Analyzing Factors Affecting U.S. College Textbook Prices:  
An ARDL Cointegration Approach  

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Abstract: The short-run and long-run effects of the input prices, the firm profits, the income, the enrollment and the market shocks on the U.S. textbook price are investigated using the ARDL approach to cointegration. The results show that, in the long-run, supply factors such as input prices and firm profits are more important than demand factors such as income and enrollment in determining the price of textbooks in the U.S. In the short-run, on the other hand, both the demand factors and supply factors are found to be significant determinants of the price of textbooks. Finally, it is found that the market shocks such as the 2008 Higher Opportunity Act and the Great Recession seem to depress price of textbooks in both the short-run and long-run.  

Keywords: ARDL, Cointegration, Prices, Textbooks, United States  

JEL Classifications: C22, I20  

1. Introduction  

U.S. college students have witnessed a rapid spike in textbook prices over the past decade. Between 2003 and 2008, for example, the Consumer Price Index for college textbook (textbook CPI) has risen by approximately 6.2% annually. During the same period, the Consumer Price Index for all items (overall CPI) has only increased by approximately 2.4% annually. Accordingly, the U.S. government has imposed federal regulations to provide some stability to the college textbook market. The 2008 Higher Education Opportunity Act (HEOA), for example, requires publishers to

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1 The authors are grateful to two anonymous reviewers’ constructive comments. Any remaining errors are the authors’.  

~ 35 ~
A number of studies have sought to investigate the college textbook market. Examples include Miller (1974), Foster and Horowitz (1996), Siegfried and Latta (1998), Clay et al. (2001), Appelman et al. (2002), Clerides (2002), Laband and Hudson (2003), Pecorino (2006), Canoy et al. (2006), Cabolis et al. (2007), Jimenez and Campos (2010). Siegfried and Latta (1998), for example, investigate the competition of the retail prices in 16 different textbooks sold at 130 colleges and universities in the U.S.; they find that virtually no distinction exists between the prices in retail centers based on competition. Canoy et al. (2006) examine the structure of the textbook market in Europe; they show that in addition to market structure, different characteristic of book markets (e.g., density of population and internet use) in each country also affect prices of books significantly. Cabolis et al. (2007) study substantial price differences in textbook prices between the U.S. and the UK; they find that price differentials are due mainly to differences in markups and hence demand. More recently, Jimenez and Campos (2010) analyze the relationship between alternative price schemes and market structures; they conclude that the more price liberalization policies could change the existing market structure. One common feature of the studies tackling this issue is that they have typically concentrated on assessing the relationship between the market structure of college textbooks and its price, and the discriminatory nature of different pricing policies. Until recently, no study has directly investigated factors affecting fast-rising textbook prices in the U.S. This is what we intend to do in this paper.

It should be emphasized at the onset that one of the central questions surrounding the drastic surge in U.S. textbook prices is: To what extent market factors (e.g., demand and supply factors) and the government regulation (i.e., HEOA) have affected the U.S. textbook price over the years. The answer to this question is of great policy significance as it is crucial to clearly and accurately understand the behavior of the U.S. college textbook market and the effectiveness of the government intervention itself. If supply (demand) factors, for example, are the main force driving changes in the textbook price, then it is reasonable to conclude that supply (demand) factors play key roles in determining the textbook market. By contrast, if market factors and the government regulation have all resulted in changes in the textbook price, then we need to decompose those effects to determine how much can be imputed to each factor and how effective the policy has been.

This study thus sets out to empirically examine the factors that contribute to the ever-changing pattern of the U.S. college textbook market in a cointegration framework. The empirical focus is on determining how the 2008 Higher Education Opportunity Act and demand and supply factors have affected the U.S. college textbook price in the short-and long-run. To that end, we adopt an autoregressive distributed lag (ARDL) approach to cointegration proposed by Pesaran et al. (2001). Since the ARDL enables us to conveniently derive an error-correction model (ECM) via a simple linear transformation, it is well suited to estimate both the short-run and long-run parameters of the model simultaneously. We hope that this dynamic approach should lead to a better understanding of factors driving up the recent textbook prices in the U.S.
2. The Model and The Method

2.1. A Price Model of U.S. College Textbooks

In explaining variations in the price of U.S. college textbooks, we first define the aggregate demand for college textbooks as follows:

\[ D = f_1(p, y, z_1) \]  

(1)

where \( D \) is the aggregate demand for college textbooks; \( p \) is the aggregate price; \( y \) is the aggregate income; and \( z_1 \) is other shift factors affecting demand. We then define the aggregate supply of college textbooks as follows:

\[ S = f_2(p, ip, z_2) \]  

(2)

where \( S \) is the aggregate supply of college textbooks; \( ip \) is the aggregate factor costs (input prices); and \( z_2 \) is other shift factors affecting supply. The market equilibrium conditions for the demand and supply of college textbooks yield:

\[ p = g_1(y, ip, z_1, z_2) \]  

(3)

Since aggregate college enrollment (\( en \)) and firm profits (\( fp \)) are considered to be of central importance to determine demand for and supply of college textbooks, these shift variables are selected for inclusion in the empirical model.\(^2\) Additionally, the 2008 Higher Education Opportunity Act (\( dum_1 \)) and other U.S. market shocks such as the so-called Great Recession of 2008 (\( dum_2 \)) may result in changes in the textbook market. To capture such effects, two dummy variables are also included in the model. Therefore, to examine factors affecting the price of college textbooks, the following specification is chosen for the empirical analysis:

\[ p = g_2(y, ip, en, fp, dum_1, dum_2) \]  

(4)

2.2. The ARDL Modelling

Equation (4) is then specified in a log linear form as follows:

\[ \ln p_t = \beta_0 + \beta_1 \ln y_t + \beta_2 \ln ip_t + \beta_3 \ln en_t + \beta_4 \ln fp_t + \beta_5 dum_1 + \beta_6 dum_2 + u_t \]  

(5)

where \( dum_1 \) is a dummy variable capturing the effect of the 2008 Higher Education Opportunity Act on textbook prices – taking on a value of one after July 2010 when the regulations in all U.S.

\(^2\) Firm profits are thought to influence supply of college textbook through a change in number of sellers in the market. For example, an increase in firm profits in the textbook market causes more firms to enter the market, thereby resulting in an increase in textbook supply.
colleges was implemented, zero otherwise; \( dum_2 \) is a dummy variable capturing the Great Recession impact – equals one if the month is between November 2008 and March 2011, zero otherwise; and \( u_t \) is the error term. If an increase in income increases demand for college textbooks and hence prices, it is expected that \( \beta_1 > 0 \). If an increase in input prices pushes up textbook prices through a surge in the cost of production, it is expected to that \( \beta_2 > 0 \). If a rise in college enrollment increases in demand and prices, it is expected that \( \beta_3 > 0 \). If an increase in firm profits reduces prices through increased number of potential sellers in the market, it is expected that \( \beta_4 < 0 \). Finally, if the market shocks reduces prices through a decline (rise) in demand (supply), it is expected that \( \beta_5 < 0 \) and \( \beta_6 > 0 \).

Recall that the central focus of this paper is to examine the short-run and long-run dynamics of the price of college textbooks in the U.S. In estimating Equation (5), therefore, short-run dynamics should be incorporated into estimation procedure. This task can be achieved by reformulating Equation (5) as an error-correction model (ECM) as Pesaran et al. (2001) recommend:

$$
\Delta \ln p_t = \beta_0' + \sum_{i=1}^{n} \beta_{1i}' \Delta \ln p_{t-i} + \sum_{i=0}^{n} \beta_{12i}' \Delta \ln y_{t-i} + \sum_{i=0}^{n} \beta_{13i}' \Delta \ln ip_{t-i} + \sum_{i=0}^{n} \beta_{14i}' \Delta \ln en_{t-i} + \sum_{i=0}^{n} \beta_{15i}' \Delta \ln fp_{t-i} + \beta_6' dum_1 + \beta_7' dum_2 \\
+ \theta_0 \ln p_{t-1} + \theta_1 \ln y_{t-1} + \theta_2 \ln ip_{t-1} + \theta_3 \ln en_{t-1} + \theta_4 \ln fp_{t-1} + \varepsilon_t
$$

(6)

where \( \Delta \) is the difference operator; \( n \) is number of lags. Pesaran et al. (2001) recommend applying an \( F \)-test in Equation (6) to establish joint significance of lagged level variables – the null hypothesis of no cointegration, namely, \( H_0: \theta_0 = \theta_1 = \theta_2 = \theta_3 = \theta_4 = 0 \) - as a sign of cointegration. For this, they tabulate new two sets of critical values (upper and lower critical values) that account for order of integration of the variables. An upper and lower critical values, for example, assume that all variables are \( I(1) \) and \( I(0) \), respectively. Once Equation (6) is estimated, coefficient estimates of first-differenced variables (coefficient estimates of the summation signs (\( \Sigma \))) reflect the short-run relationships. The long-run effects are obtained by the estimates of \( \theta_1 \), \( \theta_2 \), \( \theta_3 \) and \( \theta_4 \) that are normalized on \( \theta_0 \).

3. Data

The U.S. Consumer Price Index for college textbooks (2009=100) is used as a proxy for the price of U.S. college textbooks and is collected from the Bureau of Labor Statistics (BLS). The U.S. Producer Price Index for textbook publishers (2009=100) is used as a proxy for the input prices and is taken from the BLS. The U.S. disposable income is used as a proxy for U.S. aggregate income and is obtained from the Bureau of Economic Analysis (BEA). The consumer price index (2009=100) taken from the BLS is used to derive the real disposable income. The total corporate profits in the information sector are used as a proxy for the firm profits in the textbook market and are collected from the BEA. The total enrollment is taken from the U.S. Census Bureau.
The dataset contains monthly observations for November 2002 to February 2013 (2002:M11-2013:M2). This time span has been dictated by availability of the data for all variables in this series. For example, the U.S. consumer price index for college textbooks could only be traced back to November 2002, while the college enrollment could be collected only to February 2013. Finally, all variables are in natural logarithms.

4. Empirical Results

Table 1 summarizes our key results of the long-run coefficient estimates of the price model of U.S. college textbooks.\(^3\) The results show that the estimated coefficients of the supply factors - input prices and firm profits - are statistically significant at the 5% level. A positive coefficient of input prices on textbook prices indicates that an increase in input prices pushes up the cost of production and hence prices in the long-run. A negative coefficient of firm profits on textbook prices suggests that, in the long-run, an increase in firm profits causes more firms to enter the market and increase competition, thereby lowering textbook prices; in other words, higher profits are incentivized to reduce prices to stay competitive in a crowded market. However, the estimated coefficients of the demand factors - income and enrollment - are found to be statistically insignificant even at the 10% level, implying that they have little effect on textbook prices. The results thus provide empirical evidence that supply factors have played more important roles in influencing the U.S. college textbook market over the past decade. It is important to note that among the supply factors, the input prices are more pronounced than the firm profits in determining prices; for example, a 1% increase in the input prices causes the textbook prices to increase by approximately 2.063%, while the textbook prices increase by only 0.029%, given a 1% decrease in the firm profits. Finally, the estimated effects of the two market shocks are found to be statistically significant at least at the 10% level. A negative coefficient of the 2008 Higher Education Opportunity Act (dum\(_1\)) on textbook prices indicates that the legislation is effective in reducing the rate of price increases; for example, the bill causes textbook prices to drop by approximately 2.7%. A negative coefficient of the Great Recession (dum\(_2\)) on textbook prices also suggests that the severe economic downturn depresses textbook prices by approximately 2.8%.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(y_t)</td>
<td>-0.176</td>
<td>-0.739</td>
</tr>
<tr>
<td>ln(i_{pt})</td>
<td>2.063</td>
<td>10.545**</td>
</tr>
<tr>
<td>ln(n_t)</td>
<td>0.087</td>
<td>0.534</td>
</tr>
<tr>
<td>ln(f_{pt})</td>
<td>-0.029</td>
<td>-4.552**</td>
</tr>
<tr>
<td>dum(_1)</td>
<td>-0.027</td>
<td>1.864*</td>
</tr>
<tr>
<td>dum(_2)</td>
<td>-0.028</td>
<td>-2.349**</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.914</td>
<td>-1.840*</td>
</tr>
</tbody>
</table>

Notes: ** and * denote statistical significance at the 5% and 10% levels, respectively.

\(^3\)Note that, unlike standard cointegration methods (i.e., Johansen, 1988), the ARDL can be applicable irrespective of whether the regressors are I(0) or I(1) and does not require pre-testing for unit roots.
We now turn our attention to Table 2 and discuss the results of short-run coefficient estimates of the model. The results show that, as seen in the long-run results, both input prices and firm profits are the significant factors affecting textbook prices in the short-run. It is also found that income is highly significant, indicating that, unlike the long-run results, income is an important determinant of textbook prices in the short-run. As seen in the long-run results, however, enrollment is found to be statistically insignificant, showing lack of significant short-run relation between enrollment and textbook prices. Finally, the two market shocks are found to have significantly negative short-run effects on textbook prices.

Table 2. Estimated short-run coefficients of the price model of U.S. college textbooks

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δlny_{t}</td>
<td>-0.075</td>
<td>-1.239</td>
</tr>
<tr>
<td>Δlny_{t-1}</td>
<td>0.192</td>
<td>3.079**</td>
</tr>
<tr>
<td>Δlny_{t-2}</td>
<td>0.097</td>
<td>1.641</td>
</tr>
<tr>
<td>Δlnp_{t}</td>
<td>-0.251</td>
<td>-1.430</td>
</tr>
<tr>
<td>Δlnp_{t-1}</td>
<td>-0.529</td>
<td>-2.948**</td>
</tr>
<tr>
<td>Δlnen_{t}</td>
<td>0.016</td>
<td>0.524</td>
</tr>
<tr>
<td>Δlnp_{t}</td>
<td>-0.001</td>
<td>-0.152</td>
</tr>
<tr>
<td>Δlnp_{t-1}</td>
<td>-0.009</td>
<td>-1.278</td>
</tr>
<tr>
<td>Δlnp_{t-2}</td>
<td>0.016</td>
<td>3.048**</td>
</tr>
<tr>
<td>dum_{1}</td>
<td>-0.005</td>
<td>-2.089**</td>
</tr>
<tr>
<td>dum_{2}</td>
<td>-0.005</td>
<td>-2.386**</td>
</tr>
<tr>
<td>ec_{t-1}</td>
<td>-0.186</td>
<td>-4.177**</td>
</tr>
</tbody>
</table>

R^2 =0.30, \hat{\sigma} =0.0053, AIC=454.04, SBC=431.67, \chi^2_{SC}(4) =5.49[0.24], \chi^2_{FF}(1) =0.03 [0.86]

Notes: Δ represents the first difference of each variable; for example, Δlny_t, Δlny_{t-1}, and Δlny_{t-2} are lagged changes of the first difference of income. ** denotes statistical significance at the 5% level. ec_{t-1} indicates an error-correction term. \hat{\sigma} is the standard error of the regression. AIC and SBC are Akaike’s and Schwarz’s Bayesian Information Criteria. \chi^2_{SC}(4) and \chi^2_{FF}(1) indicate chi-squared statistics to test for no serial correlation and no functional form misspecification with p-values given in brackets.

In order for our estimation to be valid, we must provide evidence of the existence of a long-run (cointegration) relationship among the variables using an F-test. If the calculated F-statistic is greater than the upper critical value, the null hypothesis of no long-run relationship (H_0: \theta_0= \theta_1= \theta_2= \theta_3= \theta_4=0) in Equation (6) can be rejected, supporting cointegration. For this, the optimal lag length for the model is found to be three (n=3) using the Akaica Information Criterion (AIC). The results show that the calculated F-statistic is 5.12, exceeding the upper critical value of 3.52 (4.01) at the 10% (5%) level. Accordingly, the null hypothesis can be rejected, indicating the existence of a stable long-run relationship among the five variables. Further, the error-correction term (ec_{t-1}) is found to be negative and highly significant, providing further evidence of the long-run relationship among variables (Kremers et al., 1992; Banerjee et al., 1998). The coefficient of ec_{t-1} in our model is -0.186, suggesting that deviation from the long-run equilibrium is corrected by 19% in one month;
in other words, it takes more than 5 months (e.g., 1/0.186=5.4 months) in order to fully correct disequilibria.

Finally, the Lagrange multiplier (LM) and RESET tests show that our model is serial correlation free and correctly specified (Table 2). The cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) show the estimated coefficients are generally stable over the sample period.

5. Concluding Remarks

In this paper, we examine both the short-run and long-run dynamics of U.S. college textbook prices. The effects of the input prices, the firm profits, the income, the enrollment and the market shocks (i.e., 2008 Higher Education Opportunity Act) on the U.S. textbook price are investigated using an ARDL cointegration approach. The results show that the supply factors such as input prices and firm profits play key roles in determining the U.S. college textbook price in both the short-run and long-run. We also find that the demand factors (i.e., income) appear to have significant effects on the U.S. college textbook price in the short-run, but not in the long-run. From methodological perspective, these findings explain why it is crucial to incorporate both the short-run and long-run dynamics in a textbook price model. From policy perspective, these findings suggest that any policy decision made by the federal government directed at textbook producers has impacts on the U.S. college textbook market in both the short-run and long-run. In other words, government policies implemented by overlooking the supply side of the textbook market could leads to undesirable outcomes in the long-run.

Finally, it is found that the market shocks such as the 2008 Higher Education Opportunity Act and the Great Recession have a beneficial effect on reduction in textbook prices in both the short-run and long-run. From these findings, we conclude that the required disclosure of textbook prices, unbundling of college textbooks from supplemental materials, and development and provision of custom textbooks are set in such a way that the 2008 HEOA indeed effectively regulates the rate of textbook price increases. As such, as long as the U.S. textbook market is regulated under the legislation, textbook prices are expected to remain stable in the future. However, the full recovery of the U.S. economy from the Great Recession in the foreseeable future may increase pressure on U.S. textbook prices.

References


