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Disease or utopia? Testing Baumol in education[☆]

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HIGHLIGHTS

- Both Baumol's cost disease and income effects can generate increasing prices.
- As a quantity-measure, change in teacher–pupil ratios can test explanations.
- We consider both growth rates and the first-differences of such rates.
- We find negative correlations between our quantities and manufacturing wages.

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ABSTRACT

Baumol's Cost Disease offers a compelling hypothesis of rising unit costs in stagnant sectors, but increased productivity in progressive sectors may generate the same prediction through income effects. We examine quantity (rather than expenditure) data from the U.S. educational sector to distinguish between these explanations. Our results indicate significant negative impacts of manufacturing productivity on teacher–pupil ratios.

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Expenditure growth outstripping inflation is now well-documented in a number of sectors, with education and health care the canonical examples. The cost disease concept introduced by Baumol (1967) offers a compelling, if grim, explanation of this trend in labor-intensive industries. The cost disease broadly posits that "stagnant" sectors with no productivity growth must increase wages in order to compete for workers with the high productivity growth "progressive" sectors. Such stagnant-sector wage growth inevitably generates unbalanced growth among sectors.

A much less dire interpretation of this unbalanced growth, however, is also available. Cowen (1996) offers an income-effect explanation in which consumers feel so much richer from the increases in manufacturing productivity (and the concomitant decrease in the prices of manufactured goods) that their demand for services such as education and health care rises. This higher demand then increases labor demand and drives the higher wages. Rather than a cost-disease, this sectoral imbalance is a "cost-utopia" (p. 208), and society is strictly better off. This key point was first made by Robinson (1969), and Baumol (2012) indicates a shift to this latter position.

While the cost disease has long provided a shorthand explanation for rising costs in service sectors, it is only recently that econometric evidence has been provided for the core Baumol mechanism. Hartwig (2008, 2011), Bates and Santerre (2013), and Colombier (2012) all examine growth rates in per-capita health care expenditures and find significant correlations with the extent to which overall wage growth has outstripped overall productivity growth. To our knowledge, there have been no comparable studies in education.

The disease-vs.-utopia dispute is ultimately a cost vs. demand question, but both hypotheses predict higher wages and unit

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costs. As such the distinction can only be answered by moving beyond price and expenditure data and instead examining quantity data. This is exactly what we do in this paper. Given the relative stasis of classroom technology, the teacher–pupil ratio at K-12 public schools is in some ways the ideal measure. If there are fewer teachers per pupil (i.e., larger classes) when manufacturing productivity is high, we infer that the original Baumol story has merit, and the increased opportunity costs of teachers force school districts to move up their labor demand curves.[1] If, however, we see a positive correlation between teacher–pupil ratios and manufacturing productivity, then demand increases for public education stemming from positive income effects must dominate.[2]

1. Model and methods

Our study employs three identifying assumptions: (1) Workers can move across occupations; (2) Workers cannot move across state lines; and (3) Productivity shocks across the progressive and stagnant sectors are uncorrelated. The first assumption is the heart of Baumol's general equilibrium story of labor markets, and the second is needed to exploit cross-sectional variation within the US data. The third assumption is the most onerous, although perhaps less so in education. Broad technological improvements may increase labor productivity across all sectors. The nature of bias in estimation should this assumption be violated is uncertain; stagnant sectors could maintain their size (or expand) to satisfy more needs or shrink to contain costs. Given the prominent role of the public sector in education, our expectation is that this bias would be negative.

While it is not an identifying assumption, it is useful to think about income effects arising from cheaper manufactured goods by considering the case when a state's progressive sector's production is consumed entirely within the state (i.e., no interstate trade). Baumol's original analysis simplifies matters by assuming that all productivity gains are captured by workers. In competitive markets, one might instead expect these productivity gains to be shared between workers (in the form of higher wages) and consumers (in the form of lower prices). If there is no interstate trade, then these consumer gains (and hence income effects) are isolated to the state with the labor productivity growth. If, however, interstate trade is total so that all states benefit from the lower prices proportionally to their population, then the impact of income effects on education demand will hinge on the nature of scale economies in the progressive sector. Under constant returns, the benchmark state will see no decrease in its income effects from the no-interstate trade case. Only under decreasing returns will interstate trade mitigate against the finding of a real income effect.

Like Baumol (1967), we assume that wages in the progressive sector follow productivity. This enables us to use observed manufacturing wage growth as a proxy for productivity growth in the progressive sector. We posit a Cobb–Douglas reduced form specification that links the stagnant sector's equilibrium quantity Q^S to the progressive sector's wages W^P and other regressors X. For state i in year t,

$$Q_{it}^S = \left(W_{it}^P\right)^{\gamma} X_{it}^{\beta} \exp\left(\varepsilon_{it}\right). \tag{1}$$

Our use of the progressive sector's wage proxies for the true but unobserved variable of productivity. Given this proxy, our foremost concern is that demand shocks (e.g., a macroeconomic boom) would affect the demands for both the progressive and stagnant sectors and yield an upward bias on γ. We include measures of income in X in an attempt to address this concern, but we note that any additional omitted demand factors work against the original disease interpretation and in favor of the utopia interpretation.

Taking logs and then first-differencing generates the familiar analogue to the existing cost disease literature:

$$\ln\left(\frac{Q_{it}^S}{Q_{it-1}^S}\right) = \gamma \ln\left(\frac{W_{it}^P}{W_{it-1}^P}\right) + \beta \ln\left(\frac{X_{it}}{X_{it-1}}\right) + \varepsilon_{it} - \varepsilon_{it-1}. \tag{2}$$

This first differencing removes any time-invariant state-specific unobservables and also yields a regression that seeks to explain growth rates of quantities with growth rates of progressive wages and other regressors. The estimated sign of γ then reveals the dominant explanation, with negative implying cost-disease and positive indicating income effects.

While broadly similar to the literature, there are two key distinctions between the above and the specifications used previously. First, our dependent variable is the growth rate of per capita quantity, whereas the literature has focused on the growth rate of per capita expenditures. This emphasis on expenditures naturally conflates the distinct impacts on quantities and unit costs. Second, our data enable us to focus on the growth rate of the progressive sector's wage directly. Building on Hartwig (2008), the literature has instead considered a Baumol variable, constructed as the difference of the aggregate wage's growth rate and gross production's growth rate.

It is of course possible that the differenced disturbance $\varepsilon_{it} - \varepsilon_{it-1}$ still exhibits a substantial state-specific component (e.g., certain states exhibit higher growth rates than others). We address this concern by separately using fixed effects and first-differencing the data again. Our two general specifications are therefore

$$\ln\left(\frac{Q_{it}^S}{Q_{it-1}^S}\right) = \gamma \ln\left(\frac{W_{it}^P}{W_{it-1}^P}\right) + \beta \ln\left(\frac{X_{it}}{X_{it-1}}\right) + \theta_i + \omega_{it} \tag{3}$$

$$\ln\left(\frac{Q_{it}^S}{Q_{it-1}^S}\right) - \ln\left(\frac{Q_{it-1}^S}{Q_{it-2}^S}\right) = \gamma\left(\ln\left(\frac{W_{it}^P}{W_{it-1}^P}\right) - \ln\left(\frac{W_{it-1}^P}{W_{it-2}^P}\right)\right) + \beta\left(\ln\left(\frac{X_{it}}{X_{it-1}}\right) - \ln\left(\frac{X_{it-1}}{X_{it-2}}\right)\right) + \upsilon_{it}. \tag{4}$$

If our simple model is a good approximation of the true reduced form, we expect that the estimates of γ will be similar across the two specifications.

2. Data

Our data are drawn from publicly available sources, which are cited in Table 1. The sample covers the 50 states and the District of Columbia from 1997 to 2010. We treat a state-year as the unit of observation, so we have thirteen years of growth rates for each state. The variable of interest is the number of teachers per 1000 pupils in each state's primary and secondary public schools. Our key independent variable for this regression is the ratio of manufacturing real wage and salary disbursement to manufacturing wage and salary employment.[3] To alleviate concerns that the Great Recession may corrupt the results, we include an indicator for any year occurring after 2007. Other control variables are per capita

[1] The use of this sector requires the public choice assumption that school district governance reflects voters/consumer preferences.

[2] We also conducted the exercise using a per capita measure of hours worked in health care. While results were similar and statistically significant, the technological advances in health care made our identifying assumptions more questionable and hence all interpretations suspect.

[3] This measure conflates both the wage and hours worked. If labor supplies slope upward but are not vertical, this variable's coefficient would overstate the pure wage effect.

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Table 1
Descriptive statistics, teachers per thousand pupils in US K-12 public schools (1997–2010).[a]

Variables	*N*	Mean	S.D.	Max	Min	Definition
TP[b]	659	0.006	0.040	0.236	−0.268	Growth rate of state teachers per thousand pupils
MWD[c]	659	0.011	0.023	0.132	−0.170	Growth rate of state per employee manufacturing real wage and salary disbursement
MWE[c]	659	−0.028	0.042	0.058	−0.213	Growth rate of state manufacturing wage and salary employment
GDP[c]	659	0.012	0.026	0.090	−0.086	Growth rate of state per capita real GDP
DI[c]	659	0.012	0.022	0.109	−0.103	Growth rate of state per capita real disposable income
NDI[c]	659	0.015	0.101	0.243	−0.416	Growth rate of state per capita real non-disposable income
TP-dif[b]	606	−0.004	0.061	0.281	−0.416	Difference of TP between current and previous years
MWD-dif[c]	606	0.000	0.035	0.175	−0.303	Difference of MWD between current and previous years
MWE-dif[c]	606	−0.003	0.048	0.232	−0.162	Difference of MWE between current and previous years
GDP-dif[c]	606	−0.002	0.031	0.151	−0.154	Difference of GDP between current and previous years
DI-dif[c]	606	−0.002	0.032	0.140	−0.164	Difference of DI between current and previous years
NDI-dif[c]	606	−0.005	0.122	0.499	−0.420	Difference of NDI between current and previous years

Notes:
[a] Omitted observations from D.C. and Wyoming in 2002 generate a slightly unbalanced panel. Growth rates are calculated using logs of raw level data, i.e., growth rate$_t$ = $\ln(X_t/X_{t-1})$. Real values are converted from raw nominal values using CPI as deflator (http://www.bls.gov/cpi).
[b] Source: Elementary/Secondary Information System, National Center for Education Statistics (http://nces.ed.gov/ccd/elsi).
[c] Source: US Bureau of Economic Analysis, US Census Bureau (http://www.bea.gov/regional/#gsp).

Table 2
OLS regression of growth rate of teachers per 1000 pupils in US K-12 public schools (1998–2010).

Dep var	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	TP						
MWD	−0.177***	−0.187***	−0.190***	−0.191***	−0.185***	−0.177***	−0.181***
	(0.061)	(0.065)	(0.065)	(0.064)	(0.068)	(0.057)	(0.063)
MWE					0.062	0.070*	0.097*
					(0.038)	(0.042)	(0.058)
Post2007?	−0.018***	−0.018***	−0.018***	−0.017***	−0.016***	−0.016***	−0.016***
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
GDP			0.012			−0.035	
			(0.068)			(0.074)	
DI				0.028			0.000
				(0.047)			(0.054)
NDI				0.008			−0.019
				(0.014)			(0.020)
Fixed effect on state	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	659	659	659	659	659	659	659
R^2	0.046	0.083	0.083	0.084	0.086	0.087	0.087

Clustered standard errors in parentheses (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).
Estimates for constant terms are not shown.
Variables:
TP = growth rate of state teachers per thousand pupils
MWD = growth rate of state per employee manufacturing real wage and salary disbursement
MWE = growth rate of state manufacturing wage and salary employment
Post2007? = Binary indicator for latter/last period after 2007 (i.e., 2008 or later)
GDP = growth rate of state per capita real GDP
DI = growth rate of state per capita real disposable income
NDI = growth rate of state per capita real non-disposable income.

gross domestic product, per capita disposable income, and per capita non-disposable income. All nominal variables are deflated to real values using the national Consumer Price Index.

Table 1 displays the descriptive statistics and notations for our education sample. The growth rate of manufacturing employment is also included in anticipation of a robustness check. The first six rows reflect log growth rates as defined in (3) and the last six rows reflect differenced log growth rates as defined in (4).

3. Results

Employing the teacher–pupil ratio as our measure of quantity, Table 2 displays the estimates of Eqs. (2) and (3), and Table 3 displays those of Eq. (4). Use of state fixed effects is denoted at the bottom of each table. Standard errors are robust to arbitrary heteroskedasticity when fixed effects are not employed and are clustered consistent with the fixed effects using STATA otherwise.

Estimates of the key parameter γ are in the top row of each table. In all regressions, our measure of productivity growth in the progressive sector has a significantly negative relationship with the quantity measure. Baumol's original (and more pessimistic) story appears to carry the day.

There is little variation in the estimates of γ across the different specifications, with a range from −0.15 to −0.19. Referring back to (1), the elasticity interpretation is that a 10% increase in the progressive sector's wages would generate a roughly 2% decrease in the teacher–pupil ratio. The Great Recession indicator's effect is negative for growth rates but unimportant for changes in growth rates. The estimated coefficients on the control variables are somewhat unusual, as they exhibit notable contrasts across Eqs. (3) and (4). Specifically, the growth rate of per capita gross state product is minimally correlated with the teacher–pupil growth rate, but the differenced sample generates a negative correlation (counterintuitively suggesting that education is an income–inferior good).

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Table 3
OLS regression of difference of growth rate of teachers per 1000 pupils in US K-12 public schools (1998–2010).

Dep var	TP-dif					
	(1)	(2)	(3)	(4)	(5)	(6)
MWD-dif	−0.192*** (0.067)	−0.151** (0.067)	−0.186*** (0.069)	−0.196*** (0.068)	−0.151** (0.066)	−0.189*** (0.070)
MWE-dif				−0.045 (0.044)	0.003 (0.046)	−0.023 (0.072)
Post2007?	−0.007 (0.006)	−0.008 (0.006)	−0.007 (0.006)	−0.007 (0.006)	−0.008 (0.006)	−0.007 (0.006)
GDP-dif		−0.187** (0.076)			−0.189** (0.080)	
DI-dif			−0.079 (0.090)			−0.071 (0.096)
NDI-dif			−0.006 (0.020)			0.000 (0.027)
Fixed effect on state	No	No	No	No	No	No
Observations	606	606	606	606	606	606
R-squared	0.015	0.024	0.017	0.016	0.024	0.017

Heteroskedasticity–robust standard errors in parentheses.
Estimates for constant terms are not shown (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).
Variables:
TP-dif = Difference of TP between current and previous year
MWD-dif = Difference of MWD between current and previous year
MWE-dif = Difference of MWE between current and previous year
Post2007? = Binary indicator for latter/last period after 2007 (i.e., 2008 or later)
GDP-dif = Difference of GDP between current and previous year
DI-dif = Difference of DI between current and previous year
NDI-dif = Difference of NDI between current and previous year.

Our model asserts that manufacturing productivity growth drives labor demand and consequently manufacturing wages, but supply shocks in that labor market could also affect those wages. Such supply shocks would then also manifest in the numbers of employed workers. Given that manufacturing employment is the denominator of our raw dependent variable, such a story could render our results spurious. We therefore consider in the last columns of Tables 2 and 3 whether changes to manufacturing employment drive teacher–pupil ratios, distinct from their impacts through our inferred manufacturing wage. While the estimated coefficients of this additional regressor are marginally significant in Table 2, in no case does this variable's inclusion substantively change our previous findings.

4. Conclusions

Baumol (2012) concludes that a country can continue to consume essential services from low-productivity sectors if its people simply recognize their increased wealth from the productivity gains of the progressive sector. Another interpretation of our study is asking if the institutions in the US have made this leap. Our results indicate that the answer is still no; higher manufacturing productivity growth is associated with lower quantities of education consumed. We believe that a critical extension to this literature is whether this reflects some failure of the political system or whether voters believe that diseconomies of scale in governance mean that the cost disease as originally conceived by Baumol is more permanent.

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