EXTERNAL DEBT AND GDP RELATIONSHIP: 
A DYNAMIC ANALYSIS FOR TURKEY

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ABSTRACT

External debt and GDP relationship is mostly investigated empirically for different countries in the literature. Most of these studies employ co-integration and Granger causality tests and assume a static link. This study differentiates from existing papers by employing Kalman Filter algorithm in order to analyze time varying empirical link between external debt and GDP.

In this paper, we investigated external debt and GDP relationship for 1989Q4-2011Q4 periods. Firstly, we analyzed stationarity characteristics of series employing various unit root tests and all series found in I(1). Then, we investigated co-integration relationship between GDP and external debt employing Bound test approach proposed by Peseran at al. 2001 and found long run co-integration relationship between external debt and GDP. Finally, we analyzed external debt elasticity of income dynamically by employing Kalman Filter models.

The empirical results suggest that external debt elasticity of income is decreasing in 1994 and 2001 crises period and then increasing after last quarter of 2002 which coincides with the political stability term of Turkey. These findings support success of efficient debt management and fiscal policy after crises period.

Keywords: External Debt, Bound Test, Kalman Filter, Turkey
JEL Codes: H63; C22,
I. INTRODUCTION

The main objective of the countries is to increase the gross domestic product as well as to improve the social and economic development of society. This objective could be realized with sustainable economic growth which becomes a very important challenge for developing countries facing the budget deficit caused by the gradually expanding current account deficit and the high level of debt service, especially external debt service.

The domestic resources of developing countries remain insufficient to maintain a sustainable economic growth. This inadequacy of domestic resources is especially due to inter-countries differences and inequitable distribution of resources among countries. Actual saving gap in developing countries raises the need of external funds for financing of investments. This gap is also viable for the Turkish economy. Especially after 1950, due to the lack of qualified labor force and technology, external debt has increased to maintain sustainable economic growth.

External debt was firstly defined in 1984 by the working group of external debt statistics of four international institutions including IMF, World Bank, Bank of International Settlements (BIS) and OECD as follows; external debt, at any given time, is the outstanding amount of those actual current, and not contingent, liabilities that require payment(s) principal and/or interest by the debtor at some point(s) in the future and that are owed to nonresidents by residents of an economy (Klein, 1994).

Between 1994-2001 period Turkey faced three economic crises and two of them had reflected Turkey’s own economic imbalances directly. After 2001 crises period, Turkish economy became more stable because of the political and structural transformation. The external debt stock of Turkey was $113.6 billion in 2001 and reached $208.4 billion by 2006 and $306.7 billion in 2011.

Most of the studies in the literature investigate the relationship between external debt and economic growth employing co-integration and Granger causality tests and assume a static link. This study differentiates itself from existing works by employing the Kalman filter algorithm in order to account for time varying empirical link between external debt and GDP.

The paper is organized as follows. The next section briefly introduces literature review. Section 3 presents data and methodology. Section 4 shows empirical results and section 5 includes the conclusion.
II. LITERATURE REVIEW

Many empirical studies especially focus on heavily indebted poor countries and analyze external debt and economic growth relationship via different econometric techniques including co-integration, causality analysis and GMM and panel data analysis in the literature.

Chowdhury (1994) investigated public and private external debt and GNP relationship for developing and debtor Asian and Pacific countries between 1970 and 1988 by employing Granger causality test. He found public and private sector external debts have a small and negative effect on GNP.

Clements et al. (2003) analyzed how external debt affects economic growth for low income countries. They investigated external debt and economic growth relationship for 55 low income countries for 1970-1999 periods employing panel data analysis and GMM method. They found that a decrease in the external debt stock has a direct positive effect on GDP per capita growth in low income countries, which means that there is negative relationship between external debt and economic growth.

Scharek (2004) investigated the relationship between external debt and economic growth using data set of 59 developing and 24 developed countries for 1970-2002 period employing panel data analysis and generalized method of moments (GMM) model. He found negative and significant relationship between external debt and economic growth in developing countries. Moreover, he analyzed effects of public and private sector external debt on economic growth separately and found negative relationship from public external debt to economic growth but not vice versa.

Cordella et al. (2005) investigated how the relationship between external debt and economic growth changes according to debt level in developing countries employing panel data and General Methods of Moments (GMM) model for 79 developing countries covering the period 1970-2002. They found negative relationship between external debt and economic growth in the cases of no excessive debt burden.

Wijeweera et al. (2005) investigated external debt and GDP and economic growth relationship for Sri Lanka for the 1952-2002 period employing co-integration analysis and error correction model. They found negative but statistically insignificant relationship between external debt service and Gross Domestic Product (GDP) in the long term and statistically insignificant relationship in the short-term.

Ogunmuyiwa (2011) investigated external debt and economic growth relationship for Niger using time series data for the period 1970 - 2007 within the framework of an error correction model. According to the empirical results, he found weak and statistically insignificant relationship between external debt and economic growth and he could not find any causality relationship between economic growth and external debt.

There are also studies which investigated the external debt and economic growth relationship for Turkey. These studies are as Karagöl (2002), Javed and Şahinöz (2005), İpek and Yaşar (2008) and Uysal (2009).

Karagöl (2002) examined the relationship between external debt burden and economic growth for Turkey using five variables VAR model employing co-integration and Granger causality analysis. He found external debt burden negatively affects economic growth in the long run. Furthermore, he found unidirectional causality from external debt to GDP for Turkey.

Javed and Şahinöz (2005) investigated effects of external debt on investment, export and economic growth for Turkey covering the 1983-2002 period and stated that external debt has a negative effect on investment and positive effect on exports, however no effect on economic growth.

İpek and Yaşar (2008) analyzed the relationship between economic growth and external debt within the framework of the co-integration and causality analysis with data from 1989 to 2007. They concluded that there is a co-integration between external debt and economic growth and they found bidirectional causality between external debt and economic growth in both long term and short term.

Uysal et al. (2009) investigated external debt and economic growth relationship for Turkey covering the 1965-2007 period by employing VAR model and found negative relationship between external debt and economic growth.

Most of these studies in the literature concentrate on external debt and economic growth relationship. In this study, we investigated external debt and GDP relationship different from literature.
III. DATA AND METHODOLOGY

In this study, we tried to investigate the relationship between external debt and Gross Domestic Product (GDP). We used quarterly real GDP and real external debt series covering the period 1989Q4-2011Q4.

The real GDP series in 1998 constant thousand Turkish Liras were obtained from Turkish Statistical Institute. Real GDP series between the 1989Q4-1997Q4 period were obtained by employing 1987 based constant GDP growth rates. External debt series were obtained from Undersecretariat of Treasury converted to Turkish Liras using average the exchange rate and deflated by employing GDP deflator. Both real GDP and real external debt series were seasonally adjusted using the Tramo-Seats methodology and measured in natural logarithms similar to the empirical literature and natural logarithms of GDP and external debt were denoted as LY and LDB respectively.

Firstly, we analyzed stationarity properties of the series by employing mostly used unit root tests in empirical studies including ADF, PP and Ng-Perron tests in empirical analysis.

After determining stationarity properties for series, we investigated the existence of the long term co-integration relationship between real GDP and real external debt series employing Bound Test developed by Pesaran et al. (2001). Bound test approach has some advantages over the conventional co-integration models. Firstly, The Bounds testing approach can be employed irrespective of whether the regressors are purely I(0) or I(1) (Peseran et al., 2001). Secondly, the bound test co-integration approach has superior properties in small sample sizes than other co-integration approaches (Narayan and Narayan, 2004; Mangir and Ertuğrul, 2012).

Finally, we investigated dynamic relationship between external debt and GDP by following a dynamic approach employing Kalman filter to depict the time varying interaction between external debt and economic growth.

IV. RESULTS

IV.1. Unit Root Tests

Firstly, we investigate stationarity characteristics of series. In this respect, we employed ADF (1979), PP (1988) and Ng-Peron (2001) tests. The results of unit root tests are presented in Table 1.
Table 1: Unit Root Test Results

<table>
<thead>
<tr>
<th>Test Results</th>
<th>LY</th>
<th>ΔLY</th>
<th>%1=-4.066</th>
<th>%5=-3.462</th>
<th>ADF critical values for LY and ΔLY</th>
<th>%1=-3.507</th>
<th>%5=-2.895</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADF Test Results</td>
<td>-2.645</td>
<td>-9.188*</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>LDB</td>
<td>-1.907</td>
<td>-8.290*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP Test Results</td>
<td>-2.883</td>
<td>-9.16*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDB</td>
<td>-2.094</td>
<td>-8.289*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ng-Perron Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ng-Perron critical values for LY and LDB series; MZa, MZt, MSB, MPT respectively; %1 significance level -23.80, -3.42, 0.14 and 4.03 %5 significance level for -17.30, -2.91, 0.17 and 5.48.</td>
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</table>

According to Table 1,

- For ADF and PP tests, the null hypothesis suggests that the series include unit root. The calculated t statistics for all variables are less than the critical values in their level forms for both ADF and PP tests. Thus, the null hypothesis cannot be rejected, suggesting that all variables are nonstationary in their level forms. The results of the first differenced variables show that the calculated t statistics for all variables are greater than the critical values at %1 levels, suggesting that all variables are integrated of order I(1) according both ADF and PP tests.

- For Ng-Peron test, according to $MZ_a$, $MZ_t$ tests the null hypothesis indicates that the series have unit root and according to MSB and MPT tests the null hypothesis indicates that the series are stationary. For $MZ_a$, $MZ_t$ tests, the calculated t statistics for LY and LDB are less and for MSB and MPT tests the calculated t statistics for LY and LDB are greater than the critical values suggesting that LY and LDB are nonstationary in their level forms. For the first difference of series, according to $MZ_a$,
tests, the calculated t statistics for LY and LDB are greater and for MSB and MPT tests the calculated t statistics for LY and LDB are less than the critical values at 1% levels, suggesting that LY and LDB become stationary after differencing so that LY and LDB series are I (1) according to Ng-Peron tests.

In summary, unit root tests shows that LY and LDB series are stationary after differencing so that LY and LDB series are I(1).

IV.2. Bound Test Co-Integration Approach

After investigating stationarity of series, we analyze co-integration relationship between real GDP and real external debt by employing Bounds Test approach developed by Pesaran et al. (2001). For the Bound test analysis, we firstly formed the Unrestricted Error Correction model (UECM). UECM specification for our study is shown in equation 1.

\[ \Delta L Y_t = \alpha_0 + \alpha_1 t + \sum_{i=1}^{m} \alpha_{2i} \Delta L Y_{t-i} + \sum_{j=0}^{m} \alpha_{3j} \Delta LDB_{t-j} + \alpha_4 L Y_{t-1} + \alpha_5 L DB_{t-1} + \mu_t \]

Where, LY is log of real GDP, LDB log of real external debt. In UECM model in equation 1, “m” represents number of lags and “t” represents trend variables.

For testing co-integration relationship, the statistic underlying the procedure is the Wald or F-statistic in a generalized Dickey-Fuller type regression, which is used to test the significance of lagged levels of the variables under consideration in a conditional UECM (Narayan and Narayan, 2004). Null hypothesis for F test is established as \( H_0 = \alpha_4 = \alpha_5 = 0 \) for our study and calculated F statistics is compared with table bottom and upper critical levels in Pesaran et al. (2001). If the computed F-statistic falls outside the critical bounds, a conclusive decision can be made regarding co-integration without knowing the order of integration of the regressors. For instance, if the empirical analysis shows that the estimated F statistics is higher than the upper bound of the critical values, then the null hypothesis of no co-integration is rejected. If the estimated F statistics is lower than the bottom bound of critical values, there is no co-integration relationship between the series (Narayan and Narayan, 2004). If the calculated F statistics is between the bottom and upper critical values, no exact opinion can be made (Karagöl, Erbaykal and Ertuğrul, 2007).
Maximum lag number for UECM model is taken 8 and according to Schwarz criteria and lag number is found 1\(^3\). After determining lag number of UECM model, we investigate co-integration relationship by comparing the computed F-statistic from UECM model with table bottom and upper critical levels in Pesaran et al. (2001). Table 2 shows the bound test results.

**Table 2. Bound Test Results**

<table>
<thead>
<tr>
<th>K</th>
<th>F statistics</th>
<th>Critical Value at 5% Significance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Bottom Bound</td>
</tr>
<tr>
<td>1</td>
<td>8.33</td>
<td>6.56</td>
</tr>
</tbody>
</table>

\(k\) is number of independent variable number in equation 1. Critical values are taken from Table C1.v at Pesaran et al. (2001:300)

According to Table 2, F statistics is higher than the upper bound of the critical values; therefore the null hypothesis of no co-integration is rejected. As a result, we found a significant long run co-integration relationship between real GDP and real external debt according to Bound test analysis.

### IV.3. Dynamic Approach

In order to investigate dynamic relationship between real GDP and real external debt, we employ dynamic approach on a classical reference of Harvey (1990) that introduces Kalman filter approach. The Kalman filter approach is based on a form of state space representation. A linear state space of the dynamics of an equation can be represented as

\[
y_t = c_t + Z_t \alpha_t + \epsilon_t
\]

\[
\alpha_{t+1} = d_t + T_t \alpha_t + \nu_t
\]

where in our case \(\alpha\) is a 2x1 vector of unobserved state variables, where, \(c_t, Z_t, d_t, \) and \(T_t\) are adaptable vectors and matrices, and where \(\epsilon_t\) and \(\nu_t\) are vectors of mean zero, Gaussian disturbances. As stated in equation (3), unobserved state vector \(\alpha_t\) is assumed to change over time as a first-order vector auto-regression. The Kalman filter recursively estimates the parameters by updating the estimation with every additional observation (Ertuğrul, 2012).

The Kalman filter specification used in our study is presented in equations 4 and 5 below.

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\(^3\) Serial correlation for UECM model investigated by employing Breusch-Godfrey serial correlation LM test and no serial correlation found in UECM model. Test results can be taken from the authors.
\[ LY_t = a_0 + a_{i,t} LDB_t + \varepsilon_t \]  \hspace{1cm} (4)

\[ a_{i,t} = a_{i,t-1} + \nu_{i,t} \]  \hspace{1cm} (5)

The \( a_{i,t} \) coefficient in equation (4) indicates external debt elasticity of income. External debt elasticity of income shows percentage change in income in response to a one percent change in external debt. If external debt elasticity of income increases, same proportion external debt change will cause more income change.

The time varying parameter estimates for external debt elasticity of income employing Kalman Filter approach in 1994Q1-2011Q3 period are shown in Figure 1. The parameter estimates for all variables of Kalman Filter approach are statistically significant.

**Figure 1: Parameter Estimates for External Debt Elasticity of Income**

Our results show that external debt elasticity of income decreases in crises period of Turkey including 1994 and 2001 and then begins to increase after last quarter of 2002 which coincide with the political stability term of Turkey.

**V. CONCLUSION**

The domestic resources of developing countries remain insufficient to maintain a sustainable economic growth. This inadequacy of domestic resources is especially due to inter-countries differences and inequitable distribution of resources among countries. Actual
saving gap in developing countries raises the need of external funds for financing of investments.

External debt and economic growth and GDP relationship is mostly investigated empirically for different countries by employing various econometric techniques in the literature. Most of these studies employ co-integration and Granger causality tests and assume a static link. This study differentiates from existing papers by employing Kalman Filter algorithm in order to analyze time varying empirical link between external debt and GDP.

In this study, we try to investigate dynamic relationship between external debt and GDP for Turkey. The study uses quarterly real Gross Domestic Product (LY) and real external debt (LDB) series covering the period 1989Q4-2011Q4.

In empirical analysis firstly, we analyzed stationarity properties of the series by employing ADF, PP and Ng-Perron tests and all unit root tests shows that LY and LDB series are stationary after differencing so that LY and LDB series are I(1).

Then, we investigated the existence of the long term co-integration relationship between real GDP and real external debt series employing Bound Test developed by Pesaran et al. (2001) and found a significant long run co-integration relationship between real GDP and real external debt according to Bound test analysis.

Finally, we investigated dynamic relationship between external debt and GDP by following a dynamic approach employing Kalman filter. Our results show that external debt elasticity of income decreases in crises period of Turkey including 1994 and 2001 and then begins to increase after last quarter of 2002 which coincide with the political stability term of Turkey. These findings are compatible with prudential fiscal and monetary policy stance of Turkey after 2001 crises period and support success of efficient debt management and fiscal policy after crises period.
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