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The response of US college enrollment to unexpected changes in macroeconomic activity

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This paper estimates the extent and magnitude of US college and university enrollment responses to unanticipated changes in macroeconomic activity. In particular, we consider the relationship between enrollment, economic growth, and inflation. A time series analysis known as a vector autoregression is estimated and impulse response functions are calculated to measure the enrollment response to these economic shocks. The results suggest that enrollment patterns differ by gender and are consistent with economic theory.

Keywords: college enrollment; macroeconomics; time series; economic growth; inflation

Introduction

Institutions of higher education require enrolled students for their continued operations. Various methods to manage enrollments have existed since the creation of the earliest colleges and universities (Kroc and Hanson 2001). However, declining US college enrollments in the late 1970s and 1980s forced institutions to formally develop enrollment management techniques, particularly in the form of organized recruiting processes (Hossler 1996). Today, enrollment management includes the set of activities employed by institutions to control both the size and characteristics of their enrolled student bodies (Hossler 1996). Thus, the concept of enrollment management not only includes the recruitment of new students, but also the persistence and graduation of enrolled students.

A key element to effective enrollment management is an understanding of enrollment trends and, in particular, how enrollments may respond to changes in the economic environment in which colleges operate. This research explores how and to what extent unexpected changes in macroeconomic activity impact enrollment at US colleges and universities. The findings should be particularly useful to higher education administrators and leaders who are actively engaged in enrollment management.

Background

Strategic enrollment management plays an integral role in accessibility to higher education most directly through institutional-specific policies regarding admissions

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standards, provision of scholarships and other gift aid, marketing strategies, and university outreach programs. However, institutional accessibility is also influenced by a myriad of additional factors, many of which are external to an individual student's and/or the institution's direct control: federal and state policies, socio-economic status, physical location, availability of external scholarships, extent of encouragement and support, and intellectual capability are just a few. Moreover, these factors are affected by the overall economic climate that exists when college-choice and enrollment decisions are made (Card and Lemieux 2000; DeJong and Ingram 2001; Long 2004).

In fact, a number of economic factors have been shown to affect an individual's decision to attend college including costs, income, and quality (Long 2004). Related research by Card and Lemieux (2000) and DeJong and Ingram (2001) showed that the economic returns to acquiring education are affected by how the overall economy is performing. Delles and Koubi (2003) and Delles and Sakellans (2003) provide evidence that schooling is countercyclical, is negatively related to the real interest rate, and positively related to ability-to-pay. Clearly, current economic circumstances are an important determinant in college enrollment trends.

However, no study to date has examined enrollment patterns over time to see how enrollment changes following unanticipated changes in economy-wide measures of performance, controlling for current economic circumstances. Standard macroeconomic theory distinguishes between anticipated and unanticipated information in decision-making processes, that is, people may make decisions (e.g., about what house to buy, when to purchase a car, when to invest in the stock market, etc.) depending on what they expect to happen (Barron, Ewing, and Lynch 2006). Sudden unexpected events can interrupt the behavior of agents in the economy and this may be reflected in the aggregate time series data. In the case of enrollment, an unanticipated recession or spike in consumer prices may alter the decisions of some. In fact, the timing, the extent, and the magnitude of planned purchases and investments, in either physical or human capital, may be altered when actual opportunity costs differ from expected opportunity costs. For example, during an anticipated recessionary period universities will plan for increases in enrollment as more students choose to forego wages and employment for acquisition of human capital. Standard forecasting models can be used to predict the increase in enrollment in light of an expected change in the economy. In models that capture the response or change in enrollment to anticipated changes in economic activity, an expectation of output growth will correspond to lower enrollment. However, the response to an unanticipated upturn in the economy (e.g., the expected increase in output was 1% but actual increase was 2% resulting in a greater than expected increase) may exacerbate the drop in enrollment with higher than expected numbers of current students deciding not to re-enroll or larger than expected numbers of incoming students failing to enroll. To date, no study has documented or attempted to measure these 'last minute' changes and alterations in enrollment decisions on the aggregate level of college enrollment. Given that the acquisition of human capital (i.e., schooling) may have long-lasting effects on the income-generating potential and career choices of persons, as well as the overall future productivity of the economy, the importance of the results from this study is interesting in their own right. However, in terms of enrollment management, the results will help institutions to strategically plan for times in which economic conditions may change quickly and/or unexpectedly. Moreover, enrollment patterns may differ by gender, as at least some evidence indicates that labor market opportunities and preferences differ by gender (Croson and Gneezy 2004; Ewing, Levernier, and Malik 2002).

Our research fills a void in the literature by examining how male and female enrollment patterns respond to unexpected changes in economic activity. In particular, we focus on two common economic indicators: economic growth and inflation. Improved knowledge as to how enrollment patterns are affected by these macroeconomic factors will enable university and college leaders, as well as policymakers, to respond more effectively to changes in economic conditions.

Data

The annual data are for total fall in college enrollment in US degree-granting institutions[1] stratified by gender and two common measures of how the economy is performing (i.e., growth in total economic output and inflation). The sample period is from 1963 to 2004. Enrollment data are from the U.S. Department of Education, National Center for Education Statistics, Digest of Education Statistics, 2007 (table 179). The industrial production (IP) index is used as the measure of real economic output and the consumer price index (CPI) for all urban consumers is used to compute inflation. Economic growth and price inflation are computed as $(x_t - x_{t-1})/x_{t-1}$, where x is either the CPI or IP, and t denotes the time period. Economic performance data are from the Federal Reserve Bank of St. Louis Economic Database (FRED II). In what follows, we utilize the convention in the macroeconomics literature and use the natural log of enrollment, Table 1 provides descriptive statistics for the variables used in the study. We let MALE denote the change in total male enrollment and FEMALE the change in total female enrollment.[2] Economic growth is denoted by GROWTH and inflation is denoted by INF. From Table 1 we see that average annual growth in female enrollment (4.1%) has exceeded that of male enrollment (2.2%).

Figure 1 shows the corresponding plots for enrollment growth by gender and economic growth, while Figure 2 shows the plots for inflation and enrollment growth. It is interesting to note that while the changes in enrollment for females and males follow similar patterns over time, the movements over time are not perfectly correlated. For instance, the magnitude of changes is often times quite different over the sample period even when the changes are in the same direction. For example, following the 1990–1991 recession, the growth in female enrollment took off at a relatively much higher rate (as evidenced by the 'steepness' of the line around the 1992–1993 period in Figure 1) compared to the increase in male enrollment growth. Also, for example, during the peak inflation of 1980, the growth rate in female enrollment fell more sharply than that for males.[3]

Table 1. Descriptive statistics.

	MALE	FEMALE	GROWTH	INF
Mean	0.021871	0.040715	0.031475	0.045759
Median	0.011705	0.032326	0.041223	0.035463
SD	0.034745	0.034517	0.042094	0.029127

Note: MALE denotes the growth in total male enrollment. FEMALE denotes the growth in total female enrollment. GROWTH is the annual growth rate of industrial production. INF is the consumer price inflation rate. Number of observations is 41.

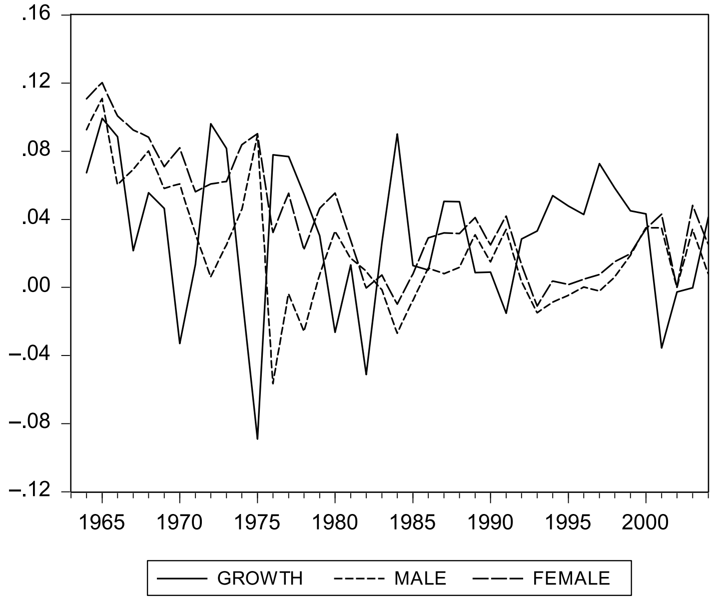

Figure 1. Economic growth and changes in enrollment.
Note: MALE denotes the growth in total male enrollment. FEMALE is the growth in total female enrollment. GROWTH is the annual growth rate of industrial production.

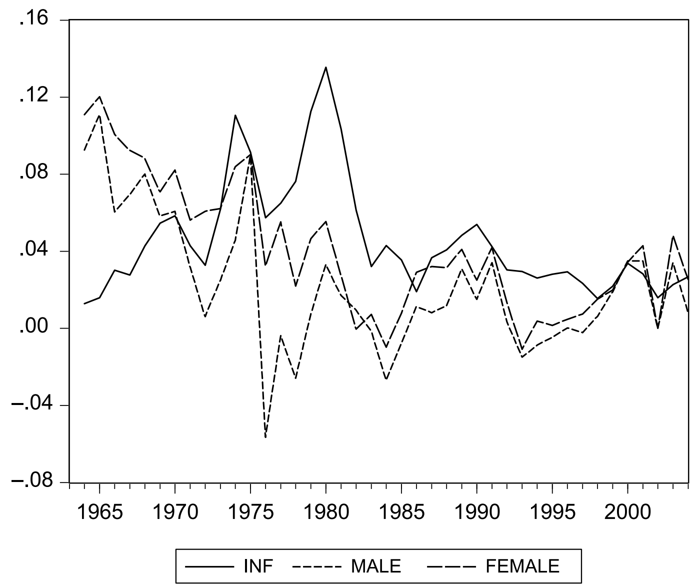

Figure 2. Inflation and changes in enrollment.
Note: MALE denotes the growth in total male enrollment. FEMALE is the growth in total female enrollment. INF is the consumer price inflation rate.

Econometric methodology and results

This study utilizes time series econometric methods. Specifically, we estimate a vector autoregression (VAR) separately for the change in (log) female enrollment and the change in (log) male enrollment where the explanatory variables of interest are economic growth and inflation. Economic theory suggests that these two macroeconomic factors should be related to college enrollment. First, economic growth means more jobs, in which case people would have better labor market opportunities and some would forgo school for work. Second, when inflation rises, all prices generally go up so that the total cost of attending school increases and, therefore, enrollment may fall. However, there is another effect. It may be that people view additional schooling as a hedge against inflation (i.e., protection against inflationary risks). That is, people may perceive that schooling is more valuable under (unexpected) inflationary conditions because educational attainment raises and/or protects their future earning power.[4] Under this scenario, enrollment would rise. In the end, since these two inflation arguments work in opposite directions, the answer to this question is an empirical issue.

In order to investigate the relationship between enrollment and macroeconomic factors, we estimate the VAR models and then perform a simulation called an 'impulse response analysis' that produces an impulse response function (IRF). The IRFs trace out the future changes in enrollment that are predicted to occur following an unexpected rise in (1) economic growth and (2) inflation. The specifics of the VAR and impulse response are outlined below.

Recall that we are interested in the response of changes in (male and female) enrollment to 'shocks' in the economic performance variables. VAR models and IRFs are ideal for this type of dynamic analysis (Enders 2004). In terms of the latter technique, the conventional impulse response method is often criticized because results are subject to the 'orthogonality assumption.' That is, they may differ markedly depending on the ordering of the variables in the VAR (Lutkenpohl 1991). The generalized methodology of Pesaran and Shin (1998) overcomes this problem. The generalized impulse responses are not sensitive to the ordering of the variables.

The three-equation VAR(m) model is given by the following, where m represents the number of lags or (vector) autoregressive terms:

$$\begin{aligned}
\mathrm{ENROLL}_t &= \alpha_{10} + \sum\nolimits_{i=1}^{m} a_{i1}\mathrm{ENROLL}_{t-i} + \sum\nolimits_{i=1}^{m} b_{i1}\mathrm{GROWTH}_{t-i} \\
&\quad + \sum\nolimits_{i=1}^{m} c_{i1}\mathrm{INF}_{t-i} + v_{1t} \\
\mathrm{GROWTH}_t &= a_{20} + \sum\nolimits_{i=1}^{m} a_{i2}\mathrm{ENROLL}_{t-i} + \sum\nolimits_{i=1}^{m} b_{i2}\mathrm{GROWTH}_{t-i} \\
&\quad + \sum\nolimits_{i=1}^{m} c_{i2}\mathrm{INF}_{t-i} + v_{2t} \\
\mathrm{INF}_t &= a_{30} + \sum\nolimits_{i=1}^{m} a_{i3}\mathrm{ENROLL}_{t-i} + \sum\nolimits_{i=1}^{m} b_{i3}\mathrm{GROWTH}_{t-i} \\
&\quad + \sum\nolimits_{i=1}^{m} c_{i3}\mathrm{INF}_{t-i} + v_{3t}
\end{aligned} \tag{1}$$

In matrix notation, the VAR(m) model is written compactly as:

$$g_t = a_0 + b(L)g_t + v_t \tag{2}$$

Here, we let g_t be the 3×1 vector of enrollment and economy-wide variables (ENROLL, which is either MALE or FEMALE, and GROWTH and INF, respectively), a_0 the constant term vector, and v_t be the corresponding disturbance vector (i.e., v_{1t}, v_{3t}, and v_{2t} are the shocks to the three variables of interest). In the analysis, we estimate the VAR system separately for males and females, thus allowing the coefficients to have different effects (magnitudes) on enrollment by gender. L denotes a polynomial in the lag operator, thus, the right-hand side of Equation (2) contains only past values of the three variables as well as the constant and error terms.[5]

Now consider the following moving average representation of the three-equation VAR(m) model, where the constant terms may be ignored:

$$g_t = \psi(L)v_t \tag{3}$$

Let $E(v_t\, v'_t) = \Sigma_v$ such that shocks are contemporaneously correlated. The generalized IRF of g_i to a unit (one standard deviation) shock in g_j is given by:

$$\psi_{ij,h} = (\sigma_{ii})^{-1/2}(\mathrm{e}'_j \sum\nolimits_v e_i) \tag{4}$$

Table 2. VAR results for growth in male college enrollment.

	MALE	GROWTH	INF
MALE(t–1)	−0.023204	0.411515	0.030437
	(0.15984)	(0.28598)	(0.12927)
	[−0.14517]	[1.43894]	[0.23545]
MALE(t–2)	0.503323	−0.287867	−0.072868
	(0.13696)	(0.24505)	(0.11077)
	[3.67494]	[−1.17473]	[−0.65784]
GROWTH(t–1)	0.028417	0.264202	0.249193
	(0.11491)	(0.20560)	(0.09294)
	[0.24729]	[1.28501]	[2.68131]
GROWTH(t–2)	0.299708	−0.314242	−0.005381
	(0.11805)	(0.21121)	(0.09547)
	[2.53882]	[−1.48779]	[−0.05636]
INF(t–1)	0.602503	−1.304773	1.084642
	(0.22417)	(0.40108)	(0.18130)
	[2.68771]	[−3.25313]	[5.98264]
INF(t–2)	−0.617449	0.792213	−0.190924
	(0.27331)	(0.48900)	(0.22104)
	[−2.25919]	[1.62008]	[−0.86377]
C	−0.003368	0.055683	−0.001830
	(0.01215)	(0.02173)	(0.00982)
	[−0.27723]	[2.56193]	[−0.18632]
Adjusted R-squares	0.630202	0.357178	0.722588

Note: MALE denotes the growth in total male enrollment. FEMALE denotes the growth in total female enrollment. GROWTH is the annual growth rate of in industrial production. INF is the consumer price inflation rate. Standard errors in ( ) and t-statistics in [ ].

Table 3. VAR results for growth in female college enrollment.

	FEMALE	GROWTH	INF
FEMALE(t–1)	0.305239	0.565155	0.116842
	(0.16895)	(0.39511)	(0.18152)
	[1.80671]	[1.43039]	[0.64370]
FEMALE(t–2)	0.416569	–0.293152	–0.067221
	(0.15313)	(0.35812)	(0.16452)
	[2.72033]	[–0.81859]	[–0.40857]
GROWTH(t–1)	0.073598	0.157903	0.248715
	(0.07671)	(0.17939)	(0.08241)
	[0.95946]	[0.88021]	[3.01784]
GROWTH(t–2)	0.091194	–0.247422	0.002982
	(0.08151)	(0.19063)	(0.08758)
	[1.11879]	[–1.29795]	[0.03405]
INF(t–1)	0.297469	–1.424147	1.048152
	(0.17517)	(0.40966)	(0.18821)
	[1.69815]	[–3.47637]	[5.56919]
INF(t–2)	–0.395220	0.844907	–0.150825
	(0.21175)	(0.49520)	(0.22750)
	[–1.86646]	[1.70618]	[–0.66296]
C	0.007036	0.052051	–0.005076
	(0.00895)	(0.02094)	(0.00962)
	[0.78571]	[2.48557]	[–0.52757]
Adjusted R-squares	0.791117	0.376803	0.722191

Note: MALE denotes the growth in total male enrollment. FEMALE denotes the growth in total female enrollment. GROWTH is the annual growth rate of in industrial production. INF is the consumer price inflation rate. Standard errors in ( ) and t-statistics in [ ].

Table 4. VAR Granger-causality/block exogeneity Wald Tests.

	Panel A			Panel B		
	Dependent variable					
	MALE			FEMALE		
Excluded	Chi-sq	df	Prob.	Chi-sq	df	Prob.
GROWTH	6.860482	2	0.0324	2.105781	2	0.3489
INF	7.224154	2	0.0270	3.542935	2	0.1701
All	38.30710	4	0.0000	20.17836	4	0.0005

Note: The null hypothesis being tested is that the lagged values of the dependent variable (i.e., either growth or inflation) are jointly insignificant. Rejection of the null (i.e., Prob. value < 0.05) indicates that the lagged values help to predict the current value of the independent variable under consideration (i.e., enrollment growth). Rejection of the null is said to constitute 'Granger-causality.'

where σ_{ii} is the i^{th} diagonal element of Σ_v e_i is a selection vector with the i^{th} element equal to one and all other elements equal to zero, and h is the horizon (in our case, measured in annual increments).

Key features of the generalized IRF are that the responses are invariant to any re-ordering of the variables in the VAR and, as orthogonality is not imposed, it allows for meaningful interpretation of the initial impact response of each variable to shocks to any other variable. Generally speaking, the generalized IRF provides more robust results than the orthogonalized method. In the study of economic systems in which events may occur that simultaneously or contemporaneously affect each, the ability to capture these immediate responses of endogenous variables to shocks is especially appealing.

The results from the impulse response analysis reveal some interesting findings. Males respond to a sudden unexpected rise in economic growth by reducing enrollment in colleges thus suggesting that they are taking jobs in the labor market (Figure 3). That is to say, when economic time is suddenly and unexpectedly good, relatively fewer males decide to enroll in college. In contrast, female enrollment does not respond to the sudden unexpected rise in economic growth (Figure 4). This finding is consistent with that found by Ewing, Levernier, and Malik (2002) who found that female and male unemployment rates differ in their responses to economic growth shocks. They attributed this finding to a number of reasons such as males are traditionally the first to be hired or recalled from layoffs, etc. perhaps due to discrimination or occupational segregation, etc. In other words, females are not drawn out of college enrollment at the first sign of economic growth.

A second finding is that females respond immediately to a sudden unexpected rise in inflation with higher enrollment rates and this effect lasts for a good two years. Male enrollment also responds to the unexpected rise in inflation but with a lag and the effect does not last as long. An economic argument may be made that people tend to hedge against inflation by accumulating more human capital.

A third finding is that there is dramatically more persistence (i.e., effects last longer before things return to normal) with respect to ‘own’ shocks in the change in female enrollment rates than in male enrollment. The finding that sudden unexpected increases in enrollment tend to persist more for females than for males (see top panel in Figures 3 and 4) is consistent with theories of behavioral economics. In particular, gender differences in preferences with respect to risk-taking, social preferences, and reaction to competition may explain the persistence pattern in enrollment (Croson and Gneezy 2004).

Concluding remarks

This study focused on the response of changes in (male and female) enrollment to unanticipated changes in economy-wide performance variables. Economic theory suggests that macroeconomic factors such as growth and inflation should be related to college enrollment patterns. Economic growth is associated with a better labor market and this should lead some to forgo school for work. However, the impact of a sudden rise in inflation is more ambiguous as it has two effects. First, by increasing the total cost of attending school, enrollment may fall. Second, enrollment may rise if people view additional schooling as a protection against inflationary risks. That is, people may perceive that schooling is more valuable under inflationary conditions because educational attainment raises their future earning power.

We document differences in enrollment patterns by gender. Male enrollment growth falls in response to unanticipated economic growth, perhaps to take advantage of opportunities in the labor market, while female enrollment growth is unresponsive. Our results also indicate that a rise in both female and male enrollment growth is associated with unexpected increases in inflation. However, the inflation

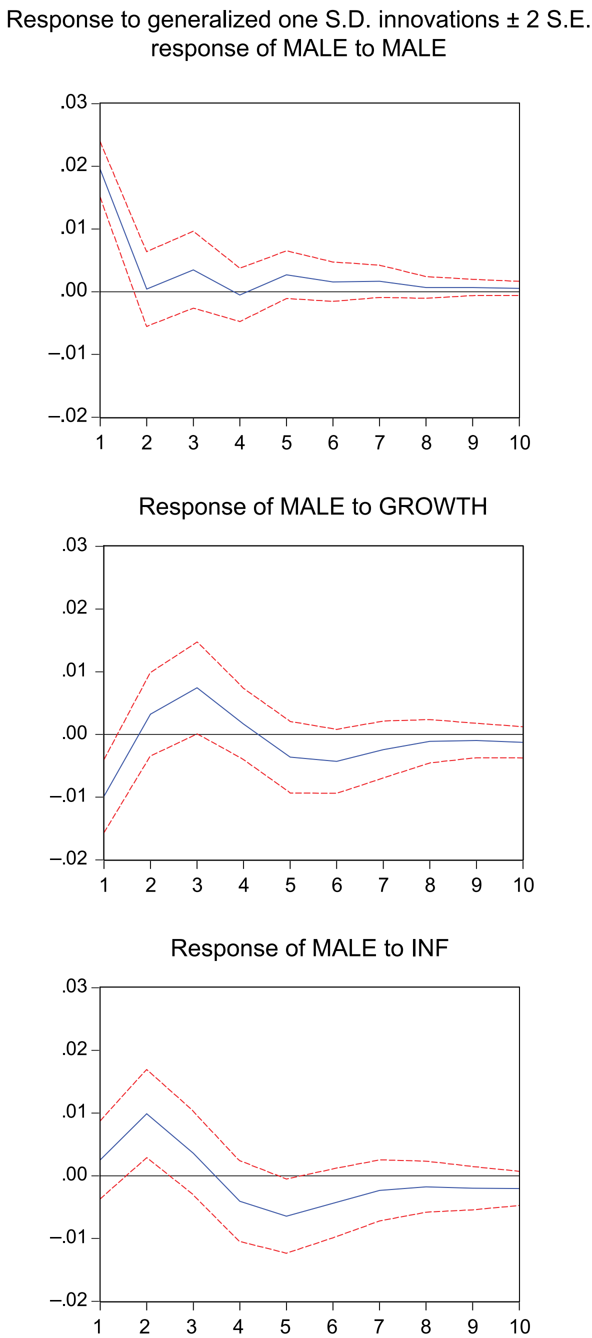

Figure 3. Generalized impulse responses for male enrollment.

impact on males is much less severe than it is for females. Finally, we find that female enrollment growth exhibits more persistence than males in terms of 'own' shocks. These findings provide useful information for issues related to enrollment management. For instance, improved forecasts of enrollment should lead to more

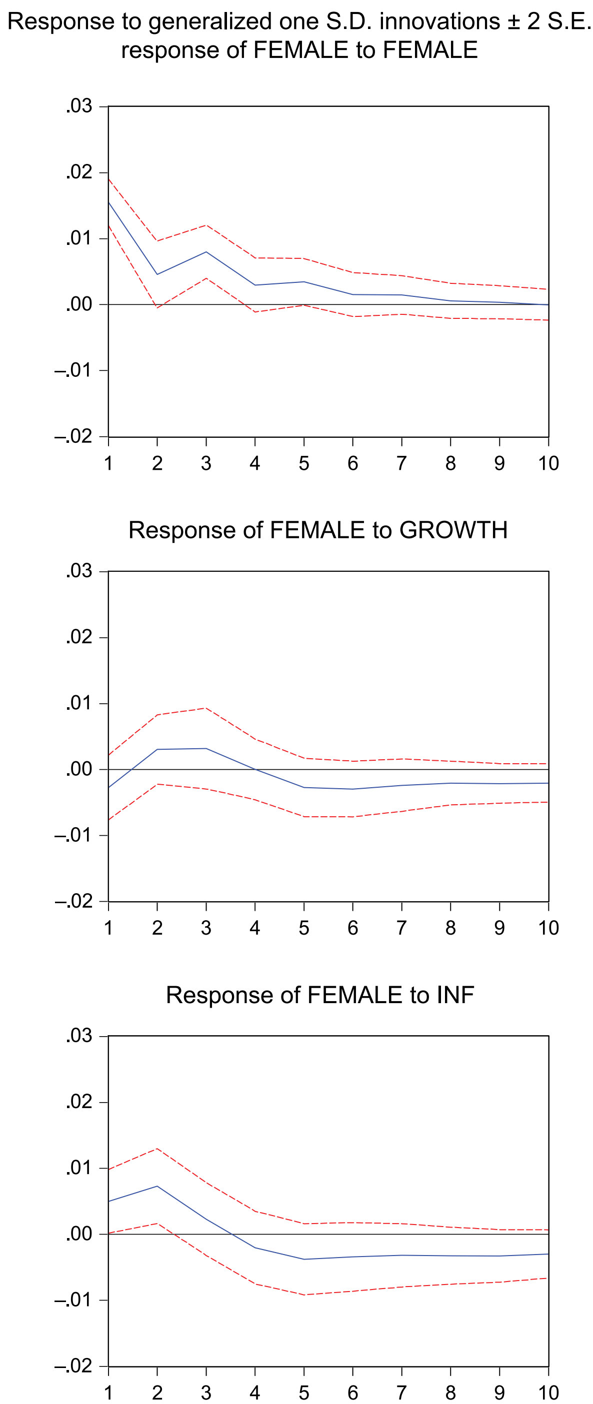

Figure 4. Generalized impulse responses for female enrollment.

accurate planning for future staffing needs, class scheduling, facilities management, and other areas.

The competitive nature of higher education has led university and college leaders to better utilize enrollment management data. According to Swail and Wilkinson (2007), strategic enrollment management actively integrates planning, strategies, and structures in the formal enrollment management units with the institution's evolving strategic planning, its academic vision, and its fundamental mission. The use of time series econometric models to understand the underlying dynamics of enrollment patterns is one way to facilitate this integration within institutions of higher education. The findings presented in this paper complement the primarily micro-based literature on enrollment and the economy.

Acknowledgement

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Notes

1. Data are reported for institutions that were accredited by an agency or association that was recognized by the U.S. Department of Education or recognized directly by the Secretary of Education. While the use of annual data is common in the study of macroeconomics, our analysis is limited to annual observations (e.g., as opposed to semester) due to the availability of statistics on enrollment.
2. Specifically, the change in enrollment is given by the first-difference of the natural log of enrollment and thus may be referred to as the growth in enrollment.
3. No evidence of a significant time trend in the enrollment growth rates was detected using standard augmented Dickey-Fuller (ADF) tests with constant and trend, although the growth rates series were found to be stationary. Further, a series of rolling Chow breakpoint tests failed to show any evidence of structural change in the enrollment growth rate series.
4. For example, expected future real income is future nominal income less the expected inflation rate, where educational attainment enhances nominal income. In a simple model, one can illustrate that individuals will choose the level of education to obtain based upon their notion of future purchasing power. Since real future income falls with unexpected inflation, then individuals may choose to acquire additional education to compensate for this risk.
5. Tables 2 and 3 show the results from the estimation of the two VARs. Adjusted R-squares are 0.63 and 0.79 for male and female enrollment equations in the two VARs, respectively. No evidence of remaining serial correlation was detected using the LM test, additionally, the residuals in the VARs appeared to be normal as indicated by the Jarques-Berra statistic, kurtosis and skewness. Thus, no more information is contained in the regression residuals that could be used to improve model performance (i.e., the VAR models are correctly specified). Table 4 (Panels A and B) provides the corresponding χ^2 test statistics for block exogeneity tests. The null hypothesis being tested is that the lagged values of the dependent variable (i.e., GROWTH or INF) in the enrollment growth equation are jointly insignificant. Rejection of the null (i.e., Prob. value < 0.05) indicates that the lagged values help to predict the current value of the independent variable under consideration (i.e., enrollment growth). Rejection of the null is said to constitute 'Granger-causality.' When considered jointly (i.e., as a block), evidence of Granger-causality of macroeconomic factors to enrollment is found for both males and females.

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