Public Funding of Investment in Transport and Communication and Economic Growth in Iran based on Gregory-Hansen Cointegration Analysis

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Abstract

This paper examines causal relationships between investment in transport and communication (TC) by public funding and GDP for Iran using annual data over the period 1970-2014. A three-variable model is formulated with oil revenues as the third variable to empirically examine the long-run co-movement between these variables based on the Gregory-Hansen (1996) cointegration technique, allowing for the presence of potential structural breaks in data. The results suggest that there is a long-run relationship between these variables. The Granger Causality test indicates strong unidirectional effects from oil revenues and GDP to TC. But there is no evidence that TC promotes long-term economic growth. Moreover, the main results in this paper confirm that there is an instantaneous as well as unidirectional causal link running from oil revenues and GDP to TC. The results is attributed to rent seeking activities, low productivity and mass of unfinished or long-delayed development projects, particularity during the oil booms.

JEL classifications: C12; C22; C52; E21; F43

Keywords: Unit root, Cointegration, Granger Causality, transport and communication, Economic Growth

1. Introduction

There is widespread agreement that transportation and communication capital to have a crucial impact on economic growth and productivity and a positive crowding effect on the private capital formation. Public expenditure including transportation and communication can be growth-enhancing although providing essential infrastructures such as electricity, telecommunications, water and sanitation, waste disposal, education and health. Yet, these expenditures can be growth-retarding (for example, the negative effect associated with taxation and excessive debt). The impact of government expenditure on economic growth is still an unsettled topic theoretically as well as empirically (Grossman, 1988). However, two approaches to public expenditure have been launched in literature: Wagner's and Keynes approach.

The Wagner's law predicts that as income per capita increases, the share of the public sector in the national economy grows continually (Musgrave and Musgrave, 1988). The Wagner's approach implies that government expenditures are endogenous to economic development. The second proposition is associated with Keynesians. To Keynes, public expenditure is an exogenous factor and a policy instrument for increasing national income. Consequently, he supposes that the causality of the relationship between public expenditure and national income runs from expenditure to income. Moreover, public transportation and communication serves as provisions of certain public goods (Abdullah, 2000). Some scholars argue that increase in government expenditure on transportation and communication infrastructures promotes economic growth. Expenditure on infrastructure such as transportation and communications increases private sector investment and profitability of firms, thus encouraging economic growth. Supporters of this view concluded that expansion of government expenditure contributes positively to economic growth.

However, some researchers maintain the claim that increasing government expenditure threat economic growth and higher expenditure may shrink performance of the economy. For example, in an attempt to finance growing expenditure, government may raise taxes and/or borrowing. Higher tax discourages firms and laborers, reducing investment, income and demand. Moreover, if government increases borrowing (especially from the banks) in order to finance its expenditure; it will crowd out the private sector, leading to reducing private investment. Furthermore, in a tender to remain in power, politicians and governments officials sometimes increase expenditure and investment in unproductive plans or in goods that the private sector can manufacture more efficiently.

Given the issues raised above, this paper examines the causal relationship between public stock in transportation and communication and economic growth in Iran during 1970-2014. Section 2 discusses the methodology and data. We also present the empirical results of the paper in section 2, and section 3 concludes.

2. Methodology and Empirical Results

We apply a three variable model to examine the causal relationship between public stock in transportation and communication and GDP with oil revenues included in model as conditioning variable along with these two variables. Data used in the analysis are annual time series during the period 1970-2014 on (logarithm of) real public stock in transportation and communication (TC), real GDP (GDP) and real oil revenues (OIL) for Iran. The data series are obtained from Central Bank of Iran (CBI). Considering the short sample period, a tri-variate model is used to empirically examine the long-run co-movement and the causal relationship between transportation and communication and real GDP.

2.1. Zivot and Andrews Unit Root Test

Conventional tests for identifying the existence of unit roots in a data series include that of the Augmented Dickey Fuller (ADF) (1979, 1981) or Phillips-Perron(1988). So in the first step of the empirical analysis, the Phillips - Perron unit-root tests have been carried out for the all variables: public stock in transportation and communication, GDP and oil revenues (OIL), all in logarithm. The results reported in Table 1, indicate that all of the variables are nonstationary. However, recent contributions to the literature suggest that such tests may incorrectly indicate the existence of a unit root, when in actual fact the series is stationary around a one-time structural break (Zivot and Andrews, 1992; Pahlavani, et al, 2006). Zivot and Andrews (ZA) (1992) argue that the results of the conventional unit root tests may be reversed by endogenously determining the time of structural breaks. The null hypothesis in the Zivot and Andrews test is a unit root without any exogenous structural change. The alternative hypothesis is a stationary process that allows for a one-time unknown break in intercept and/or slope. Following Zivot and Andrews, we test for a unit root against the alternative of trend stationary process with a structural break both in slope and intercept. Table 1 provides the results. As in the Phillips-Perron case, the estimation results fail to reject the null hypothesis of a unit root for all variables. The same unit root tests have been applied to the first difference of the variables and in all cases we rejected the null hypothesis of unit root. Hence, we maintain the null hypothesis that each variable is integrated of order one or I(1).

Table 1:

Unit-root tests of Phillips-Perron(PP) and Zivot and Andrews (ZA)

public stock in transportation and communication(TC)		Real GDP		Oil Revenues(OIL)	
PP	ZA	PP	ZA	PP	ZA
-0.83	-1.48(1979)	-1.69	-1.88(1979)	-1.23	-1.54(1979)

Note: The break point in ZA unit root test is presented in brackets. Empirical results fail to reject the null hypothesis of unit-root in all cases. The lag lengths for the ZA and PP tests are chosen by using SC's information criterion and Newey and West (1987) method respectively. Critical values for ZA tests were obtained from Zivot and Andrews (1992). Break points are reported in

2.2 The Gregory-Hansen Cointegration Analysis

Cointegrationtest means looking for a stationary long-run relationship between non-stationary variables. It has been introduced for the first time in 1980's by Engle and Granger (1987), Johansen (1988, 1991), Johansen and Jeslius (1990, 1992) and the others. There are some methods for testing for cointegration the most well-known of which is Johansen test. However, as noted by Perron(1989), ignoring the issue of potential structural breaks can render invalid the statistical results not only of unit root tests but also of cointegration tests. Kunitomo (1996) argues that in the presence of a structural change, traditional cointegration tests, which do not allow for this, may produce spurious cointegration. Therefore one has to be aware of the potential effects of structural effects on the results a cointegration test, as they usually occur because of major policy changes or external shocks in the economy.

The Gregory-Hansen approach (1996) (hereafter, GH) addressed the problem of estimating cointegration relationships in the presence of a potential structural break by introducing a residual-based technique so as to test the null hypothesis (no cointegration) against the

alternative of cointegration in the presence of the break (such as a regime shift). In this approach the break point is unknown, and is determined by finding the minimum values for the ADF t-statistic.

By taking into account the existence of a potential unknown and endogenously determined one-time break in the system, GH introduced three alternative models. The first model includes intercept or constant (C) and a level shift dummy. The second alternative model (C/T) contains an intercept and trend with a level shift dummy. The third model is the full break model (C/S), which includes two dummy variables, one for the intercept and one for the slope, without including trend in model. This model allows for change in both the intercept and slope.

These tests detect the stability of cointegrating vectors over time in the presence of structural breaks in the form of level shift, level shift with trend, and regime shift. Table 2 reports all cases. when dependent variable is public stock in transportation and communication, the null hypothesis of no cointegration relationships is rejected in favor of the existence of one cointegrating relationship, allowing for a one time structural break (although not rejected when GDP is dependent variable). The results show that the variables under examination do not drift apart for Iran. The estimated long run relationship using the C/S is of the form:

$$TC = 1.34 + 3.01GDP - 1.84D - 1.23D(GDP) - 0.005trend$$

$$t \qquad (6.51)(4.93) \qquad (5.93) \quad (5.50) \qquad (5.94)$$

where dummy $D = 0$ if $t \leq 1979$ and $D = 1$ if $t > 1979$. Both the intercept and the intercept at the time of regime shift (Islamic Revolution in Iran) are significant. Moreover, the income elasticity of public stock in transportation and communication before the regime shift and at the time of regime shift is significant. The income elasticity before the regime shift is 3.01, far more than unity. It decreases by 1.23 with regime shift. Therefore, we can see that income elasticity has decreased after regime shift and took a different path, implying more inclination to cutting public investment in transportation and communication after the revolution. So, the income elasticity of government recurrent expenditure in Iran, after the Islamic revolution amount to 1.78 significantly more than unity, implying that public stock in transportation and communication progressively increase when income increase.

Table 2:
Gregory-Hansen cointegration tests

Dependent Variable	Model	Test Statistic	Break Point
GRE			
	C	-7.54[*]	1979
	C/T	-6.74[*]	1979
	C/S	-5.20[*]	1980
GDP			
	C	-1.77	1979
	C/T	-1.51	1979
	C/S	-1.09	1979

Notes: C denotes level shift, C/T denotes level shift with trend, and C/S denotes regime shift. The lag length is chosen based on minimum SC.* denotes significant at the 5% level. Critical values were obtained from Gregory and Hansen (1996).

2.3. Granger Causality Tests

The existence of cointegrating relationship between TC and GDP for Iran suggests that there must be long run Granger causality in at least one direction (Hatanaka, 1996). In this section, we test for Granger Causality between log of real public stock in transportation and communication (TC), log of real GDG per capita (GDP) and log of oil revenues(OIL). Cointegration implies that causality exists between the three series but it does not indicate the direction of the causal relationship. The dynamic Granger causality can be captured from the vector error correction model (VECM) derived from the long-run cointegrating relationship (Granger 1988). Defining the error term from equation (1) to be ECT_{it} , the dynamic error correction model of our interest by focusing on public stock in transportation and communication (TC) and GDP is specified as follows:

$$\Delta GDP_t = \alpha_y + \beta_y ECT_{t-1} + \gamma_{y1i}\Delta TC_{t-1} + \gamma_{y2i}\Delta TC_{t-2} +$$
$$\delta_{y1}\Delta GDP_{t-1} + \delta_{y2}\Delta GDP_{t-2} + \lambda_{y1}\Delta OIL_{t-1} + \lambda_{y2}\Delta OIL_{t-2} + \varepsilon_{yt} \quad (1)$$

$$\Delta TC_t = \alpha_T + \beta_T ECT_{t-1} + \gamma_{T1}\Delta TC_{t-1} + \gamma_{T2}\Delta TC_{t-2} +$$
$$\delta_{T1}\Delta GDP_{t-1} + \delta_{T2}\Delta GDP_{t-2} + \lambda_{T1}\Delta OIL_{t-1} + \lambda_{T2}\Delta OIL_{t-2} + \varepsilon_{Ti} \quad (2)$$

$$ECT = GRE - 1.12 - 2.52GDP + 2.64D + 0.83D(GDP) + 0.004 trend \quad (3)$$

where Δ is a difference operator; ECT is the lagged error-correction term derived from the long-run cointegrating relationship; The β_i $(i = y, T)$ are adjustment coefficients; a is long run coefficient or elasticity and the $\varepsilon_{it}s$ are disturbance terms assumed to be uncorrelated and random with mean zero.

Sources of causation can be identified by testing for significance of the coefficients on the lagged variables in Eqs. (1) and (2). First, by testing $H_0 : \gamma_{Ti} = 0$ for all i in Eq. (2) or $H_0 : \delta_{yi} = 0$ for all i in Eq. (1), we evaluate Granger weak causality. This can be implemented using a standard F-test. Masih and Masih (1996) and Asafu-Adjaye (2000) interpreted the weak Granger causality as 'short run' causality in the sense that the dependent variable responds only to short-term shocks to the stochastic environment.

Another possible source of causation is the ECT in Eqs. (1) and (2). In other words, through the ECT, an error correction model offers an alternative test of causality (or weak exogeneity of the dependent variable). The coefficients on the ECTs represent how fast deviations from the long run equilibrium are eliminated following changes in each variable. If, for example, β_T is zero, then TC does not respond to a deviation from the long run equilibrium in the previous period. Indeed $\beta_T = 0$ or $\beta_y = 0$ is equivalent to both the Granger non-causality in the long run and the weak exogeneity (Hatanaka, 1996). This can be tested using a simple t-test.

It is also desirable to check whether the two sources of causation are jointly significant, in order to test Granger causality. This can be done by testing the joint hypotheses $H_0 : \beta_T = 0$ and $\delta_{Ti} = 0$ for all i in Eq. (2) or $H_0 : \beta_y = 0$ and $\gamma_{yi} = 0$ for all i in Eq.(1). This is

referred to as a strong Granger causality test. The joint test indicates which variable(s) bear the burden of short run adjustment to re-establish long run equilibrium, following a shock to the system (Asafu-Adjaye, 2000). A test of these restrictions can be done using F-tests.

Another concept related to Granger-causality is that of instantaneous causality. Roughly speaking, a variable TC is said to be instantaneously causal for another time series variable GDP if knowing the value of TC in the forecast period helps to improve the forecasts of GDP. It turns out, however, that in a bi-variate VAR process, this concept reduces to a property of the model residuals. More precisely, let $\varepsilon_t = (\varepsilon_{Tt}, \varepsilon_{yt})$ be the residual vector of $y_t = (\Delta TC, \Delta GDP)$; then, ΔTC is not instantaneously causal for ΔGDP if and only if ε_{yt} and ε_{Tt} are uncorrelated. In turn, ΔTC is instantaneously causal for ΔGDP if and only if ε_{Tt} and ε_{yt} are correlated. Consequently, the concept is fully symmetric. If ΔGDP is instantaneously causal for ΔTC, then ΔTC is also instantaneously causal for ΔGDP. Hence, the concept as such does not specify a causal direction. The causal direction must be known from other sources. Still, if it is known from other sources that there can only be a causal link between two variables in one direction, it may be useful to check this possibility by considering the correlation between the residuals (Lutkepohl, 2004).

The results of the F test for both long run and short run causality are reported in Table 3. As is apparent from the Table, the coefficients of the ECT, GDP and OIL are significant in the TC equation which indicates that long-run and short-run causality run from GDP and OIL to public stock in transportation and communication. So, GDP and OIL strongly Granger-causes transportation and communication. OIL does Granger cause GDP at short run at 1% level, without any significant effect on output in long run. Weak exogeneity of GDP indicate that this variable does not adjust towards long-run equilibrium.

Moreover, the interaction terms in the TC equation are significant at 1% level. These results imply that, there is Granger causality running from GDP and Oil to transportation and communication in the long-run and short run, while transportation and communication have a neutral effect on GDP in both the short- and long-run. In other words, GDP is weakly exogenous and whenever a shock occurs in the system, transportation and communication would make short-run adjustments to restore long-run equilibrium.

Table 3:
Result of Panel causality tests

Dependent Variable	Source of causation(independent variable)						
	Short-run			Long-run	Joint (short-run/long-run)		
	ΔGDP	ΔTC	ΔOIL	ECT(-1)	ΔGDP, ECT(-1)	ΔTC, ECT(-1)	ΔOIL, ECT(-1)
ΔGDP	-	F=0.62	F=6.61***	F=0.81	-	F=0.42	F=4.90**
ΔTC	F=5.52***	-	F=5.99***	F=8.08***	F=8.81***	-	F=9.59***

***significant at 1%

Testing for instantaneous causality can be done by determining the absence of instantaneous residual correlation. Because only one correlation coefficient is tested to be

zero, the number of degrees of freedom of the approximating chi-square distribution is one. Clearly, it is sufficient to report the test result for only one instantaneous causal direction because the test value for the other direction is identical given that it tests the very same correlation coefficient. The test statistics based on the residuals of the VECM is 10.23, being highly significant.

These results imply that, there is instantaneous as well as unidirectional Granger causality running from OIL and GDP to TC, while public stock in transportation and communication has an insignificant effect on GDP in both the short- and long-run. In other words, OIL and GDP are exogenous and whenever a shock occurs in the system, TC must be reduced to maintain the long run relationship.

3. Conclusion

This paper applies Gregory-Hansen (1996) cointegration and error correction modeling techniques in order to test causal relationship between public stock in transportation and communication (TC) and real GDP in Iran based on annual data from 1970 to 2014. Oil revenues (OIL) are also included in the model along with these two variables. Prior to cointegration analysis, the Zivot and Andrews unit root test has been applied to test the stationarity of the variables. The empirical results indicate that we cannot find enough evidence against the null hypothesis of unit root. However, for the first difference of the variables, we rejected the null hypothesis of unit root. It means that the variables are I(1). The results show that there is a long-run relationship between TC, GDP and OIL. The value of the income elasticity before the regime shift is 3.01, much more than unity, while it comes to 1.78, yet significantly more than unity, after the Islamic revolution recognized as the second regime. It means that public investment in transport and communication (TC) progressively increases with income in the both regimes.

We also find strong support for the exogeneity of GDP and OIL. The main results in this paper confirm that there is an instantaneous and unidirectional causal link running from GDP and OIL to TC. Our findings also indicate that public investment in transport and communication (TC) does not play a significant role in promoting economic growth in Iran. The government should ensure that capital expenditures are properly managed to accelerate economic growth. The low contribution or failure of public transport and communication for economic growth could be attributed to rent seeking activities, low productivity and mass of unfinished or long-delayed development projects, particularity during the oil booms.

Acknowledgements

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