 603 - 23.

Hirsch, B.T. and D. A. Macpherson, (2003) Union membership and coverage database from the current population survey: Note, *Industrial and Labor Relations Review*, Vol. 56, No. 2, January, pp. 349-54.

Nordhaus, W. D. (2008) Baumol's diseases: A macroeconomic perspective, *The B.E. Journal of Macroeconomics*, 8(1) Contributions, Article 9.

Staiger, D., and J. K. Stock. 1997. Instrumental variables regression with weak instruments. *Econometrica* 65:557–86.

Stock, James H., and Motohiro Yogo. 2002. Testing for weak instruments in linear IV regression. NBER Working Paper No. 284. Cambridge, MA: NBER.

Triplett, J.E. and B. P. Bosworth (2003) Productivity measurement: Issues in services industries: 'Baumol's cost disease' has been cured, *FRBNY Economic Policy Review*, 9(3), 23-33.

Wooldridge, J.M. (2002). *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA.: The MIT Press.

Table 1: Descriptive Statistics

	Mean	Standard Deviation	Minimum	Maximum
Private education's share of total labor	0.016	0.008	0.003	0.051
Nominal Unit Cost (Education Wage) Growth	0.043	0.058	-0.338	0.597
Baumol Variable	0.027	0.027	-0.200	0.288
Growth of Income (GSP per capita)	0.046	0.038	-0.331	0.324
Growth of Percent Old	0.007	0.012	-0.071	0.100
Growth of Unemployment Rate	0.006	0.181	-0.841	0.783
Growth of Union Membership Rate	-0.024	0.092	-0.459	0.426
Growth of Poverty Rate	0.001	0.180	-1.356	1.033
Population Growth	0.010	0.010	-0.062	0.083
Growth of Nominal Housing Prices	0.054	0.049	-0.248	0.263

Table 2: OLS Results Explaining Unit Cost (Wage) Growth in the Private Education Sector

Estimated Coefficient (Absolute Value of t-statistic)	
Constant	0.0006*** (11.34)
Baumol Variable	0.0009 (0.94)
Growth of Income (GSP per capita)	0.0005 (0.70)
Adjusted R^2	0.540
Number of Observations	1,450

1. One, two, and three asterisks imply statistical significance at the 10, 5, and 1 percent levels, respectively.
2. Standard errors clustered at the state level
3. Includes state- and time-fixed effects

Table 3: 2SLS Results

	First Stage (Dependent variable = Baumol variable)	Second Stage (Dependent variable = Unit Cost or Wage Growth)
	Estimated Coefficient (Absolute Value of t-statistic)	
Constant	0.050 (66.58)	0.0000003 (0.002)
Baumol Variable		0.013*** (3.54)
Growth of Income (GSP per capita)	-0.621*** (49.77)	0.008*** (3.51)
Growth of Average Housing Price	0.086*** (9.63)	
Adjusted R^2	0.758	0.502
Number of Observations	1,450	1,450

1. One, two, and three asterisks imply statistical significance at the 10, 5, and 1 percent levels, respectively.
2. Standard errors clustered at the state level
3. Includes state- and time-fixed effects

Table 4: Further 2SLS Results Explaining Unit Cost (Wage) Growth in the Private Education Sector

	With individual state time trends	With individual state time trends and additional covariates
	Estimated Coefficient (Absolute Value of t-statistic)	
Constant	-0.016*** (15.90)	-0.016*** (6.13)
Baumol Variable	0.013*** (3.38)	0.022** (2.30)
Growth of Income (GSP per capita)	0.008*** (3.19)	0.015** (2.27)
Growth of Percent Old		0.007* (1.91)
Growth of the Unemployment Rate		0.001** (2.40)
Growth of the Union Membership Rate		-0.00009 (0.50)
Growth of the Poverty Rate		0.00002 -(0.19)
Growth of Population		-0.002 (0.46)
Adjusted R^2	0.488	0.432
Number of Observations	1,450	1,450

1. One, two, and three asterisks imply statistical significance at the 10, 5, and 1 percent levels, respectively.
2. Standard errors clustered at the state level
3. All specifications include state- and time-fixed effects