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Public versus Private Education in Hawaii and Its Role in the State's Economy

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Abstract
This study presents a time-series evidence on the timing and degree of feedback relationship between participation in education and income growth in Hawaii. Using the unrestricted vector autoregression approach and two related measures of linear dependence and feedback, the results suggest that across all educational levels, i.e., K-12 and tertiary, participation in public education could be a good predictor of income growth in Hawaii. However, decomposing the feedback effect by frequency suggests that the dominance of public education over private education in explaining the variation in income growth to be concentrated mainly on the short-run to medium-run for tertiary level and long-run to permanent effect for K-12 level. Hawaii state legislature and educators should perhaps take these results as a motivation not to ignore the problems plaguing Hawaii's public schools but should work towards greater improvement and support for public education given its

predicted significant overall contribution to the Hawaiian economy.

Introduction

The lackluster condition of the Hawaiian economy when compared with the economic expansion in the mainland state economies since late 1991 led the Hawaiian legislature to reassess the economy's traditional sole dependence on the tourism industry. To help revive the economy, the state government focused on educational reform as one of their priorities. Hawaii needs to build its human capital stock to be an active player in the new information or knowledge-based global economy. To help ensure the availability of educated and skilled human resources, the presence of dynamic research and teaching institutions is eminent. However, despite the pronounced good intentions and plans made by the state government, a growing number of Hawaii residents realize that not enough is being done. Based on a statewide survey, residents are generally disappointed about the economy and the condition of education. In fact, with the dreary statewide economic performance comes difficult choices and the need for re-allocation of resources. So, where does public and private education stand in all this?

In this study, an empirical investigation is done to assess and compare the relative contribution of public and private schools to Hawaii's economy. This paper presents a time-series evidence on the timing and degree of feedback relationship between participation in education and income growth in Hawaii. The empirical investigation uses two feedback methods to measure the degree of dependence or the extent of feedback between data series and a related measure to distinguish between short-run and long-run effects of a given innovation or shock. This study is intended to contribute to a better understanding of the condition and quality of the educational system in Hawaii. Also, the findings of this study may have important implications for directing resources or investment in education and shaping of Hawaii's educational policy in the future.

Education in Hawaii: An Overview

The establishment of early schools in Hawaii was due to the efforts of missionaries in the 1840s. Public education was first instituted on October 15, 1840 with mandatory attendance of children from ages four to fourteen. The upkeep of earlier statistics on education in Hawaii was difficult because of numerous changes on its classifications. For instance, the compulsory age for school attendance went through six changes: ages four to fourteen in 1840, six to sixteen in 1859, six to fifteen in 1865, six to fourteen in 1923, six to sixteen in 1937 and finally six to eighteen in 1965. Secondary education during the early monarchy years in Hawaii was also limited and left largely to government-subsidized private schools while, higher education was developed only in the twentieth century.

Hawaii became the 50th state on Aug 21, 1959. In 1960, 46% of the population had four years or more of high school training while only 9% had four years or more of college training. As of 1998, 84% of the population are high school graduates while 24% have bachelor's or advanced degree.

Overview of School Enrollment and Educational Resources

As summarized in Table 1, the participation in Hawaii's formal public education at the level of kindergarten to grade 12 had its biggest growth increase in the 1960s; while private schools had its biggest increase in enrollment in the following decade. Enrollment in K-12 exhibited contrasting trend for public and private schools, i.e., when public institutions experienced positive growth, the private institutions suffered a negative growth and vice versa.

Table 1
Average Growth Rate in K-12 and Tertiary Enrollment, Number of Schools and Teachers

	1960-69	1970-79	1980-89	1990-99
Public K-12 Institutions				
Enrollment	2.42	-0.58	0.095	0.91
Schools	0.44	0.59	0.389	0.669*
Teachers	4.49	1.05	1.34	2.051*
Private K-12 Institutions				
Enrollment	1.12	1.32	-0.403	0.18
Schools	2.63	1.38	-0.25	-1.064**
Teachers	3.36	3.03	2.62	0.177**
Tertiary Enrollment				
Public	10.37	1.31	-1.13	-0.455
Private	9.43	9.65	5.59	2.60

Note: Figures indicated with * refer only to 1990-97 while those with ** refer only to 1990-96.

For some years, the number of K-12 schools established does not seem to follow the enrollment trend. In particular, the number of public schools in the island posted an increase of 0.6% in the 1970s at a time when it experienced a comparable 0.6% decline in enrollment. Conversely, at a time of recovery in enrollment, the number of public schools established continued to decline. The number of private schools recorded big increases during the 1960s and 1970s but was drastically reversed in the 1980s and 1990s. In terms of school resources, both public and private schools had their biggest growth increase in hiring teachers during the 1960s. However, in terms of average number of pupil per teacher, private schools do a better job than public schools in providing small classes due in part to private schools continued bigger increases in hiring teachers. The public school system also continue to be plagued by other problems or concerns such as low test scores, aging facilities and low teacher morale.

For tertiary level, private universities exhibited continuous positive growth in enrollment from 1960 to 1999. In contrast, the public university suffered a drastic drop in enrollment in the 1970s relative to the previous decade, and turned into a negative growth in the 1980s and 1990s. This downward trend in enrollment may not seem surprising given that the state funding for the public university system dropped 19% in the past ten years. In fact, a national survey spotlighted Hawaii as the state with the largest loss in state support for higher education in 1998-99. Budget cuts have forced some programs to close or cease operation. A state law that sets a $352 million floor in state funding for the University of Hawaii (UH) was amended by the legislature wherein they are now to provide only for an appropriation ranging from 60-80% of funds required in addition to tuition. Beginning in 1995-1996, UH was allowed to keep tuition fees which formerly go into state general fund. Despite this change, the state university system still finds their resources constrained that they have to resort to increasing tuition fees which took a toll in their enrollment.

Data and Description of Methodology

Data on school enrollment and per capita Gross State Product were taken from The State of Hawaii Data Book, various issues, Dept. of Planning and Economic Development. Earliest available data for private universities were recorded in 1955 and were taken from various sources such as Historical Statistics of Hawaii by Robert Schmitt (1977) and Hawaii State Department of Education records. Private universities in Hawaii primarily consists of Bringham Young University of Honolulu, Chaminade University and Hawaii Pacific University. In this study, data on public university account only for enrollment at the University of Hawaii at Manoa which is the biggest institution in the state university system. Data on the number of K-12 schools and teachers for both public and private institutions were taken from the Hawaii State Department of Education records. Given the availability of relevant data, this study covers the period of 1958 to 1999.

Given that a number of models are consistent with observed correlation between human capital and income growth, I used the unrestricted vector autoregression (VAR) approach to model the dynamic relationship among pertinent variables in order to minimize specification error. The VAR approach avoids the need for tight structural modeling by treating variables in a system as a function of all lagged values of all of the endogenous variables in the system (Hamilton, 1994). It uses only past regularities and historical patterns in the data as a basis for forecasting. In this study, a three-variable autoregressive system is used. The variables include income growth as proxied by the growth rate of real gross state product per capita, enrollment figures at different levels, i.e., K to 12 and higher education from both public and private schools to serve as proxies for human capital stock. A lag length of four years is used for all variables as suggested by the likelihood ratio test done. Also, based on the unit root tests conducted (Dickey, D. & Fuller, 1979; Kwiatkowski, D., Phillips, Schmidt & Shin, 1992; Phillips & Perron, 1988), the stationarity of some data series are inconclusive. Hence, the empirical investigation uses the data series in both levels and first differences or in percentage change.

The details of the two related measures of linear dependence and feedback used in this study can be found in the Appendix. To measure the degree of dependence or the extent of various kinds of feedback between income growth and participation in education as measured by school enrollment, I used Geweke's (1982) bi-variate feedback method. The feedback measures are non-negative and zero only when feedback or causality of the relevant type is not present. A simple transformation of each feedback measure gives the reduction in the prediction error variance. Also, to distinguish between short-run and long-run effects of a given shock, I decomposed the feedback by frequency using McGarvey's (1985) methodology. I used this method on an expanded three-variable VAR system.

Empirical Results and Data Analysis

The bi-variate feedback results using Geweke's method are shown in Table 2. The results suggest that both in terms of levels and first differences, the magnitude of linear feedback from participation in K-12 private education to income growth to be about five times greater than the feedback from public enrollment to income growth. However, in terms of higher education, the magnitude of feedback from the public university is bigger than the feedback from participation in private universities. Also, at all educational levels (i.e., K-12 and tertiary), the feedback from public education to income growth remains bigger than the feedback from private education. This result may suggest that in Hawaii, participation in public education could be a good predictor of income growth.

Table 2
Feedback from Participation in Education to Income Growth

K to 12	In levels	In Percentage Change
Public	0.0852 (8.17%)	0.0994 (9.46%)
Private	0.4997 (39.33%)	0.5033 (39.55%)
Higher Education		
Public	0.2477 (21.94%)	0.0743 (7.16%)
Private	0.0496 (4.84%)	0.0459 (4.49%)
All educational Levels		
Public	0.1683 (15.49%)	0.0832 (7.98%)
Private	0.0788 (7.57%)	0.0782 (7.52%)

In order to have a better idea of an innovation's short-run versus long-run effects, the feedback measure is decomposed by frequency bands. Also, the bi-variate system is extended to a three-variable system and uses the ordering of 'growth prior to public education prior to private education' in the Choleski decomposition. Although the feedback measure is consistent, McGarvey showed that, in small samples, the feedback measure is biased upward. Hence, the Monte Carlo simulation method is used to derive bias-adjusted feedback estimates. Table 3 summarizes the adjusted estimates and figures enclosed in parentheses pertain to the proportion of variance explained by a corresponding shock to a series.

Table 3
Feedback from Participation in
Education to Growth by Frequency Levels

In levels	Private K-12	Public K-12
Permanent	0.0002 (0.02%)	0.0015 (0.15%)

Long-run	0.024 (2.36%)	0.132 (12.40%)
Medium-run	0.174 (15.97%)	0.056 (5.49%)
Short-run	0.832 (56.48%)	0.043 (4.24%)
Overall	0.271 (23.74%)	0.061 (5.90%)
In Percentage Change	**Private K-12**	**Public K-12**
Permanent	0.222 (19.91%)	1.124 (67.51%)
Long-run	0.1281 (12.03%)	0.376 (31.32%)
Medium-run	0.4108 (33.69%)	0.0068 (0.68%)
Short-run	0.8790 (58.48%)	0.0893 (8.54%)
Overall	0.516 (40.29%)	0.045 (4.40%)
In Levels	**Private Universities**	**Public University**
Permanent	0.0966 (9.21%)	0.0492 (4.79%)
Long-run	0.0547 (5.32%)	0.2792 (24.36%)
Medium-run	0.0104 (1.03%)	0.1525 (14.15%)
Short-run	0.0114 (1.13%)	0.1087 (10.30%)
Overall	0.0161 (1.59%)	0.1526 (14.15%)
In Percentage Change	**Private Universities**	**Public University**
Permanent	0.0379 (3.72%)	0.0028 (0.28%)
Long-run	0.0417 (4.08%)	0.0123 (1.22%)
Medium-run	0.0612 (5.94%)	0.0797 (7.66%)
Short-run	0.0078 (0.78%)	0.0709 (6.85%)
Overall	0.0405 (3.96%)	0.0664 (6.43%)

In Levels	**Private**	**Public**
Permanent	0.00012 (0.012%)	0.1537 (14.24%)
Long-run	0.0230 (2.28%)	0.1461 (13.60%)
Medium-run	0.0048 (0.48%)	0.1256 (11.80%)
Short-run	0.0568 (5.52%)	0.0564 (5.48%)
Overall	0.024 (2.41%)	0.1038 (9.86%)
In Percentage Change	**Private**	**Public**
Permanent	0.0081 (0.81%)	0.0072 (0.72%)
Long-run	0.0137 (1.36%)	0.0201 (1.99%)
Medium-run	0.0256 (2.52%)	0.055 (5.37%)

Short-run	0.0791 (7.60%)	0.064 (6.22%)
Overall	0.0396 (3.88%)	0.055 (5.35%)

In terms of K-12 enrollment, the results suggest that private schools exhibit bigger overall effect on Hawaii's income growth relative to that of public schools, confirming the previous result under the bi-variate feedback method. However, the feedback effect is concentrated mainly in the short-run (2-3 years) to medium-run (4-12 years). Conversely, participation in K-12 public education exhibited a significant long-run to permanent effect on Hawaii's income growth relative to that of private education. This result may be explained by the growing number of high school graduates migrating out of the state. For example in 1992, the net out-migration of high school graduates was recorded to be around 690 and increased to 958 four years after. Apparently, families who could afford to send their children to private schools are willing to spend a little more to send them out of state in anticipation of more and better choices in education available in the mainland.

In terms of tertiary level, the overall contribution of public school enrollment to Hawaii's income growth is bigger than that of private universities. However, decomposing the feedback effect by frequency suggest that this dominance of public enrollment in explaining the variation in income growth seem to be concentrated mainly in the short-run to medium-run. Conversely, private universities exhibit a permanent and long-run effect in explaining the variance in Hawaii's income growth relative to that of the public university. This finding might suggests that private tertiary education may be the key to promoting long-run growth in Hawaii. Similarly, one cannot ignore the significant contribution of the public university in building Hawaii's human capital stock in the short to medium-run.

In terms of all educational levels, i.e. primary, secondary and tertiary level combined, participation in public education tend to explain a greater proportion of variance in Hawaii's income growth relative to private education across almost all frequency levels. Again, this finding confirms the previous result found in the bi-variate feedback method.

Concluding Remarks

In this study, an empirical investigation is done to assess and compare the relative contribution of public and private schools to Hawaii' economy. I employed the unrestricted vector autoregression (VAR) model that uses only past regularities and historical patterns in the data to examine the dynamic feedback relationship between participation in education and income growth. The results suggest that across all educational levels, i.e., K-12 and tertiary, participation in public education could be a good predictor of income growth in Hawaii. However, decomposing the feedback effect by frequency suggests that the dominance of public education in explaining the variation in income growth to be concentrated mainly on the short-run to medium-run for tertiary level and long-run to permanent effect for K-12 level. Hawaii state legislature and educators should perhaps take these results as a motivation not to ignore the problems plaguing Hawaii's public schools but should work towards greater improvement and support for public education given its predicted significant overall contribution to the economy. Similarly, the presence of significant contribution of K-12 private schools in the short-run to medium-run and private universities' long-run to permanent effect on Hawaii's income growth should serve as a driving force that could help bring about healthy competition and greater efficiency in the provision of educational services in Hawaii.

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Appendix

Two Related Linear Dependence and Feedback Measures

A. Geweke's (1982) method is used to measure the degree of dependence or the extent of various kinds of feedback between data series. He defined the measures of linear dependence between say, X and Y wide-sense stationary series in terms of the following linear projections,

(1) $Y_t = \Sigma^{\infty}_{s=1}\alpha_{1s}Y_{t-s} + \Sigma^{\infty}_{s=1}\alpha_{2s}X_{t-s} + u_{1t}$

(2) $Y_t = \Sigma^{\infty}_{s=1}\beta_{1s}Y_{t-s} + \Sigma^{\infty}_{s=0}\beta_{2s}X_{t-s} + u_{2t}$

(3) $Y_t = \Sigma^{\infty}_{s=1}\gamma_{1s}Y_{t-s} + u_{3t}$

where the linear feedback measure from X to Y is defined as

$$F_{X\rightarrow Y} = \log\,[\mathrm{var}\,(u_{3t})/\,\mathrm{var}(u_{1t})]$$

while the measure of contemporaneous feedback between X and Y is defined as

$$F_{X\circ Y} = \log\,[\mathrm{var}\,(u_{1t})/\,\mathrm{var}(u_{2t})].$$

So, the measure of linear dependence between X and Y or $F_{X,Y}$ is the sum of linear feedback from X to Y, $F_{X\rightarrow Y}$, linear feedback from Y to X, $F_{Y\rightarrow X}$ and instantaneous linear feedback $F_{X\circ Y}$.

$$F_{X,Y} = F_{X\rightarrow Y} + F_{Y\rightarrow X} + F_{X\circ Y}$$

where $F_{Y\rightarrow X}$ is found by switching X and Y in equations (1) and (3) and in the definition of directional feedback.

B. Building on Geweke's feedback measure, McGarvey(1985) developed a useful alternative summary measure by decomposing the feedback by frequency in order to distinguish between short-run and long-run effects of a given innovation or shock.

In the context of this study, the MA representation of the 3-variable orthogonalized autoregressive system is as follows:

$$\begin{bmatrix} X_t \\ Y_t \\ Z_t \end{bmatrix} = \begin{bmatrix} C_{11}(L) & C_{12}(L) & C_{13}(L) \\ C_{21}(L) & C_{22}(L) & C_{23}(L) \\ C_{31}(L) & C_{32}(L) & C_{33}(L) \end{bmatrix} \begin{bmatrix} \upsilon_t \\ \omega_t \\ \eta_t \end{bmatrix}$$

where for example, $C_{21}(L)$ gives the response of Y_t to innovations in X_t and, the overall feedback from X to Y is defined as

$$F_{X \rightarrow Y} = \log [\mathrm{var}(Y_t) / \mathrm{var}(Y_t) - \Sigma^{\infty}_{s=0} c_{21}(s)^2 \mathrm{var}(\upsilon_t)]$$

The transformation ($1-\exp[-F_{X \rightarrow Y}]$) gives the proportion of Y's variance explained by shocks to X.

To distinguish between short-run and long-run effects, the overall feedback is decomposed frequency bands. Feedback from X to Y over the interval (λ_1, λ_2) is defined as

$$f_{X \rightarrow Y}(\lambda_1, \lambda_2) = \log [(I_{\lambda 1}^{\lambda 2} S_Y(\lambda) d\lambda) / (I_{\lambda 1}^{\lambda 2} S_Y(\lambda) - C_{21}(\lambda)^2 \sigma_\upsilon^2) d\lambda)]$$

since $\mathrm{var}(Y) = (1/2\pi) I_\pi^{-\pi} S_Y(\lambda) d\lambda$ and $S_Y(\lambda) = C_{21}(\lambda)^2 \sigma_\upsilon^2 + C_{22}(\lambda)^2 \sigma_\omega^2 + C_{22}(\lambda)^2 \sigma_\eta^2$. So, if υ_t contributes nothing to the variance of Y at frequency λ, the ratio will be one and the feedback measure will be zero. Note that a period of a cycle is defined as the ratio of 2π to the frequency.
