Toda and Yamamoto Causality Tests Between Per Capita Saving and Per Capita GDP for India

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Abstract:
This paper looks at the relationship between per capita saving and per capita GDP for India using the Toda and Yamamoto tests of Granger causality. Data are for 1950-2004. We distinguish between three types of saving. These are household saving, corporate saving and public saving. The results show that there is no causality between per capita GDP and per capita household saving/per capita corporate saving in either direction. However, there is bi-directional causality between per capita household saving and per capita corporate saving.

JEL Categories: C22, E21

I. Introduction

During the post-independence period, India has maintained a fairly high rate of saving. There is a fair amount of controversy, however, as to whether the relatively high rate of saving has effectively contributed to economic growth or that the saving has been used, to a large extent, for unproductive purposes. The traditional neoclassical model such as Solow-Swan model and the Ramsay model imply that a high rate of saving is conducive to economic growth. While it is true that some East Asian countries which have high rates of saving achieved very high sustained growth rates before the emergence of the Asian crisis in 1997, it is hard to make generalizations. The US economy, for example, has been growing steadily at a healthy rate despite the fact that its saving rate is the lowest among the OECD countries and is still declining.

Since we cannot generalize on the basis of, say, East Asian countries, it is necessary to study a particular country over a period of time. Cross section studies assume that the saving behavior is the same across various countries – an assumption that can hardly be defended.

In contrast, this study uses time series data for India to explore the relationship between per capita saving and per capita GDP for India. In doing so, we distinguish between three types of saving: household savings, corporate saving and public saving. We use the newly developed Ng-Perron (2001) unit root tests and Toda and Yamamoto (1995) Granger causality tests which have never been applied to study the saving-GDP relationship for any country.

II. A Brief Review of the Literature

Most of the earlier empirical studies were on developed countries only. The theoretical basis for such studies came from the Solow-Swan model neoclassical growth model, the Ramsay model and the Modigliani's life-cycle model. The Solow-Swan model and the Ramsay model imply that a high rate of saving will lead to a higher growth rate. Modigliani's life-cycle model looks at the saving behavior of the individuals over the lifetime. The basic hypothesis is that individuals try to maintain the level of consumption over their lifetime. Earnings, on the other hand, increase at first, reaches a maximum, and then start to fall (around retirement from work). Thus, consumption smoothing will imply that individuals' saving will increase (as income rises) and then fall. While it is easier to test for the Solow-Swan neoclassical theory of saving when we use aggregate data, it is not possible to test for the Modigliani's life-cycle model without saving data on the micro levels. However, reliable micro-level data on saving are not easily available for developing countries.

Agrawal (2001) examines the causality between GDP and saving for a number of Asian countries. He finds that for most countries, causality flows from GDP to saving. Sinha (1996) tests for causality between total saving/private saving and economic growth for India and finds that there is no causality flowing from any direction. Sinha and Sinha (1998) tests for causality between the growth rate of GDP and the growth rate of private/public saving for Mexico. They find that the growth rate of GDP Granger causes the growth rate of private/public saving but there is no reverse causality. This is in line with the life cycle model. However, Triantis (1997) raises doubts about the validity of the life cycle model.

III. Data, Methodology and Results

Real GDP and population data are from the International Monetary Fund (2006). Data on household saving, corporate saving and public saving are from *Economic Survey of India* (2006). Annual data are for 1950 to 2004.

Household saving: Quantitatively, household saving is the most important form of saving in a country like India. For a very long time, India had been following a policy of inward looking development in which self-sufficiency was an important goal. Import of consumer goods was severely restricted. Similarly, a maze of licensing and controls restricted the growth of the domestic consumer goods industries. The new policy of opening up the domestic economy and removing many of the controls on the industrial sector was precipitated by a foreign exchange crisis of unprecedented proportion in 1991. The fall in the household saving rate was a cause for concern in many quarters. However, the fall can most likely be attributed to the sudden change in the policy of the government and a consequent increase in consumption. During the late 1990s, the household saving rate started to increase again.

Public saving: In contrast to the household saving, public saving in India has always been low. There are two major sources of public saving. One is the excess of government revenue over government expenditure. The other is the surplus of the state enterprises. The federal structure of the Indian economy implies that these expenditures and the revenues belong not only to the federal (central) government but also to the state governments. While the central government has been running at deficits in the recent past, a number of state governments have a surplus. The second source of saving comes from the surplus of the state enterprises. During the first three decades after independence, the number of state enterprises burgeoned. Among other things, the major banks were nationalized in 1969. However, many state enterprises were suffering heavy losses. The government has now embarked upon privatizing many of these enterprises.

Corporate saving: Since the saving of smaller businesses is included in the household domestic saving, corporate saving has not been very high. However, in recent years, it has been rising

All variables are expressed in per capita terms. *GDPPC, CORPSAVPC*, *HHSAVPC* and *PUBSAVPC* stand for GDP per capita, corporate saving per capita, household saving per capita and public saving per capita respectively.

Toda and Yamamoto tests are valid for integrated or cointegrated variables. We use the Ng-Perron unit root tests (Ng and Perron, 2001). The results of the unit root tests on the levels of the variables are in Table 1. The results show that no matter whether MZ^d_α or MZ^d_t or MSB^d or MP^d_T is used, *GDPPC*, *HHSAVPC* and *CORPSAVPC* are non-stationary in their levels. However, *PUBSAVPC* is stationary in its level according to MZ^d_α, MZ^d_t and MSB^d. In contrast, it is non-stationary in its level when MP^d_T is used. Since it is stationary in its level according to 3 test statistics, we take it to be stationary. Table 2 gives the results of the unit root tests on the first differences of

GDPPC, *HHSAVPC* and *CORPSAVPC*. The results show that all three variables are stationary in their first differences according to all four statistics. Since all three variables, namely, *GDPPC*, *HHSAVPC* and *CORPSAVPC* are I(1), Toda and Yamamoto (1995) tests of Granger causality can be conducted on these variables.

We follow Rambaldi and Doran (1996) in formulating the Toda-Yamamoto test of Granger causality. Where d_{max} is the maximum order of integration in the system (in our case, it is one), a VAR($k + d_{max}$) has to be estimated to use the Wald test for linear restrictions on the parameters of a VAR(k) which has an asymptotic χ^2 distribution. In our case, k is determined to be 2 by using the Akaike Information Criterion (AIC). Let *GDPPC*, *HHSAVPC* and *CORPSAVPC* be denoted by y, z and w respectively. For a VAR(3), we estimate the following system of equations:

$$\begin{bmatrix} y_t \\ z_t \\ w_t \end{bmatrix} = A_0 + A_1 \begin{bmatrix} y_{t-1} \\ z_{t-1} \\ w_{t-1} \end{bmatrix} + A_2 \begin{bmatrix} y_{t-2} \\ z_{t-2} \\ w_{t-2} \end{bmatrix} + A_3 \begin{bmatrix} y_{t-3} \\ z_{t-3} \\ w_{t-3} \end{bmatrix} + \begin{bmatrix} e_y \\ e_z \\ e_w \end{bmatrix}$$

The above system of equations is estimated by seemingly unrelated regression (SUR) method. If we want to test that *HHSAVPC* does not Granger-cause *GDPPC*, the null hypothesis will be H_0: $a^{(1)}{}_{12} = a^{(2)}{}_{12} = 0$ where $a^{(i)}{}_{12}$ are the coefficients of z_{t-i}, i=1, 2 in the first equation of the system. The other null hypotheses are similarly defined. The results of the Toda-Yamato tests of Granger causality are in Table 3. The results show that we can reject the null hypothesis that *HHSAVPC* does not cause *CORPSAVPC* at 1% level of significance. Also, we can reject the null hypothesis that *CORPSAVPC* does not cause *HHSAVPC* at 10% level of significance. Thus, there is a two-way causality between the two variables. However, we do not find any causality in either direction for all other pairs of variables.

IV. Conclusions

We study the relationship between per capita saving and per capita GDP for India using data for 1950 to 2004. We distinguish between three types of saving: household saving, corporate saving and public saving. Ng-Perron unit root tests show that all variables with the exception of per capita public saving are I(1). The results of Toda-Yamamoto tests of Granger causality show that there is bi-directional causality between per capita household saving and per capita corporate saving. However, there is no evidence of causality in any direction between per capita GDP and per capita corporate saving/per capita household saving.

Table 1. Ng-Perron Unit Root Tests on Levels

Variable	MZ^d_α	MZ^d_t	MSB^d	MP^d_T
GDPPC	0.2677	0.0930	0.3474	37.1530
	(-17.3000)	(-2.9100)	(0.1680)	(5.4800)
CORPSAVPC	0.0948	0.0353	0.3730	39.9627
	(-17.3000)	(-2.9100)	(0.1680)	(5.4800)
HHSAVPC	0.4592	0.1997	0.4381	51.1635
	(-17.3000)	(-2.9100)	(0.1680)	(5.4800)
PUBPSAVPC	-9.4780	-2.0172	0.2128	3.1911
	(-8.1000)	(-1.9800)	(0.2330)	(3.1700)

Notes: *GDPPC, CORPSAVPC*, *HHSAVPC* and *PUBSAVPC* stand for GDP per capita, corporate saving per capita, household saving per capita and public saving per capita respectively. While the other variables have a trend, *PUBSAVPC* does not. The critical values are in parentheses.

Table 2. Ng-Perron Unit Root Tests on the First Differences

Variable	MZ^{d}_{α}	MZ^{d}_{t}	MSB^{d}	MP^{d}_{T}
d(GDPPC)	-26.2821	-3.4518	0.1313	4.4718
	(-17.3000)	(-2.9100)	(0.1680)	(5.4800)
d(CORPSAVPC)	-27.9600	-3.5448	0.1268	1.4827
	(-8.1000)	(-1.9800)	(0.2330)	(3.1700)
d(HHSAVPC)	-27.4667	-3.6675	0.1335	3.5426
	(-17.3000)	(-2.9100)	(0.1680)	(5.4800)
d(PUBPSAVPC)	NA	NA	NA	NA

Notes: *d(GDPPC), d(CORPSAVPC)*, *d(HHSAVPC)* and *d(PUBSAVPC)* stand for the first differences of GDP per capita, corporate saving per capita, household saving per capita and public saving per capita respectively. *d(GDPPC)* and *d(HHSAVPC)* have a trend while *d(CORPSAVPC)* does not. The critical values are in parentheses. NA stands for “not applicable”.

Table 3. Toda-Yamamoto Tests of Granger Causality

Cause	Effect	Test Statistic	p-value
HHSAVPC	*GDPPC*	0.7867	0.6748
CORPSAVPC	*GDPPC*	3.8459	0.1462
GDPPC	*HHSAVPC*	2.7079	0.2582
GDPPC	*CORPSAVPC*	1.0764	0.5838
HHSAVPC	*CORPSAVPC*	22.4905	0.00001
CORPSAVPC	*HHSAVPC*	4.8567	0.0882

Notes: *GDPPC, CORPSAVPC* and *HHSAVPC* stand for GDP per capita, corporate saving per capita and household saving per capita, respectively. The test statistic is the χ^2 value with 2 degrees of freedom.

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