A Note on Causality between Debt and Sovereign Credit Ratings using Panel Tests

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Abstract

This paper uses linear and nonlinear panel causality tests to empirically explore the direction of causality between external debt stocks and credit ratings for a group of developing countries over the period 1998 to 2008. The results indicate that for the vast majority of the countries in the panel, a bi-directional causal relationship between external debt and sovereign ratings is evident.

Keywords: External public debt, sovereign ratings, panel data causality
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1. Introduction

Sovereign credit ratings are the risk assessments assigned by credit rating agencies to the obligations of central governments and are often used to determine whether or not loans are given, and the terms and conditions attached. These ratings therefore have implications for interest costs and, by extension, the fiscal deficit and future debt levels. Given the importance of sovereign ratings, several studies have sought to identify their determinants (see the survey of Alfonso et al., 2007). This literature has revealed that debt, *inter alia*, is an important right-hand side variable that is posited to be exogenous. This paper for the first time relaxes the exogeneity assumption by examining the causal relationship between debt and sovereign ratings in developing countries. It also acknowledges that a nonlinear causal link may exist between these two variables, given the ordinal nature of ratings as described by Bissoondoyal-Bheenick (2005). Therefore, linear and nonlinear causality methods are conducted on a 1998 to 2008 panel data set for 32 developing countries, to define the association between debt and sovereign credit ratings. The panel causality methods are described in the next section. Then, the results of the empirical analysis are discussed in the third section. This is followed by some concluding remarks.

2. Methodology and Data

2.1. Panel Causality Linear Tests

There are basically two approaches to examining causality within a panel framework. The first, developed by Holtz-Eakin *et al*. (1988) allows the autoregressive and regression coefficients of the panel to vary. This reduces significantly the degrees of freedom and relies on the 'large time dimension' assumption to derive consistent estimates. The second, suggested by Hurlin and Venet (2001) and Hurlin (2004) treats these coefficients as constant and is perhaps more appropriate for the current data set. The procedure, which is detailed in Hurlin (2004), is summarized below.

Consider the following time-stationary bi-variate vector auto-regression representation in panel form for *N* countries over *T* time periods:

$$y_{i,t} = \alpha_i + \sum_{k=1}^{p} \beta_{i,k} y_{i,t-k} + \sum_{k=1}^{p} \phi_{i,k} x_{i,t-k} + \varepsilon_{i,t} \qquad (1)$$

where the individual effects α_i, the autoregressive coefficients β_k and the regression coefficients Φ_k's are constant for all cross-section units *i* and lag orders, $k \in [1, N]$. First, homogenous and instantaneous non-causality (*HINC*) is checked by undertaking the following Wald test under the null that Φ_k=0 for all *i* and *k:*

$$F_{HINC} = \frac{(SSR_r - SSR_u)/Np}{SSR_u/\left[NT - N(1+p) - p\right]} \tag{2}$$

where SSR_u is the sum of squared residuals from Equation (1) and SSR_r is the restricted sum of squared residuals under $H_0 = \Phi_k = 0$ for all i and k. If it is not significant (note Hurlin (2004) provides the exact critical values when T is small), the *HINC* hypothesis is accepted. This result implies that the variable x is not causing y in all the countries of the sample. Hence, the non-causality result is then totally homogenous and the testing procedure goes no further.

If the *HINC* is rejected then two possibilities exist. The first is that there is a causal relationship between the two variables for each country and that this relationship is identical for all countries in the sample. This is termed homogenous causality (*HC*) and is very unlikely to occur. The more plausible hypothesis is that the causal relationships differ across countries. This is referred to as heterogeneous non-causality (*HENC*) and is the test of $H_0 : \phi_{i,k} = 0 \; \forall i \in \left[1, N\right], \forall k \in \left[0, p\right]$ against $H_1 : \phi_{i,k} \neq 0 \; \forall i \in [1, N], \forall k \in [0, p]$ with $F_{HC} = \dfrac{(SSR_r^{"} - SSR_u)/p]}{SSR_u/\left[NT - N(1+2p) - p\right]}$.

2.2. Panel Causality Non-linear Tests

Non-linear causality tests were first introduced by Baek and Brock (1992) using nonparametric methods of spatial probabilities. Harvey and

Leybourne (2007) criticized these tests on the grounds that they failed to provide appropriate statistics and suggested using the following regression model to test that *EDEBT* causes *FXLT*:

$$FXLT = \beta_0 + \beta_1 EDEBT_{it-1} + \beta_2 EDEBT_{it-2}^2 + \beta_3 EDEBT_{it-3}^3 + \beta_4 \Delta EDEBT_{it-1} + \beta_5 (\Delta EDEBT_{it-1})^2 + \beta_6 (\Delta EDEBT_{it-1})^3 \quad (3)$$

A similar expression can be derived for *FXLT* causes *EDEBT* by interchanging *EDEBT* and *FXLT* in Equation (3). The same steps that were undertaken with the Hurlin (2004) linear panel causality approach can then be followed.

2.3. Data

To arrive at a consistent data set, an initial group of countries was reduced to 32 developing countries and estimated over the annual period 1998 to 2008. Long- and short-term, foreign currency and local currency ratings were sourced from Standard and Poor's (S&P) website. The external debt data, expressed as a percentage of exports of goods, services and income and the fiscal balance, given as the cash surplus/deficit as a percentage of GDP were obtained from the World Bank's World Development Indicators. The other variables – GDP growth and inflation (percentage change in the consumer price index) – were extracted from the IMF's International Financial Statistics database.

3. Empirical Results

Panel unit tests indicated that all the variables are stationary in levels (results available on request). Hence the panel Granger causality methods

can be conducted on the statistical significance of the regression coefficients using the above mentioned Wald statistics.

3.1. Linear Panel Causality Results

Given that the variables were stationary in levels the panel regression equations were estimated in levels using the pooled ordinary least square (OLS) model and the fixed effects (LSDV) model. The pooled model assumes that the intercept (α) and slope coefficients (γ and β) do not vary across countries, while LSDV allows for a changing α. In general, results of the HINC test (see Table 1) across the estimation approaches employed and the lag lengths all suggest that the null of no homogenous and instantaneous causality between external debt and sovereign ratings, or from sovereign ratings to external debt cannot be accepted at conventional significant levels. In other words, there appears to be a bi-directional causal relationship between external debt and sovereign ratings. Table 1 also shows that these results are robust to the inclusion of controls variables that capture the effects of the fiscal balance, per capita income, inflation and GDP growth rate on external debt and sovereign ratings.

Given that there is evidence of causality between these two variables, the authors then investigate whether the causality is sourced from heterogeneous causal relationships for each country (see Tables 2). The HENC results (Table 2) show that there is a bi-directional relationship between sovereign ratings and external debt in 26 of the 32 countries

studied; the other 6 - Bolivia, Brazil, Indonesia, Pakistan, Peru, and Uruquay - reveal no causality between external debt and sovereign ratings.

Table 1: Homogenous and Instantaneous Non-Causality Tests (No Controls and Controls)

		HINC (No Controls)		**HINC (With Controls)**	
	Lags	OLS – Levels	Fixed effects – Levels	OLS – Levels	Fixed effects – Levels
$EDEBT \rightarrow FXLT$	1	22.31***	-7.08***	21.75***	-7.14***
	2	21.06***	-7.28***	20.55***	-7.36***
	3	19.96***	-5.26***	19.52***	-5.00***
$EDEBT \rightarrow FXST$	1	23.94***	-3.64***	23.37***	-3.74***
	2	22.61***	-3.68***	22.13***	-3.70***
	3	21.27***	-2.80***	20.89***	-2.58**
$FXLT \rightarrow EDEBT$	1	23.01***	-3.38***	22.45***	-3.57***
	2	22.85***	0.019	22.33***	-0.05
	3	22.37***	3.23***	21.85***	4.36***
$FXST \rightarrow EDEBT$	1	24.26***	-1.69*	23.68***	-2.01**
	2	24.02***	0.422	23.42***	0.35
	3	23.23***	1.69*	22.61***	2.45**

Note: ***,** and * indicates significance at the 1,5 and 10 percent level, respectively.

Table 2: Heterogeneous Granger Linear Causality Tests

Count	*EDEBT → FXLT*	*EDEBT → FXST*	*FXLT → EDEBT*	*FXST → EDEBT*
ARG	-2.85***	-1.93*	4.90***	4.45***
BGR	4.31***	4.15***	-2.66***	-2.24**
BOL	-1.51	-1.09	0.29	0.93
BRA	-0.92	-0.61	-0.28	0.24
CHL	5.66***	6.98***	-4.01***	-3.46***
COL	1.72*	1.53	-2.16**	0.94
CRI	6.69***	6.37***	-4.22***	-3.24***
DOM	4.56***	6.17***	-3.20***	-2.90***
EGY	3.81***	3.27***	-3.79***	-.2.66***
IDN	-0.03	0.78	-0.39	-0.38
IND	4.05***	3.84***	-3.52***	-2.54**
JAM	2.59**	3.91***	-1.69*	-1.03
JOR	3.68***	3.66***	-3.37***	-2.40**
KAZ	3.91***	3.89***	-1.80*	-1.21
LTU	8.12***	9.14***	-3.91***	-3.29***
LVA	3.55***	3.86***	-1.84*	-1.01
MAR	3.50***	3.08***	-3.67***	-2.67***
MEX	7.0***	7.08***	-4.04***	-3.25***
MYS	11.25***	11.45***	-5.23***	-4.43***
PAK	-0.69	0.25	0.51	-0.14
PER	-0.26	-0.14	-1.31	-0.33
PHL	3.78***	3.64***	-3.31***	-2.056**
POL	6.25***	6.88***	-3.79***	-3.10***
PRY	2.11**	2.93***	-2.50**	-1.90*
ROM	4.72***	4.85***	-2.05**	-1.76*
RUS	4.18***	4.47***	-2.31**	-2.44**
SLV	5.17***	4.36***	-3.25***	-2.00**
THA	7.19***	7.93***	-4.85***	-4.13***
TTO	1.75*	2.16**	-1.71*	-1.14
TUN	5.16***	4.89***	-3.43***	-2.46**
URY	0.14	0.64	0.13	0.53
ZAF	9.06***	9.44***	-4.71***	-3.91***

Note: ***,** and * indicates significance at the 1,5 and 10 percent level of testing, respectively.

3.2. Non Linear Panel Causality Results

Non-linear Granger causality between debt and credit ratings can be tested using Equation (3) and its variant. The results (see Table 3) confirm the findings of the linear causality methods that there is a bi-directional relationship between these two variables. Using the HENC tests bi-directional causality is evident for fifteen countries, namely: Bulgaria, Chile, Costa Rica, Dominican Republic, Indonesia[1], Lithuania, Mexico, Malaysia, Poland, Romania, Russia, El Salvador[3], Thailand, Tunisia and South Africa (see Table 4). The tests further confirm that short and long-term foreign currency ratings are instrumental in the determination of the external debt level of all the countries in the sample, with the exception of Argentina.

[1] The results also show that for El Salvador and Indonesia, there is only a uni-directional relationship from debt to long-term foreign currency rating, and there is no such link from debt to the short-term rating.

Table 3A: Non-Linear Causality Results: Dependent Variable (FXLT and FXST)

		FXLT		**FXST**	
Causal Variable	Lags	Coefficient	T-Statistic	Coefficient	T-Statistic
Edebt	1	0.16	31.37***	0.06	30.08***
$Edebt^2$	2	0.00	-11.70***	0.00	-10.61***
$Edebt^3$	3	0.00	0.21	0.00	0.03
Ln(Edebt)	1	-0.13	-7.49***	-0.04	-6.79***
$Ln((Edebt)^2$	1	0.00	-2.62***	0.00	-2.57**
$Ln(Edebt)^3$	1	0.00	-2.61***	0.00	-2.68**

Table 3B: Non-Linear Causality Results: Dependent Variable (EDEBT)

Causal Variable	Lags	Coefficient	T-Statistic
FXLT	1	31.01	11.52***
$FXLT^2$	2	-2.30	-6.81***
$FXLT^3$	3	0.05	3.96***
Ln(FXLT)	1	-36.12	-5.30***
$Ln(FXLT)^2$	1	2.20	2.97***
$Ln(FXLT)^3$	1	-0.02	-0.14

Table 3C: Non-Linear Causality Results: Dependent Variable (EDEBT)

Causal Variable	Lags	Coefficient	T-Statistic
FXST	1	69.06	11.61***
$FXST^2$	2	-11.40	-5.97***
$FXST^3$	3	0.51	2.70***
Ln(FXST)	1	-109.50	-8.10***
$Ln(FXST)^2$	1	5.88	1.44
$Ln(FXST)^3$	1	-0.17	-0.23

Note: ***,** and * indicates significance at the 1,5 and 10 percent level of testing, respectively.

Table 4: Heterogeneous Granger Non-Linear Causality Tests

Countr	*EDEBT → FXLT*	*EDEBT → FXST*	*FXLT → EDEBT*	*FXST → EDEBT*
ARG	-0.01	0.00	5.24	12.66
BGR	0.03*	0.01*	-11.11***	-36.44***
BOL	-0.01	0.00	-7.08*	-23.77**
BRA	0.00	0.00	-6.41**	-23.62*
CHL	0.05***	0.02***	-11.62***	-30.00***
COL	-0.01	0.00	-11.26***	-32.79***
CRI	0.09***	0.03***	-17.96***	-52.99***
DOM	0.04***	0.03***	-20.30***	-50.71***
EGY	0.02	0.00	-15.11***	-49.23***
IDN	-0.03**	0.00	-9.55***	-30.27***
IND	0.03	0.01	-14.85***	-43.75***
JAM	-0.01	0.00	-13.79***	-40.34***
JOR	0.01	0.01	-15.62***	-48.27***
KAZ	0.01	0.00	-8.56***	-26.89***
LTU	0.09***	0.04***	-11.83***	-30.60***
LVA	0.02	0.01**	-5.96**	-14.97*
MAR	0.02	0.00	-15.52***	-49.09***
MEX	0.08***	0.03***	-14.35***	-40.62***
MYS	0.34***	0.12***	-15.83***	-44.66***
PAK	-0.02	0.00	-6.99*	-28.41***
PER	0.00	0.00	-8.52**	-28.28***
PHL	0.01	0.00	-15.14***	-42.61***
POL	0.05***	0.02***	-11.99***	-33.63***
PRY	-0.02	0.00	-20.13***	-46.30***
ROM	0.02*	0.01**	-10.85***	-33.63***
RUS	0.03*	0.01**	-11.12***	-35.06***
SLV	0.03**	0.01	-13.44***	-40.68***
THA	0.13***	0.05***	-15.88***	-43.64***
TTO	0.01	0.01	-5.70**	-19.22*
TUN	0.03**	0.01**	-11.97***	-36.09***
URY	-0.01	0.00	-6.91**	-18.35*
ZAF	0.17***	0.07***	-15.56***	-43.714***

Note: ***,** and * indicates significance at the 1,5 and 10 percent level of testing, respectively.

4. Conclusion

This paper investigates the causal relationship between sovereign ratings and external debt for 32 developing countries over the period 1998-2008. The findings from the linear and non-linear panel causality analysis show that there is a bi-directional causal relationship between sovereign ratings and external debt in several of the countries studied even after adjustments are made for the effects of per capita income, inflation and GDP growth rate. One implication of this evidence is that the downgrading of a country's sovereign rating, particularly in tough times when a country may need to secure additional debt, can actually exacerbate the debt problem. Not only will the cost of hedging against losses on the country's debt rise but the downgrade means some institutional investors will no longer be allowed to buy the country's debt under the terms of their investment mandate and could lead to still higher borrowing costs.

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