STATE LOTTERIES, ISOLATION AND ECONOMIC GROWTH IN THE U.S.

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This paper uses a Granger causality test adapted for use with cross-section time series data, to (1) test the relationship between lottery revenue and state economic growth (per capita income), and (2) address the importance of cross-border purchases in the relationship. Neither issue has been empirically tested previously. Previous evidence (Caudill, et al., 1995) suggests that states surrounded by lotteries are more likely than isolated states to introduce lotteries. But the empirical results here suggest that lotteries do not contribute to economic growth unless the state is isolated from other state lotteries. The importance of isolation suggests that cross-border purchases (exports) of lottery tickets have a significant impact on the effectiveness of lotteries as fiscal policies, and that “defensive” lotteries (those introduced to keep citizens from buying tickets from neighboring states) are ineffective.

1. Introduction

Lotteries have become popular fiscal policies in the United States, mainly because of the voluntary nature of the revenue collection. Well over 30 states have adopted lotteries, making it possible for them to reduce taxes and/or increase spending on popular programs. There have been numerous studies on the economic effects of lotteries, most of which focus on public finance issues. An issue not addressed, at least empirically, is the effect of state lotteries on economic growth. Joseph Schumpeter (1934) noted that the provision of a new consumer good can be a source of economic development. Does the provision of state lotteries have this effect? This paper is an empirical analysis of the relationship between state lotteries and economic growth in the U.S.

1.1 Methodology

Several recent studies have utilized Granger causality to analyze time series data and to address the potential causal relationships relating to economic growth. The methodology is usually applied to a set

1 Clotfelter and Cook (1989) and Borg, Mason, and Shapiro (1991) are the most comprehensive studies to date. Also see Kaplan (1992), Mikesell (1992), Ovedovitz (1992), Thalheimer (1992) and Thornton (1998).

of linear, covariance-stationary time series processes. In the case of state lotteries, however, some states have introduced the lotteries only recently, and testing them individually would be problematic because of a lack of data. To overcome this problem, we utilize a methodology developed in a previous paper (Walker and Jackson, 1998).

Standard Granger causality testing requires two regressions, one to test for causality in each direction between the variables (Granger, 1969). In the case of lottery revenue (LR) and economic growth (i.e., increases in per capita income, PCI), the regressions would appear as follows:

\[ PCI_t = \sum_{l=1}^{n} \xi_l LR_{t-l} + \sum_{l=1}^{n} \lambda_l PCI_{t-l} + \epsilon_{1,t} \]  
(1)

\[ LR_t = \sum_{l=1}^{n} \phi_l LR_{t-l} + \sum_{l=1}^{n} \theta_l PCI_{t-l} + \epsilon_{2,t} \]  
(2)

where \( \epsilon_{1,t} \) and \( \epsilon_{2,t} \) are assumed to be stochastic error terms. In the case of equation (1), if \( \xi_l \neq 0 \) for any \( l = 1, \ldots, n \), then LR can be said to Granger cause PCI. This simply means that the inclusion of LR in a regression to predict PCI significantly improves the prediction of that variable. Equation (2) tests for causality from PCI to LR; causality exists in that direction if \( \theta_l \neq 0 \) for any \( l = 1, \ldots, n \). There are four possible results: (1) LR Granger causes PCI; (2) PCI Granger causes LR; (3) simultaneous causality; and (4) independence of the variables. A standard F-test is used to test the joint significance of the causal variables. Rejection of the hypothesis of non-causality implies that there exists a causal relationship.

1.2 Data

We use 490 observations on real gross lottery sales and real per capita income for 33 states. As mentioned above, there are some necessary modifications when applying Granger’s procedures to panel data. First the data must be “stacked” so that the resulting data vector for a variable appears as follows:

\[ [AZ_{1982} \ AZ_{1983} \ : \ AZ_{1995} \ CA_{1995} \ : \ WI_{1995}] \]

There are three other data modifications. We first “filter” the data using the following types of variables: (1) state dummies, which remove state-specific effects; (2) a trend variable, to eliminate any effects of common trends that may exist between the variables; (3) trend-dummy interaction terms, to remove state-specific trends that may exist in the data; and (4) a variable to remove the effect of stacking the data.

After the data are filtered, they must be tested for stationarity. We use a Phillips-


In the example shown, there are data on the AZ lottery from 1982 to 1995; the CA lottery began in 1986. Other states follow, but are omitted from the example for brevity.

The methodology briefly mentioned here is fully explained by Walker and Jackson (1998).

This variable amounts to a dummy with “1” at the first observation of each state, and “0” for all other observations. The variable removes the “blip” in the data at the first period of each state.
Perron unit root test for this purpose. If the hypothesis of a unit root can be rejected, the next step is to determine what autoregressive process generates each series. This is done by regressing the filtered series on itself with as few lag periods as possible, such that the resulting residual series is white noise. The proper lag length is determined using Box-Pierce Q-statistics on these residuals to detect any remaining systematic relationship.

Finally, once the proper lag length has been determined for each series, the two Granger causality equations may be specified, analogous to equations (1) and (2).

### 2. Empirical Results

The filtering equations for the two data series are presented below.

\[
PCL_t = \gamma_1 + \gamma_2 Tr + \gamma_3 New + \sum_{i=4}^{20} \gamma_i StD_j + \sum_{m=21}^{37} \gamma_m TrStD_n + \varepsilon_{1,t} 
\]

\[
LR_t = \eta_1 + \eta_2 Tr + \eta_3 New + \sum_{i=4}^{20} \eta_i StD_j + \sum_{m=21}^{37} \eta_m TrStD_n + \varepsilon_{2,t} 
\]

The dependent variable panels are state per capita income data (\(PCL_i\)) and state lottery revenue (\(LR_r\)), \(Tr\) is a trend variable; \(New\) is a dummy for the first observation on each state; the \(StD_j\) is a set of (17) state dummies; and the \(TrStD_n\) are the trend and state dummy interaction terms. These are the appropriate filtering equations derived from an initial run through the model. Some states must be dropped from the analysis because they do not have enough observations to support the requisite number of lag periods. The states dropped from the model are CA, FL, ID, IN, IA, KS, KY, MN, MO, MT, OR, SD, VA, WV and WI.

The residuals (\(PCLR\) and \(LRr\)) from the filtering equations (3 and 4) are used for the remainder of the analysis. The next step is to test for stationarity. Using the Phillips-Perron test, the test statistic on the residuals from (3) is -5.20; for the residuals from (4), the statistic is -6.43. With a critical value of -2.57, the hypothesis that a unit root exists may be rejected in both cases (\(\alpha = 0.01\)). Given that both series are stationary, the next step is to specify the process that generates each series.

The iterative process to determine the appropriate lag-length for the variables indicates that 5 lag periods are the minimum required for the residuals from (3), \(PCLr\), to become white noise. For (4), \(LRr\), 6 lag periods are necessary. According to the correlogram data, there appears to be no significant autocorrelation among the observation periods when these lag lengths are used.

Finally, we may specify the Granger causality test. The required regressions are

\[
PCLR_t = C + \sum_{j=1}^{5} \psi_j PCLR_{t-j} + \sum_{j=1}^{6} \pi_j LRr_{t-j} + \varepsilon_{1,t} 
\]

\[
LRr_t = C + \sum_{j=1}^{6} \tau_j LRr_{t-j} + \sum_{j=1}^{5} \delta_j PCLR_{t,j-j} + \varepsilon_{2,t} 
\]

The \(F\)-test on whether or not lottery revenue causes economic growth is performed on \(H_0 : \pi_1 = \pi_2 = \cdots = \pi_6 = 0\). That is, the hypothesis is that the \(\pi\) coefficients are not (jointly) significantly different from zero. If this hypothesis may be rejected, then Granger causality exists. The hypothesis
used to test for causality from $PCI_r$ to $LR_r$ is $H_0: \delta_1 - \delta_2 - \cdots - \delta_5 = 0$.

The results from these regressions are presented in Table 1. (The full output for this and all other steps is available from the authors.) There is significant evidence ($\alpha = 0.01$) that increases in per capita income cause increases in lottery ticket purchases. This supports the proposition that, generally, lottery tickets are normal goods. It is also consistent with the findings by Caudill, Ford, Mixon, and Peng (1995), that higher income states are more likely to introduce lotteries in the first place. There is no evidence to suggest that lottery ticket revenue spurs economic growth (i.e., the $F$ for testing $\pi_1 = \pi_2 = \cdots = \pi_6 = 0$ is statistically insignificant at any reasonable level).

### 2.1 Isolated-state Model

Mikesell (1992) found that in lottery states, counties bordering the state line of non-lottery states have higher per capita lottery ticket sales than internal counties. The magnitude of the effect of cross-border lottery ticket purchases could be an important consideration for state governments deciding whether to implement or retain lotteries. Will introducing a lottery in order to keep consumers’ money in the state (i.e., “defensive lotteries”) have any effect on economic growth? In order to get information on the importance of exporting lottery tickets (for economic growth), the proportion of bordering lottery states to total bordering states is used to separate the “isolated” states from the original model.

Each lottery state in the original model is listed in Table 2, along with its surrounding states. Those states for which no more than 50% of the adjacent states have lotteries are considered “isolated” and are tested as a group in an attempt to measure the effect of exports on economic growth. There are only 4 isolated states: AZ, CO, FL, and MT. These have a total of 43 observations. The same variables as before are used in the filtering equations (of course, minus inappropriate dummy and interaction terms). On $PCI_r$, the Phillips-Perron statistic is $-3.27$; for $LR_r$, it is $-5.74$. Because the critical value at the 1% level is $-2.62$, the unit root tests show that the filtered data series are stationary. Analysis of the correlograms indicates that the appropriate lag length for the $PCI_r$ series is 2 periods; for $LR_r$, it is 3 periods. The Granger causality test for the isolated model involves

$$PCI_t = C + \sum_{j=1}^{2} \beta_j PCI_{t-j} + \sum_{j=1}^{3} \delta_j LR_{t-j} + \mu_{t-j} \quad (7)$$

$$LR_t = C + \sum_{j=1}^{3} \lambda_j LR_{t-j} + \sum_{j=1}^{2} \omega_j PCI_{t-j} + \mu_{2,t} \quad (8)$$

According to the results (Table 3), there is weak evidence of bilateral causality ($\alpha = 0.10$). Contrary to the results in the full model, there is some evidence of a causal relationship from lottery sales to economic growth—as long as the state is “isolated.”

### 3. Conclusion

There are currently several states, including Alabama, South Carolina, and Tennessee, considering the adoption of lotteries. Policymakers have several studies at their disposal, but most consider only public finance issues. None of the previous studies...

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7 The level of 50% is chosen because it is the minimum that would allow a reasonable sample size.
Table 1. Granger Causality Test Results

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>F-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\pi_1 - \pi_2 = \ldots = \pi_6 = 0$</td>
<td>0.474</td>
<td>0.828</td>
</tr>
<tr>
<td>($L_{rr}$ does not cause $P_{Clr}$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\delta_1 = \delta_2 = \ldots = \delta_5 = 0$</td>
<td>4.87</td>
<td>0.0003</td>
</tr>
<tr>
<td>($P_{Clr}$ does not cause $L_{rr}$)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Lottery States and their Bordering States

| [AZ]: CA, NV*, UT*, NM* | MI: IN, OH, WI |
| CA: OR, NV*, AZ         | MO: KS, OK*, AR*, KY, IL, IA |
| [CO]: UT*, WY*, NE, KS, OK*, NM* | [MT]: ID, WY*, SD, ND* |
| CT: RI, MA, NY          | NH: VT, ME, MA |
| DC: VA, MD              | NJ: DE, PA, NY |
| DE: MD, NJ, PA          | NY: VT, CT, NJ, PA, MA |
| [FL]: GA, AL*           | OH: KY, MI, IN, WV, PA |
| IL: IN, IA, MO, KY, WI  | OR: WA, ID, CA, NV* |
| IA: MN, WI, IL, NE, MO  | PA: NY, NJ, WV, MD, DE |
| KS: CO, NE, MO, OK*     | RI: CT, MA |
| ME: NH                  | SD: ND*, NE, IA, MN, MT, WY* |
| MD: DC, VA, WV, PA, NJ  | VT: NY, NH, MA |
| MA: NY, CT, NH, RI, VT  | WV: VA, KY, OH, PA, MD |

Notes: * indicates no lottery; [ ] indicates isolated state. The information in this table is accurate as of 1994. While the states that began lotteries later than 1988 are not included in the model, those states are listed as neighboring states with lotteries.

Table 3. Granger Causality Test Results: “Isolated” Lotteries

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>F-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\varphi_1 = \varphi_2 = \varphi_3 = 0$</td>
<td>2.51</td>
<td>0.099</td>
</tr>
<tr>
<td>($L_{rr}$ does not cause $P_{Clr}$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\omega_1 = \omega_2 = 0$</td>
<td>2.96</td>
<td>0.067</td>
</tr>
<tr>
<td>($P_{Clr}$ does not cause $L_{rr}$)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

has considered the relationship among lotteries, isolation, and economic growth.

While data constraints prevent testing an extraordinarily large sample, the results here indicate that in cases where lottery states are isolated, economic growth may be one of the effects of the lottery. The lottery simply acts as any other fiscal policy. The more revenue brought in from out-of-state, the greater the effect of the policy. This makes sense, since it is akin to taxing out-of-state residents; obviously if you can tax them for in-state spending, the net positive effect in your state will be greater.

It appears that the export-base theory of growth applies to lotteries. (Interestingly, previous evidence suggests that the export-base theory does not apply to other forms...
of legalized gambling, particularly casinos and greyhound racing. See Walker and Jackson, 1998). Defensive lottery adoption, in an effort to keep spending at home, appears to be ineffective with regard to state economic growth. Ironically, only non-isolated states are tempted by the defensive legalization argument, yet these are precisely the states for which there are no significant growth effects from lotteries. Admittedly, economic growth per se may not be the sole purpose of lotteries. Nonetheless, the information presented here should be taken into consideration by state governments currently debating the merits of lotteries, who, as Caudill, et al. (1995) found, are more likely to adopt lotteries if surrounding states already have.

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References


