

Investigating State Appropriations and Net Tuition Revenue for Public Higher Education: A Vector Error-Correction Modeling Approach

by

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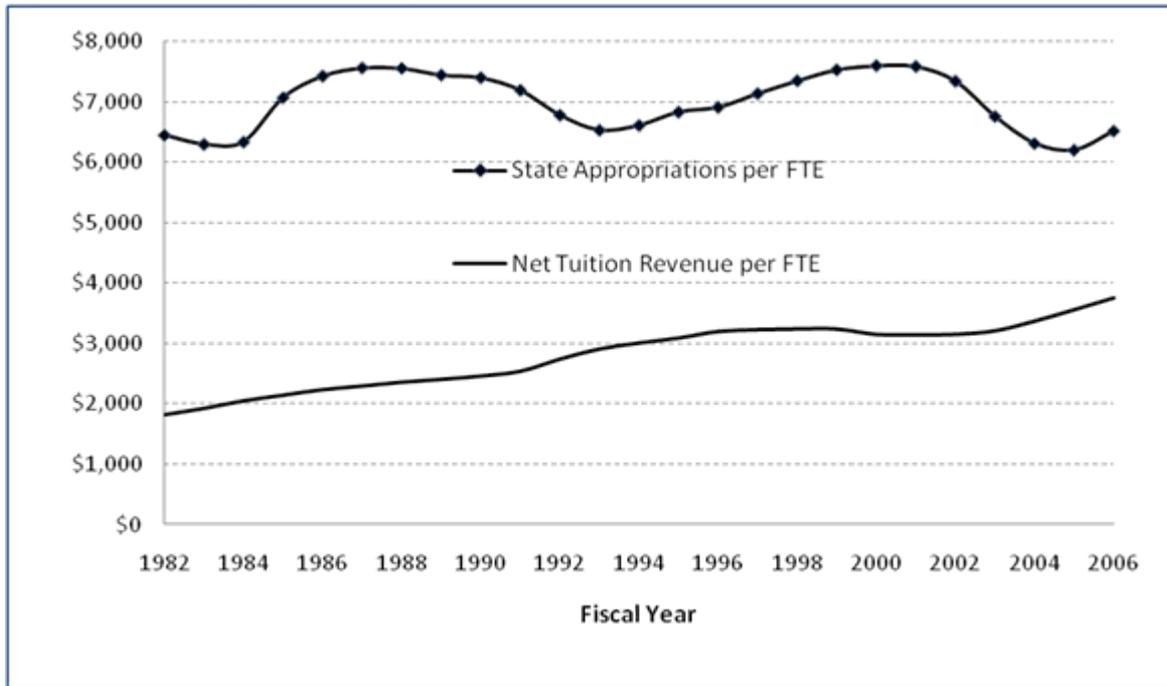
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Introduction

- Over the past few years, the growth rate in state appropriations to public higher education has declined substantially.
- Numerous reports have documented an apparent secular downward trend in state support for public higher education and an increase in tuition as a source of revenue.
- According to Hearn (2003), over the next few years, tuition revenue will become increasingly important to public higher education institutions.
- Some researchers (Koshal & Koshal, 2000) suggest there is an interdependent relationship between the state appropriations and the level of tuition at public higher education institutions.

Public Higher Education State Appropriations per FTE Student and Net Tuition Revenue per FTE Student, Fiscal Years 1982-2006



Source: State Higher Education Executive Officers.

Between 1982 and 2006, adjusting for inflation, state appropriations per full-time equivalent (FTE) student to public higher education has remained virtually ***unchanged*** while net tuition revenue per FTE student has ***increased substantially***.

Need for empirical study

- Although it has been reported (e.g., Heller, 2006; Zumeta, 2009) that state appropriations are being replaced by tuition as revenue source by public higher education institutions, there is little empirical research with respect to examining the short- and long-term relationship between state appropriations.
- More research is needed to examine the extent to which gains in net tuition revenue offset losses in state support at public colleges and universities.
- Most prior research examined net tuition revenue within the context of tuition discounting (e.g., Martin, 2002; Massa & Parker, 2007), enrollment management at private higher education institutions (e.g., Dowd, Cheslock, & Melguizo, 2008), or the relationship between state funding and tuition at public institutions in one state (e.g., Blake, 2006).

Need for empirical study

- Prior analyses of trends in state appropriations and net tuition revenue (e.g., State Higher Education Executive Officers, 2006, 2007) are descriptive and do not take into account the possible spurious relationships, endogeneity, and other unobservable variables across states.
- No known studies have used statistical techniques that distinguish between short- and long-term changes or the dynamic nature of state appropriations and net tuition with respect to how quickly short-term changes adjust to long-term trends.

This study...

- ...addresses the limitations of prior research by using statistical techniques that enable analysts to better distinguish between the short- and long-term effects of changes in state appropriations on net tuition revenue (and net tuition revenue on state appropriations) for public higher education.
- ...takes into account possible endogeneity and heterogeneity and also allows for the understanding of the extent to which short-term changes in state appropriations and net tuition revenue adjust to their respective long-term trends.

Research Design

- **Panel data**
 - times-series/cross-sectional (TSCS) data; 50 states from 1982 to 2006; analytic sample size of 1,250 state-year observations
 - State Higher Education Executive Officers (SHEEO) Association; U.S. Bureau of Economic Analysis; Postsecondary Education Opportunity website; and U.S. Department of Labor-Bureau of Labor Statistics
- **Vector error-correction (VEC) models**
 - Model-1 with state appropriations per FTE student as a dependent variable
 - Model-2 with net tuition revenue per FTE student as a dependent variable.
- **Dynamic panel modeling framework**

Variables

- Dependent
 - state appropriations per full-time equivalent FTE
 - net tuition revenue per FTE student
- Independent
 - lags of the dependent variables
 - total state taxes per capita
 - per capita income
 - Pell grant revenue per FTE student
 - year dummy variables (1983 – 2006)
- all continuous variables are log transformed

Descriptive statistics of variables used in the analyses

Variables	Average	Standard Deviation	Minimum	Maximum
State appropriations per FTE student	\$7,168	\$2,165	\$2,868	\$22,663
Net tuition revenue per FTE student	\$3,330	\$1,793	\$646	\$12,187
Total state taxes per capita	\$82	\$46	\$4	\$223
Pell grant revenue per FTE student	\$0.68	\$0.32	\$0.08	\$6.91
State per capita income	\$38,118	\$7,375	\$23,747	\$76,524

Statistical Methods

❑ Vector error-correction (VEC)

- re-parameterized vector autoregressive (VAR) models
 - VAR models - regression models with lagged (t-1, t-2, ... etc.) dependent variables as independent variables
 - Cointegration analysis – estimation of “adjustment” parameters and cointegrating equations that take into spurious relationships
- used, mostly by economists, to determine the adjustment of short-run “shocks” or effects to long-run equilibrium

❑ Dynamic panel modeling (DPM) analytical framework

- takes into account, through the use of lags and differences, endogeneity and unobserved state heterogeneity (such as history, culture, and politics) that may produce biased parameter estimates.
- estimated via **system** generalized methods of moments (**GMM**) techniques

System GMM

- When including a lagged dependent variable as an independent variable, OLS regression techniques tend to produce upwardly biased parameter estimates (Kiviet, 1995).
- On the other hand, fixed-effects regression tends to generate downwardly biased estimates (Nickell, 1981).
- According to researchers (Arellano & Bover, 1995; Blundell & Bond, 1998), regression models, via **GMM** techniques, tend to produce parameter estimates that lie between estimates produced by OLS and fixed-effects regression models with lagged dependent variables as independent variables.
- **GMM** techniques also generate instrument variables under orthogonal conditions, reducing the chance of spurious results.
- **System GMM** involves the use of lags of the differenced values of the endogenous variables and values of the exogenous variables, thereby increasing asymptotic efficiency and robustness of parameter estimates from small samples and short time periods (Arellano & Bover, 1995; Blundell & Bond, 1998).

Using **panel data** and employing **VEC models** within a **DPM** analytic framework via **system GMM**, we ask the following **research questions**:

1. In the short-run, what is the relationship between changes in state appropriations per FTE student and changes in net tuition revenue per FTE student to public higher education institutions?
2. In the long-run, what is the relationship between in state appropriations per FTE student and net tuition revenue per FTE student at public higher education institutions?

Limitations

- This study does not address **institution-level variables** that may also influence state appropriations per FTE student and net tuition revenue per FTE student.
- This paper does not address the **possible long-run equilibrium relationships that may exist between states or institutions**, otherwise known as “between cointegration” (Anderson, et al., 2006).

Pre-estimation tests

- **panel data unit root (Hadri (2000))**
 - to uncover non-stationary characteristics of the data
 - null hypothesis for the panel unit root test is a stationary time series in all states with an alternative hypothesis of a unit root (or non-stationary around a trend) in all states
- **error-correction-based panel cointegration (Westerlund (2007))**
 - determines the number of lags to include in VEC models when using panel data
 - reveals that cointegration is present between state appropriations and net tuition revenue
 - shows a linear combination of state appropriations and net tuition revenue is stationary and error correction (EC) parameters can be estimated via VEC models

Pre-estimation results: cointegration is present in the appropriations and net tuition revenue data; 2 lags

Westerlund (2007) Error-Correction-Based Panel Cointegration Tests –
State appropriations per FTE Student and Net Tuition Revenue per FTE Student

	Error correction for state appropriations & net tuition	
	Z-statistics	
Individual states (cross-sectional) (G_t)	-7.176	***
Individual states (cross-sectional) (G_a)	-2.522	**
All States (pooled) (P_t)	-4.812	***
All States (pooled) (P_a)	-4.834	***
Average lag length	2	years

Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Pre-estimation results: state appropriations and net tuition revenue are non-stationary around their respective trends

	State appropriations per FTE student	Z-statistics		Net tuition revenue per FTE student
Homoskedastic Across Units				
Time Trend Unit Root (Z_t)	32.128	*	75.196	*
		*		*
		*		*
Individual Unit Root (Z_{it})	27.117	*	35.161	*
		*		*
		*		*
Heteroskedastic Across Units				
Time Trend Unit Root (Z_t)	23.320	*	70.696	*
		*		*
		*		*
Individual Unit Root (Z_{it})	23.120	*	33.096	*
		*		*
		*		*

Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

VEC/DPM Results

Independent Variables	Dependent Variables for	
	<i>Model-1: Change in State Appropriations per FTE Student</i>	<i>Model-2: Change in Net Tuition Revenue per FTE Student</i>
Constant	-0.391 (0.808)	0.437 (2.717)
<i>State Appropriations per FTE Student</i>		
Lagged 1-Year Change in Appropriations per FTE Student	-0.235 * (0.101)	-0.210 (0.109)
Lagged 2-Year Change in Appropriations per FTE Student	-0.000 (0.058)	-0.258 * (0.118)
2-Year Lagged Net Tuition Revenue per FTE Student		-0.451 * (0.223)
<i>Net Tuition Revenue per FTE Student</i>		
Lagged 1-Year Change in Net Tuition Revenue per FTE Student	-0.042 (0.060)	-0.174 (0.199)
Lagged 2-Year Change in Net Tuition Revenue per FTE Student	0.018 (0.040)	0.237 ** (0.088)
2-Year Lagged State Appropriations per FTE Student	-0.197 (0.128)	
<i>Exogenous variables</i>		
State Taxes per capita	-0.198 * (0.078)	-0.448 ** (0.131)
Pell Grants per FTE Student	-0.139 (0.084)	-0.269 * (0.133)
Per Capita Income	0.203 (0.124)	0.303 (0.286)
<i>Error Correction (EC) Parameter</i>	-0.208 * (0.086)	-0.496 ** 0.134
Year Dummies	Yes	Yes
Number of States	50	50
Number of Observations	1,100	1,100
Number of Instruments	39	35
Arellano-Bond Test for AR1	-4.88 ***	-3.09 **
Arellano-Bond Test for AR2	-1.81	-1.85

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The standard errors, corrected for small samples (Windmeijer, 2004), are in parenthesis.

Note: The panel models are estimated using the Arellano-Bond two-step system GMM method. The Stata module, xtabond2 was used to generate estimates above.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

VEC/DPM Results

State Appropriations per FTE Student and Net Tuition Revenue per FTE Student: **Calculated Short-Run and Long-Run Coefficients** and Standard Errors, Based on Results in VEC model (1982 – 2006)

	Dependent Variables of models considered in this paper	
	<i>Model-1: State Appropriations per FTE Student</i>	<i>Model-2: Net Tuition Revenue per FTE Student</i>
<u>Independent Variables – Calculated Coefficients</u>		
<u>Net Tuition Revenue per FTE Student</u>		
Short-run effect	-0.024 (0.062)	
Long-run effect	0.052 (0.369)	
<u>State Appropriations per FTE Student</u>		
Short-run effect		-0.469 * (0.203)
Long-run effect		0.090 (0.321)

Major Conclusions

- In the short-run, net tuition revenue is negatively influenced by state appropriations but state appropriation is not influenced by net tuition revenue.
- In the short-run, for every 10 percent decrease in state appropriations, net tuition revenue increases by only five percent.
- Over the long-term, state appropriations and net tuition revenues are not inter-related.
- Contrary to the claims in a recent report by State Higher Education Executive Officers (SHEEO, 2008), the results from this study show that neither changes in state appropriations or net tuition revenue are influenced by changes in the state economy, as measured by per capita income.

Implications

- The use panel data and VEC/DPM techniques demonstrate how higher education analysts can appropriately distinguish between long- and short-run effects of changes in state appropriations and net tuition revenue for public higher education while taking possible endogeneity bias and unobserved heterogeneity into account.
- The results of this study suggest that prior analyses with respect to the relationship between state appropriations and net tuition revenue may lack precision and suffer from possible estimation bias.
- This paper advances our understanding of how VEC and DPM techniques can be used to understand the dynamic relationships among variables when utilizing panel data.
- Based on rigorous statistical analyses of the available data, the results from this paper have possible implications for informing state higher education finance policy debates with respect to discussing the impact of reduced state support for public higher education.

Thank you!