University of Innsbruck

Fiscal policy, trigger points and interest rates: Additional evidence from the U.S.

Gerhard Reitschuler, Rupert Sendlhofer

Working Papers in Economics and Statistics

2011-23

Research Platform eeecon Empirical and Experimental Economics

University of Innsbruck
http://eeecon.uibk.ac.at/

Fiscal policy, trigger points and interest rates: Additional evidence from the U.S.

Gerhard Reitschuler* Rupert Sendlhofer†

Abstract

We empirically investigate whether the relationship between interest rates and public deficits/debt may be nonlinear for the U.S. Using threshold estimation, we find evidence of level-dependent effects on interest rates, implying a significant effect of projected deficits and debt in the U.S. only if the deficit surpasses approximately 5% of GDP.

JEL classification: E43, E62, H62

Keywords: Public debt, public deficit, long-term interest rates, nonlinearity, threshold models, Domar model.

*Corresponding author; Department of Economics, *University of Innsbruck*, Universitätsstrasse 15, A-6020 Innsbruck, Austria, *E-mail address*: **gerhard.reitschuler@uibk.ac.at**

†Department of Public Finance, *University of Innsbruck*, Universitätsstrasse 15, A-6020 Innsbruck, Austria, *Phone* (+43 512 5077158) , *Fax*: (+43 512 5072788) , *E-mail address*: **rupert.sendlhofer@uibk.ac.at**

1 Introduction

The financial crisis and its subsequent recession resulted in huge increases of public deficits all over the world. This holds also true for the U.S.: In the pre-crisis years (2001-2007) the U.S. budget deficit (i.e., the net lending position of the general government) amounted to 3.2% of GDP on average but rose to 6.5%, 9.9% and 8.9% in the subsequent years. The forecasts for 2011 and 2012 are 9.8% and 7.0%, respectively (CBO, 2011). Recently, debates around the evolution of U.S. debt have emerged again, mainly in the context whether and by how much to extend the debt ceiling which was at approximately 14 trillion U.S. dollars as of July 2011. The point is that the failure to extend the debt limit would have rendered the U.S. government unable to pay its obligations, thus causing a default with obvious repercussions.[1] As a consequence of an insufficient fiscal consolidation plan and a relatively fast rising debt-to-GDP ratio the U.S. credit rating was downgraded by Standard & Poor's. Hence, in order to stabilize the debt-to-GDP ratio and prepare for long-run challenges (such as ageing of the population or growth in public health-care expenditures) the deficit needs to be reduced. This task is even more pressing if there are effects of fiscal variables on the interest rate.[2]

In general, the search for an (empirical) answer regarding the nature of the link between interest rates and fiscal variables is long and challenging. A priori, the effect of deficits on interest rates is unclear. According to textbook theory increasing deficits will raise interest rates (the conventional view) whereas Ricardian equivalence suggests that individuals view deficits as postponed tax liabilities, thus deficits should have no effects on interest rates. One possible explanation for this latter finding is that interest rates are related much more to the expectation of future budget deficits than to current and past budget deficits.

There is an extensive empirical literature on interest rate effects of public deficits and debt, most studies deal with estimating these effects for the U.S.[3] Generally, the empirical evidence is mixed (see Gale and Orszag, 2003): papers using deficit projections, such as the ones by Gale and Orszag (2004) or Laubach (2009), tend to show significant positive effects of deficits on interest rates. Results from studies using a VAR-framework are more

[1] Zivney and Marcus (1989) find that the only known instance of technical default in the U.S. in 1979 caused a 60 basis point increase in T-bill rates.

[2] The Council of Economic Advisers (2003) estimates that interest rates rise by about 3 basis points for every additional $200 billion in government debt.

[3] For Europe see, e.g., Faini (2006), Afonso (2010) or Marattin and Salotti (2010).

ambiguous: Engen and Hubbard (2004) find significant effects of government debt on the long-term real rate of interest; Evans and Marshall (2007), who analyze which type of shock affects interest rate variability, find no evidence that fiscal policy shocks have an effect on the interest rate.

Several recent contributions have assessed interest effects of fiscal variables within a panel setting: Ardagna et al. (2007) find significant effects of deficits/debt on long-term interest rates using a nonlinear specification for a panel of 16 OECD countries. In accordance with these results, Baldacci and Kumar (2010) show that higher deficits/debt lead to a significant increase in long-term interest rates for a panel of 31 countries. The magnitude of this effect depends on country specific characteristics (e.g., fiscal and institutional conditions) and spillovers from global financial markets.

All in all, even though most studies in the recent literature finds an effect of deficits/debt on the interest rate in the U.S., the overall evidence is still ambiguous which may be due to the fact that nonlinearity has been discarded. Nonlinear effects have been considered in the literature by estimating the underlying model using square terms (e.g., Ardagna et al., 2007), country-specific characteristics (e.g., Baldacci and Kumar, 2010) or sub-samples of countries (e.g., Marattin and Salotti, 2010).[4] We contribute to this literature by applying another methodology and showing that there are indeed such nonlinear effects. In addition, we demonstrate how such nonlinear impacts can change the standard results in the tradition of Domar (1944) and hence the leeway of fiscal policy.

The paper is organized as follows: Section 2.1 introduces the empirical model and the regression results for the linear case, section 2.2 sketches the idea of nonlinearity and the corresponding empirical results. Section 3 shows some simulations of rising deficits/debt under the hypothesis of nonlinearity and section 4 concludes.

[4] Laubach (2009) discusses structural breaks in the fiscal coefficients, but he does not consider nonlinear effects. In a more recent paper (Laubach, 2011) he actually mentions the possibility of nonlinearity with regard to the interest rate-deficit nexus.

2 Empirical results

2.1 The baseline model

For our empirical investigation we use annual as well as semiannual data for the U.S. from 1976 to 2011.[5] In testing the relationship between deficits/debt and interest rates we use the baseline specification in Laubach (2009).[6] Thus, the baseline regression is:

$$E_t i_{t+k} = \beta_0 + \beta_1 E_t \pi_{t+k} + \beta_2 E_t f_{t+k} + \beta_3 E_t u_{t+k} + \epsilon_t \quad (1)$$

where the dependent variable is the long-term nominal interest rate expected to exist k periods ahead (in most regressions we use the five-year-ahead ten-year forward rate calculated from the the zero-coupon yield curve), f_{t+k} is the given measure of fiscal policy, i.e. (projections of) government deficits/debt (we use the five-year-ahead projections from the U.S. Congressional Budget Office (CBO henceforward)), $E_t \pi_{t+k}$ is an indicator for expected inflation,[7] and u_{t+k} stands for additional regressors. As additional regressors we use the dividend yield and the trend growth rate.

Insert Table 1 around here

The results of the linear model with annual as well as semiannual data show that public deficits and debt seem to have a significant positive effect on the long-term interest rate.[8] Two of the control variables, namely the dividend yield and the trend growth rate, turn out insignificant, inflation expectations turn out positive and significant as expected.[9]

One issue to be mentioned is endogeneity. The main problem with regard to the underlying specification is potential reverse causality since the effects of fiscal policy can hardly be

[5] A detailed documentation of the data can be found in the appendix.

[6] Other specifications have been tried as well, using other variables does not change the results significantly. The results are available upon request.

[7] Lindé (2001) states that the use of expected inflation in the empirical specification plays a role, i.e., conventional view is supported when a proxy for expected inflation is used.

[8] Note that all regressions using semiannual data suffer from autocorrelation. This is due to the fact that deficits/debt projections of the CBO in January and in mid-year are relatively similar (the correlation coefficient is 0.90). Thus the regressions using semiannual data have to be treated with caution. Adding an AR-term changes the results slightly, the main conclusions, however, stay the same.

[9] Engen and Hubbart (2004) note that instead of using levels of interest rate and debt changes should be used. Using changes renders some of the control variables insignificant, however, the main effect of deficits and debt stays the same.

isolated from other factors affecting interest rates such as, for instance, the business cycle. Since automatic fiscal stabilizers increase deficits during recessions, whereas at the same time long-term interest rates decrease due to an expansive monetary policy stance, deficits and interest rates may be negatively correlated even though the partial effect of deficits on interest rates is positive. As mentioned by Laubach (2009) one solution is to use fiscal variables and interest rate projections several years into the future which are likely to be little affected by the current state of the business cycle, which is also the strategy followed in this paper. Hence the estimation results above and below should not suffer too much by reverse causality. However, in order to test statistically whether the underlying specification should take endogeneity into account (i.e., whether it should be estimated using instrumental variables), the Durbin-Wu-Hausman test was performed. The test statistic for annual (semiannual) data takes the value of 0.426 (0.852), hence we cannot reject the null that OLS estimation yields consistent estimates (i.e., any endogeneity among the regressors would not have deleterious effects on OLS estimates).

2.2 The nonlinear extension

In a recent paper, Laubach (2011) emphasizes the potential relevance of nonlinear effects with regard to the relationship between fiscal variables and interest rates: While usually the effects of government debt or deficits on interest rates seem to be significant but modest, there are situations (particularly in times when default risk becomes an issue) in which interest rates react very sensitively to fiscal policy changes and interest rate effects can thus become very large.

Thus the intuition with regard to the nonlinear relationship between interest rates and government deficits/debt is straightforward:

It is known from the literature of (Non-Keynesian) effects that the relationship between deficits/debt and consumption may be nonlinear (see, e.g., Giavazzi et al., 2000, Giavazzi and Pagano, 1990): Up to a certain level, expansive fiscal policy (i.e., rising deficits and debt levels) stimulates consumption. This effect, however, may revert at some point (of debt level) when consumers feel that an adjustment is about to come which implies that expectations play a central role when a certain trigger point is reached.[10] Indeed, the re-

[10] Bertola and Drazen (1993) hypothesize that significant government spending cuts take place only when the ratio of government spending to output hits a trigger point.

spective literature has found evidence that such expectations do exist. There are certainly reasons to hypothesize that such nonlinear effects may also hold true with respect to the relationship between interest rates and deficits/debt.

In fact, some papers have found such nonlinear effects such as the papers by Ardagna et al. (2007) and Baldacci and Kumar (2010) mentioned above. In addition, Favero and Giavazzi (2007) find that fiscal policy effects on interest rates depend on the path of the debt-to-GDP ratio: these effects are weaker when the debt ratio is on stable path. Reinhard and Rogoff (2010) and Reinhard et al. (2003) in their "debt intolerance" analysis find that thresholds obviously matter with regard to public debt, i.e. as debt levels rise towards historical limits or as countries hit debt intolerance ceilings, risk premia begin to rise sharply. Caporale and Williams (2002) find that when the stock of debt is low, financial markets consider it as high quality and an increase in its level is associated with a fall in interest rates. However, when government debt reaches a threshold, further increases are associated with higher interest rates. These findings also suggest that the relation between long-term interest rates and debt might be nonlinear and depend on the level of the debt. Thus, in a nutshell, thresholds obviously matter when it comes to estimating the effects of deficits and debt on interest rates.

The assumption of nonlinearity raises the question of the appropriate empirical specification to be tested. An initial indication of the presence of nonlinearities can be drawn from Figure 1 that shows the five-year-ahead ten-year forward rate against the CBO's five-year-forecast of deficits and a locally weighted scatterplot smoothing line (see Cleveland, 1993 and 1994). This non-parametric approach fits a local linear regression line for each data point in the sample, weighting the other observations: Data points that are relatively far from the point being evaluated get small weights in the sum of squared residuals, while closer data points get higher weights. The resulting nonlinear curve is presented in Figure 1. The shape of the curve suggests that deficit projections do not affect interest rates up to a certain threshold which then subsequently takes place. Figure 1 in line with the literature mentioned above thus suggests the use of a specification which takes this specific nonlinear form into account.

Insert Figure 1 around here

The empirical investigation of nonlinearity in the relationship between interest rate and debt was formalized in papers by Ardagna et al. (2007), Gruber and Kamin (2010) and Faini (2006). They estimate the nonlinear model adding a square term for the fiscal variable.

Thus the baseline model given by (1) is extended as follows:

$$E_t i_{t+k} = \beta_0 + \beta_1 E_t \pi_{t+k} + \beta_2 E_t f_{t+k} + \beta_3 E_t f_{t+k}^2 + \beta_4 E_t u_{t+k} + \epsilon_t \tag{2}$$

The estimation results can be seen in Table 2. The results using annual and semiannual data show contradicting evidence: as for deficits, the fiscal variable is nonsignificant in levels but positive and significant for the square thus confirming the hypothesis of nonlinearities. As for debt, however, both the simple as well as the quadratic term are nonsignificant.

Insert Table 2 around here

However, assessing nonlinearity by using a square term may actually show a misleading picture as the contradicting results using the square specification already indicate. The main problem is that such a specification approximates a hump- or U-shaped relationship, i.e. the function has to be symmetric. Thus, when the real function is discontinuous, a quadratic model would be misspecified. In order to approximate an asymmetric function, a piecewise-linear methodology may hence be more appropriate. Such a specification can approximate an asymmetric function, at the same time, however, a hump-shaped function is also nested in this approach.

A specification that allows for such an asymmetry is given by

$$E_t i_{t+k} = \beta_0 + \beta_1 E_t \pi_{t+k} + \beta_2^i E_t f_{t+k} + \beta_3 E_t u_{t+k} + \epsilon_t \tag{3}$$

where

$$i = \begin{cases} 1 \; if \; E_t f_{t+k} \leq \gamma \\ 2 \; if \; E_t f_{t+k} > \gamma \end{cases} \tag{4}$$

The specification is, thus, piecewise-linear, and the expected level of government deficits/debt, $E_t f_{t+k}$, is responsible for the regime being active. The threshold parameter, γ, needs to be estimated as well. If γ were known, the estimation of β_2^i, $i = 1, 2$ would be relatively simple by dividing the sample into two subsamples, assigning label 1 and 2 according to (4) and estimating the β_2-parameter for each subsample. However, for the underlying model, following Hansen (2000), the estimation of γ is performed by conducting a grid search on $E_t f_{t+k}$

and estimating (3) for every realized value of $E_t f_{t+k}$.[11] Finding a least squares estimator of γ is achieved by evaluating the sum of squared errors of model (3) for all possible values of γ and choose the estimator $\widehat{\gamma}$ fulfilling

$$\widehat{\gamma} = argmin_{\{E_t f_{t+k}\}} \sum_t \widehat{\epsilon}_t (E_t f_{t+k})^2 \tag{5}$$

that is the value of $E_t f_{t+k}$ which minimizes the sum of squared residuals in (3)-(4).[12]

Another issue is the test for linearity. Testing $\beta_2^1 = \beta_2^2$ under H_0 presents an extra difficulty since the threshold parameter, γ, is only identified under the alternative hypothesis of nonlinearity, thus classical tests (such as the F-test) have nonstandard distributions. The problem is solved by applying a bootstrap procedure where – using the linear relationship – artificial data on the dependent variable is simulated and both a linear and a piecewise linear model with the estimated threshold is calculated.[13] The corresponding test statistic is computed and the procedure is repeated a large number of times, leading to an approximate distribution of the test statistic under the null of linearity. The percentage of replicated test statistics that exceed the original value of the test statistic computed with real data is then the p-value of the linearity test.[14]

Insert Table 3 around here

Insert Table 4 around here

Tables 3 and 4 present the estimated parameters from equation (3)–(4) with annual and semiannual data, together with the test statistic for linearity and the p-value resulting from the bootstrap method described above. While the linear model shows a significant effect of government debt and deficits on interest rates and the addition of a quadratic term leads to contradicting results, these conclusions change if we allow for a nonlinear, level-dependent effect of government debt and deficits on interest rates. The results indicate evidence of nonlinearity at the 0% significance level, and the estimated threshold is at $\gamma = 4.72$ (annual

[11] The grid search is proceeded after trimming a certain percentage (in our case 25%) on the tails of the empirical distribution of $E_t f_{t+k}$ for obvious identification reasons.

[12] See Hansen (1996, 2000) for the properties of this estimator.

[13] See Andrews and Ploberger (1994), Hansen (1996, 2000).

[14] The asymptotic distribution of the likelihood ratio test is nonstandard and strictly dominates the χ^2 distribution. Due to its distribution the critical values cannot be tabulated.

data) and $\gamma = 3.37$ (semiannual data). The significant partial correlation between interest rates and government debt and deficits in the linear model now changes: there is no effect of government debt and deficits on interest rates below the estimated threshold, above the threshold the relationship appears positive and significant and much larger in magnitude than in the linear case. The adjusted R^2 rises by several percentage points as compared to the simple and the squared specification. As a robustness exercise we also estimated the nonlinear model given by (3) using the three-year-ahead five-year forward rate and the three year forecast of deficits/debt (see tables 5 and 6). In both cases the estimates are very much the same as in the baseline nonlinear regressions.

Insert Table 5around here

Insert Table 6 around here

The results (using annual data) imply that there is a significant effect of projected deficits and debt in the U.S. only if the deficit surpasses approximately 5% of GDP. For deficits above the threshold, a percentage point increase in the deficit-to-GDP ratio (debt-to-GDP ratio) raises the interest rate by approximately 40 basis points (5 basis points). This result sheds new light on the interest rate-deficit/debt nexus: the fiscal impulse has to be of a rather large magnitude in order to have an effect on interest rates.

Empirically, the years where (projected) deficits surpass the estimated threshold are from 1982 to 1985, i.e. the period where the military buildup under Reagan took place. It was also the time when actual deficits were substantial (i.e., between 4 and 6 percent of GDP) and when the debt ceiling surpassed one trillion for the first time. In the period from 1981 to 1985 the debt ceiling more than doubled (the cumulative extension amounted to 111%), which was never the case again before and after that time. The massive investment in military in the Cold War years in combination with the substantial extension of the debt ceiling thus may have shaped the expectation among market participants of permanently high future budget deficits with obvious effects on the path of public debt.

3 Simulations

This section shows how our empirical results could change the leeway of fiscal policy. We simulate the implications within the framework of a standard model in the tradition of

Domar (1944).[15] The model shows the limits of the debt-to-GDP ratio (b) and the interest-to-GDP ratio (z) with a constant deficit-to-GDP ratio (d), a constant nominal interest rate (i) and a constant growth rate of nominal GDP (n).[16] The debt-to-GDP ratio converges to $b^* = d/n$ and the interest-to-GDP ratio to $z^* = i(d/n)$ with continuous time.[17]

The limits of b and z are calculated for different values of d and i (in the case of i only if d surpasses the threshold). Thus the long-run effects of a gradual increase in the deficit-to-GDP ratio can be simulated.[18] We use the estimation results based on annual data, therefore the nonlinear effects set in when d surpasses the threshold value of 4.72%.[19] We simulate the effects of increasing deficits on b^*, z^* and on the limit of the primary deficit-to-GDP ratio (dp^*). For a given limit of z we can calculate the limit of dp using $dp = d - z$. If $dp < 0$, there is a primary surplus.

Three scenarios are simulated (see Table 7): In scenario A (the baseline) there are no effects of deficits or debt on the interest rate, in scenario B (C) there is a nonlinear effect of deficits (debt). The following values are used in our calculations: The initial value of i amounts to 7.9% (equivalent to the mean of the long-term nominal interest rate used in our estimations), n is 6.5% (equivalent to the mean of the growth rate of nominal GDP from 1976-2010). d starts with 0% and increases stepwise with 0.1 percentage points thus rising gradually to 12%.

[15] Further developments and extensions of the standard model can be found in Blanchard et al. (1990) and in Frisch (1997).

[16] As we have estimated the effects on the nominal interest rate we use the model in nominal terms. The growth rate n remains at a constant level in the simulations. In a Non-Ricardian world there could be long-run effects of public debt on the growth rate (Zagler and Dürnecker, 2003). Freedman et al. (2009) show within a DSGE model that a permanently higher deficit-to-GDP ratio leads to lower levels of real GDP in the long-run; another recent study (Bassetto and Butters, 2010) demonstrates that there is no positive relationship between high deficits and high inflation in industrialized countries. Hence, the negative effect of deficits/debt on the real growth rate is not counterbalanced. Therefore our simulation results with a constant growth rate of nominal GDP could be quite favorable cases. With a lower growth rate the limits of b and z would be higher.

[17] We concentrate on b^* and z^* as the data and the estimation results can only be meaningfully used for these calculations.

[18] Mind that we are not interested in the short-run effects and in the concrete paths to the limit.

[19] Using semiannual data, the results are very similar. However, in the case of debt effects (scenario C) semiannual data lead to considerably lower limits of z for high deficit-to-GDP ratios. Thus, there is almost no difference between the limits of z and dp in the case of scenario B and C.

The simulations illustrate what would have happened with regard to the limits if the expected deficit-to-GDP ratio had permanently increased to very high levels (e.g., 10% or higher) and how nonlinear effects influence these limits. Table 7 shows selected results for the limits of b, z and dp. The effects on b^* do not depend on the scenario as $b^* = d/n$. The limit of b is increasing from 0.308 (d = 2%) to 1.846 (d = 12%). Figure 2 illustrates the effects on z^* and on dp^*.

Insert Table 6 and Figure 2 around here.

In the baseline scenario of Figure 2 the increase in d leads to an ongoing rise in z^* which is the result of a growing debt-to-GDP ratio (baseline effect). In Scenario B (C) the overall effect consists of the baseline effect and the nonlinear interest rate effect of deficits (debt). The additional effects are not present until passing the threshold level. Scenario C with the nonlinear effect of debt shows the highest limits of z.

The limits of the primary deficit-to-GDP ratio (see Figure 2) represent the effect of different deficit levels on the leeway of fiscal policy. As a result of $i > n$ (which is usually the case) a primary surplus is needed in all scenarios and at all deficit levels to sustain a constant b. The need for a primary surplus increases with the deficit level. The highest primary surpluses are necessary in case of nonlinear debt effects. The nonlinear effects are in some way like pitfalls. Until passing the threshold level only the baseline effect is relevant for the limits of z and dp. After passing the threshold level fiscal policy is suddenly confronted with additional nonlinear effects on the interest rate.

4 Conclusions

This piece of research presents evidence concerning nonlinear effects of fiscal variables on interest rates for the U.S. Using threshold estimation, we find evidence of level-dependent effects of deficits/debt on interest rates, implying that the correlation between interest rates and government debt and deficits appears nonsignificant for levels of deficits below the estimated threshold which is at approximately 5% of GDP. For values of government deficits above the threshold, the relationship appears positive and significant. In other words, the fiscal impulse has to be of a rather large magnitude in order to have an effect on interest rates. In addition, we calculate how these nonlinear effects influence the limits of the interest-to-

GDP ratio and the primary deficit-to-GDP ratio. The negative effects on the leeway of fiscal policy are significantly increasing with the deficit-to-GDP ratio. Future research should attempt to cover the same aspects for other countries especially those that are strongly affected by the financial crises. Assessing the (potentially nonlinear) effect of debt and deficits on interest rates for a sample of countries, e.g, countries of the European Union, could help to shed new light on the interest rate-debt nexus in broader perspective.[20]

A Data

We use data from 1976 to 2011. The variables used in this study are the long-term nominal interest rate expected to exist k periods ahead, forecasts of budget deficits and debt, inflation expectations, the dividend yield and the trend growth rate. Some of the time series we use have been recalculated and differ slightly from those in Laubach (2009). Using these time series, however, does not change the baseline results in Laubach (2009) significantly. Here follows a description of the main variables used:

Long-term nominal interest rate: Average of one-year forward rates 5-14 years ahead and 3-5 years ahead, calculated from the zero-coupon yield curve based on the data provided by Gürkaynak et al. (2007), sampled on the last trading day of the month of the CBO release.

Deficit and debt: The Congressional Budget Office's (CBO) projected 5-year-ahead deficit (+) or surplus (–) and debt held by the public as percent of GDP. The series was obtained by the biannual CBO budget report available from the website of the CBO.

Expected inflation: The series is composed of three parts, partly available from Laubach (2009). Until 1981:Q1, the series is an estimated step function based on Kozicki and Tinsley (2001). From 1981:Q2 until 1991:Q2 the series is based on the Hoey survey of bond market participants and since 1991:Q3 on the Survey of Professional Forecasters carried out by the Federal Reserve Bank of Philadelphia. The series is interpolated to monthly frequency and sampled corresponding to the interest rate data.

Dividend yield: Calculated as net dividends as percent of equity shares at market value

[20] One major difficulty in international comparisons lies in interest rate projections which are not available to the extent as for the data used in this study (see Faini, 2006).

(directly or indirectly) held by households and nonprofit organizations excluding defined benefit plans. All series can be found in the Flow of Funds Accounts available from the website of the Fed.

Trend growth rate: CBO's projected 5-year-ahead real GDP growth. The series was obtained by the biannual CBO budget report available from the website of the CBO.

References

[1] Afonso, A. (2010), Long-term government bond yields and economic forecasts: Evidence for the EU, Applied Economics Letters 17, 1437-1441.

[2] Andrews, D. and W. Ploberger (1994), Optimal tests when a nuisance parameter is present only under the alternative, Econometrica 62 (6), 1383-1414.

[3] Ardagna, S., Caselli, F. and T. Lane (2007), Fiscal discipline and the cost of public debt service: Some estimates for OECD Countries, The B.E. Journal of Macroeconomics 7 (1), Article 28.

[4] Baldacci, E. and M.S. Kumar (2010), Fiscal deficits, public debt, and the sovereign bond yields, IMF Working Paper, WP/10/184.

[5] Bassetto, M. and R.A. Butters (2010), What is the relationship between large deficits and inflation in industrialized countries? Economic Perspectives 34 (3), 83-100.

[6] Bertola G. and A. Drazen (1993), Trigger points and budget cuts: Explaining the effects of fiscal austerity, American Economic Review 83 (1), 11-26.

[7] Blanchard, O., Chouraqui, J.-C., Hagemann, R.P. and N. Sartor (1990), The sustainability of fiscal policy: New answers to an old question, OECD Economic Studies 15, 7-36.

[8] Caporale G. and G. Williams (2002), Long-term nominal interest rates and domestic fundamentals, Review of Financial Economics 11, 119-130.

[9] Cleveland, W.S. (1993), Visualizing data, Hobart Press.

[10] Cleveland, W.S. (1994), The elements of graphing data, Hobart Press.

[11] Congressional Budget Office (CBO) (2011), The budget and economic outlook: Fiscal years 2011 to 2021, Washington.

[12] Council of Economic Advisers (2003), Economic report of the president, US Government, Washington.

[13] Domar, E.D. (1944), The "burden of the debt" and the national income, American Economic Review 34 (4), 798-827.

[14] Engen, E.M. and R.G. Hubbart (2004), Federal government debts and interest rates, NBER Macroeconomics Annual 19, 83-138.

[15] Evans, C.L. and D.A. Marshall (2007), Economic determinants of the nominal treasury yield curve, Journal of Monetary Economics 54, 1986-2003.

[16] Faini, R. (2006), Fiscal policy and interest rates in Europe, Economic Policy 21(47), 443-489.

[17] Favero, C. and F. Giavazzi (2007), Debt and the effects of fiscal policy, CEPR Discussion Paper 6092.

[18] Freedman, C., Kumhof, M., Laxton, D., Muir, D. and S. Mursula (2009), Fiscal stimulus to the rescue? Short-run benefits and potential long-run costs of fiscal deficits, IMF Working Paper, WP/09/255.

[19] Frisch, H. (1997), The algebra of government debt, Finanzarchiv N.F. 54 (4), 586-599.

[20] Gale, W.G. and P.R. Orszag (2003), The economic effects of long-term fiscal discipline, The Urban-Brookings Tax Policy Center, Discussion Paper No. 8/2003.

[21] Gale, W.G. and P.R. Orszag (2004), Budget deficits, national saving, and interest rates, Brooking Papers on Economic Activity 2004 (2), 101-210.

[22] Giavazzi, F., Japelli, T. and M. Pagano (2000), Searching for non-linear effects of fiscal policy: Evidence from industrial and developing countries, European Economic Review 44 (7), 1259-1289.

[23] Giavazzi, F. and M. Pagano (2000), Can severe fiscal contractions be expansionary? Tales of two small European countries, NBER Macroeconomics Annual, 1990.

[24] Gruber, J. and S. Kamin (2010) Fiscal positions and government bond yields in OECD-countries, Federal Reserve System, International Finance Discussion Papers 1011/2010.

[25] Gürkaynak, R.S., Sack, B. and J.H. Wright (2007), The U.S. treasury yield curve: 1961 to the present, Journal of Monetary Economics 54, 2291-2304.

[26] Hansen, B. (1996), Inference when a nuisance parameter is not identified under the null hypothesis, Econometrica 64 (2), 413-30.

[27] Hansen, B. (2000), Sample splitting and threshold estimation, Econometrica 68 (3), 575-603.

[28] Kozicki, S. and P.A. Tinsley (2001), Shifting endpoints in the term structure of interest rates, Journal of Monetary Economics 47, 613-652.

[29] Laubach, T. (2009), New evidence on the interest rate effects of budget deficits and debt, Journal of the European Economic Association 7(4), 858-885.

[30] Laubach, T. (2011), Fiscal policy and interest rates: The role of sovereign default risk, mimeo.

[31] Lindé, J. (2001), Fiscal policy and the yield curve in a small open economy, Finnish Economic Papers 4, 65-83.

[32] Marattin, L. and S. Salotti (2010), The Euro-dividend: Public debt and interest rates in the Monetary Union, Università degli studi di bologna, Dipartimento di scienze economiche, Quaderni - Working Papers DSE No. 695.

[33] Reinhart, C.M., Rogoff, K. S. and M. Savastano (2003), Debt intolerance, in W. Brainerd and G. Perry (eds.), Brookings Papers on Economic Activity.

[34] Reinhart, C.M. and K. Rogoff (2010), Growth in a time of debt, American Economic Review 100 (2), 573-78.

[35] Zagler, M. and G. Dürnecker (2003), Fiscal policy and economic growth, Journal of Economic Surveys 17 (3), 397-418.

[36] Zivney, T. and R. Marcus (1989), The day the United States defaulted on treasury bills, The Financial Review 24 (3), 475–489.

Table 1: Baseline results

	annual data		semiannual data	
Fiscal variable	def_{t+5}	$debt_{t+5}$	def_{t+5}	$debt_{t+5}$
constant	4.66*** (0.74)	3.85*** (0.99)	4.32*** (0.76)	3.43*** (1.22)
π^e	1.31*** (0.13)	1.37***(0.14)	1.18*** (0.16)	1.20***(0.17)
div yield	-0.04 (0.17)	-0.07 (0.18)	0.11 (0.17)	0.20 (0.18)
trend growth	-0.4/ (0.28)	-0.61* (0.29)	-0.39 (0.31)	-0.46 (0.39)
f_{t+k}	0.21*** (0.06)	0.02* (0.01)	0.18*** (0.07)	0.02 (0.01)
R^2_{adj}	0.88	0.85	0.85	0.82
DW	1.16	1.03	0.59	0.51

***(**)[*] stands for 1% (5%) [10%] significant, standard errors in parenthesis; the dependent variable is the five-year-ahead 10-year forward rate; DW is the Durbin-Watson test statistic.

Table 2: Nonlinearity results: square

	annual data		semiannual data	
Fiscal variable	def_{t+5}	$debt_{t+5}$	def_{t+5}	$debt_{t+5}$
constant	4.89*** (0.66)	4.09*** (1.53)	4.71*** (0.46)	4.93*** (1.13)
π^e	1.13*** (0.13)	1.36*** (0.16)	1.17*** (0.10)	1.34*** (0.12)
div yield	0.09 (0.16)	0.09 (0.19)	0.12 (0.09)	0.12 (0.12)
trend growth	-0.62** (0.26)	-0.65* (0.36)	-0.70*** (0.16)	-0.76*** (0.24)
f_{t+k}	0.09 (0.07)	0.01 (0.05)	0.04 (0.04)	-0.03 (0.04)
f^2_{t+k}	0.06*** (0.02)	0.00 (0.00)	0.06*** (0.02)	0.00 (0.00)
R^2_{adj}	0.90	0.85	0.89	0.85
DW	1.38	1.02	0.73	0.56

***(**)[*] stands for 1% (5%) [10%] significant, standard errors in parenthesis; the dependent variable is the five-year-ahead 10-year forward rate; DW is the Durbin-Watson test statistic.

Table 3: Nonlinearity results: threshold, annual data

Fiscal variable	$debt_{t+5}$		def_{t+5}	
Parameter	**Lower regime**	**Upper regime**	**Lower regime**	**Upper regime**
constant	5.06*** (0.95)		5.35*** (0.77)	
π^e	1.31*** (0.13)		1.29*** (0.12)	
divyield	-0.05 (0.13)		-0.06 (0.14)	
trend growth	-0.64*** (0.24)		-0.59* (0.25)	
f_{t+k}	0.01 (0.01)	0.05*** (0.01)	0.07 (0.08)	0.42*** (0.09)
γ	def_{t+5} =4.72		def_{t+5} =4.72	
R^2_{adj}	0.89		0.89	
DW	1.29		1.32	
Linearity Test	17.01 (p-value 0.00)		9.27 (p-value 0.00)	

***(**)[*] stands for 1% (5%) [10%] significant, standard errors in parenthesis; the dependent variable is the five-year-ahead 10-year forward rate; DW is the Durbin-Watson test statistic. 2,000 replications were used in the bootstrap for the linearity test.

Table 4: Nonlinearity results: threshold, semiannual data

Fiscal variable	$debt_{t+5}$		def_{t+5}	
Parameter	**Lower regime**	**Upper regime**	**Lower regime**	**Upper regime**
constant	4.58*** (0.60)		4.74*** (0.47)	
π^e	1.21*** (0.10)		1.21*** (0.09)	
divyield	0.17* (0.10)		0.11 (0.09)	
trend growth	-0.67*** (0.16)		-0.63*** (0.16)	
f_{t+k}	0.00 (0.01)	0.02*** (0.01)	0.02 (0.05)	0.31*** (0.06)
γ	def_{t+5} =3.37		def_{t+5} =3.37	
R^2_{adj}	0.88		0.89	
DW	0.66		0.68	
Linearity Test	14.10 (p-value 0.00)		13.63 (p-value 0.00)	

***(**)[*] stands for 1% (5%) [10%] significant; standard errors in parenthesis the dependent variable is the five-year-ahead 10-year forward rate; DW is the Durbin-Watson test statistic. 2,000 replications were used in the bootstrap for the linearity test.

Table 5: Nonlinearity results: threshold, annual data

Fiscal variable	$debt_{t+3}$		def_{t+3}	
Parameter	**Lower regime**	**Upper regime**	**Lower regime**	**Upper regime**
constant	5.19*** (1.18)		5.25*** (0.83)	
π^e	1.55*** (0.15)		1.54*** (0.15)	
divyield	-0.24 (0.22)		-0.19 (0.23)	
trend growth	-0.83*** (0.29)		-0.91*** (0.29)	
f_{t+k}	0.00 (0.02)	0.05*** (0.02)	-0.08 (0.10)	0.39*** (0.11)
γ	def_{t+3} =4.47		def_{t+3} =4.47	
R^2_{adj}	0.89		0.88	
DW	1.66		1.70	
Linearity Test	16.45 (p-value 0.00)		14.17 (p-value 0.00)	

***(**)[*] stands for 1% (5%) [10%] significant, standard errors in parenthesis; the dependent variable is the three-year-ahead 5-year forward rate; DW is the Durbin-Watson test statistic. 2,000 replications were used in the bootstrap for the linearity test.

Table 6: Nonlinearity results: threshold, semiannual data

Fiscal variable	$debt_{t+3}$		def_{t+3}	
Parameter	**Lower regime**	**Upper regime**	**Lower regime**	**Upper regime**
constant	5.04*** (0.78)		4.54*** (0.47)	
π^e	1.57*** (0.11)		1.55*** (0.09)	
divyield	0.02 (0.10)		0.07 (0.09)	
trend growth	-1.00*** (0.19)		-1.04*** (0.16)	
f_{t+k}	-0.01 (0.01)	0.01 (0.01)	0.14 (0.05)	0.22*** (0.08)
γ	def_{t+3} =3.51		def_{t+3} =3.51	
R^2_{adj}	0.88		0.89	
DW	0.88		1.01	
Linearity Test	8.51 (p-value 0.01)		17.75 (p-value 0.00)	

***(**)[*] stands for 1% (5%) [10%] significant, standard errors in parenthesis; the dependent variable is the three-year-ahead 5-year forward rate; DW is the Durbin-Watson test statistic. 2,000 replications were used in the bootstrap for the linearity test.

Table 7: Limits of b, z and dp (Selected results)

d	2%	2%	2%	4%	4%	4%	6%	6%	6%
Scenario	A	B	C	A	B	C	A	B	C
b^*	0.308	0.308	0.308	0.615	0.615	0.615	0.923	0.923	0.923
z^*	0.024	0.024	0.024	0.049	0.049	0.049	0.073	0.078	0.082
dp^*	-0.004	-0.004	-0.004	-0.009	-0.009	-0.009	-0.013	-0.018	-0.022

d	8%	8%	8%	10%	10%	10%	12%	12%	12%
Scenario	A	B	C	A	B	C	A	B	C
b^*	1.231	1.231	1.231	1.538	1.538	1.538	1.846	1.846	1.846
z^*	0.097	0.114	0.128	0.122	0.156	0.184	0.146	0.202	0.250
dp^*	-0.017	-0.034	-0.048	-0.022	-0.056	-0.084	-0.026	-0.082	-0.130

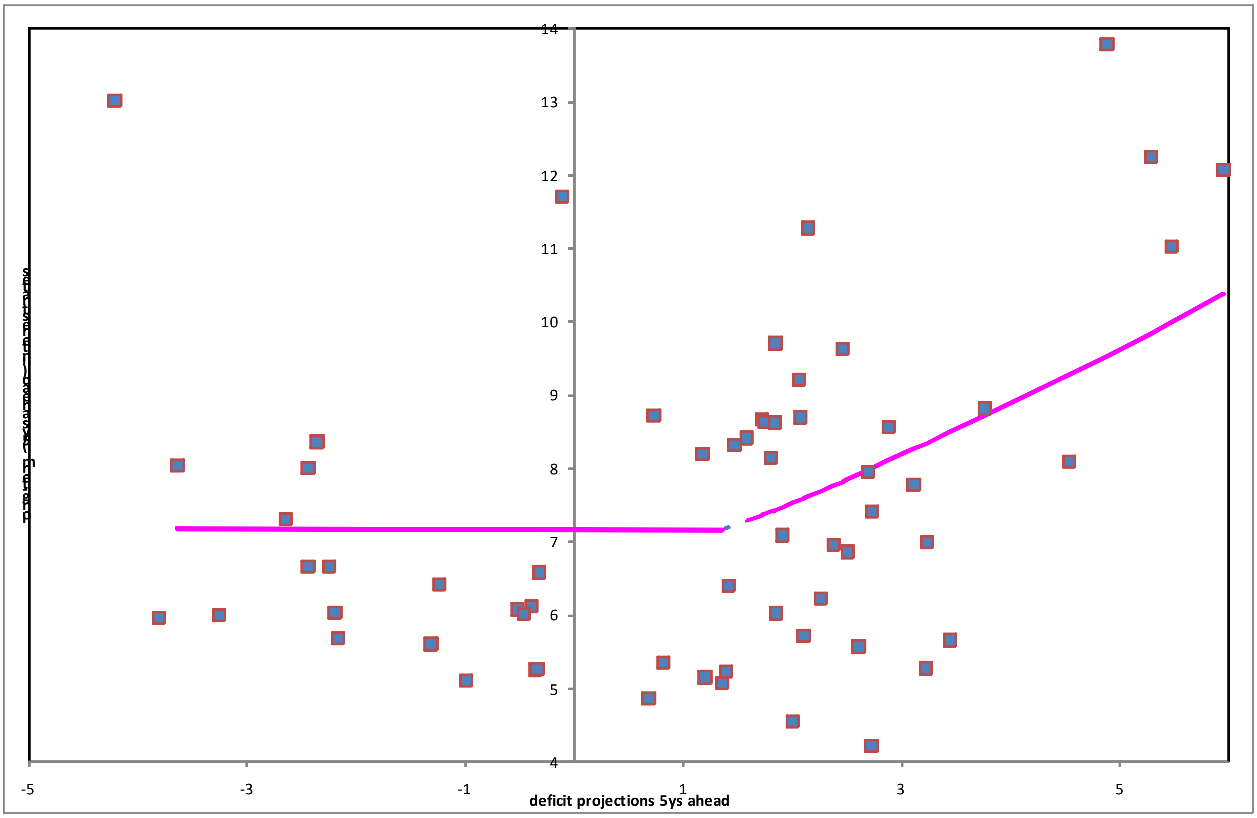

Figure 1: Deficit projections and forward rates

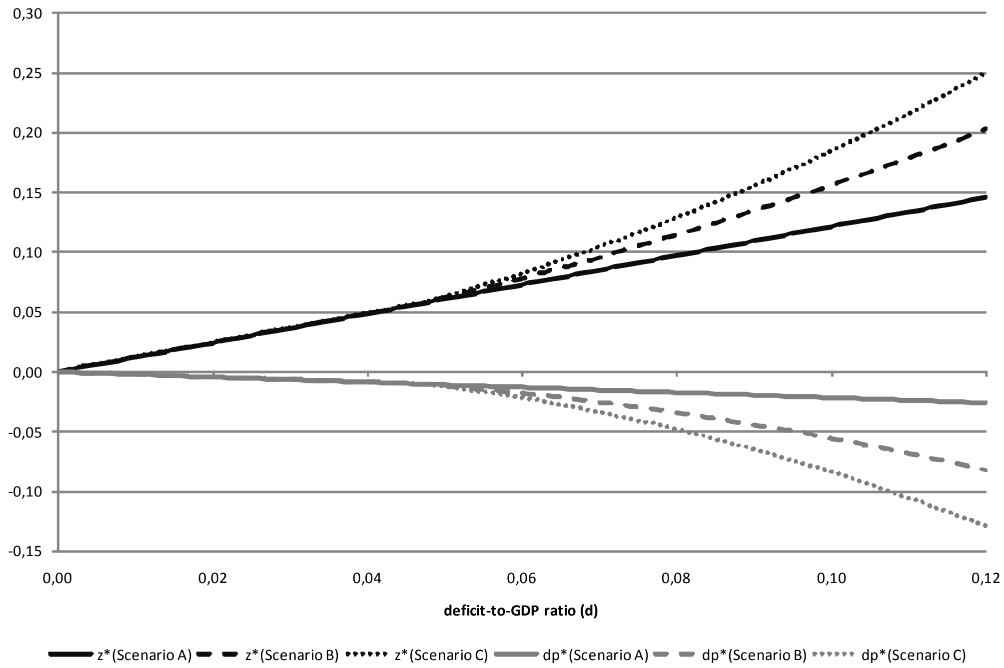

Figure 2: Limits of z and dp

University of Innsbruck - Working Papers in Economics and Statistics
Recent Papers can be accessed on the following webpage:

http://eeecon.uibk.ac.at/wopec/

2011-23 **Gerhard Reitschuler, Rupert Sendlhofer:** Fiscal policy, trigger points and interest rates: Additional evidence from the U.S.

2011-22 **Bettina Grün, Ioannis Kosmidis, Achim Zeileis:** Extended beta regression in R: Shaken, stirred, mixed, and partitioned

2011-21 **Hannah Frick, Carolin Strobl, Friedrich Leisch, Achim Zeileis:** Flexible Rasch mixture models with package psychomix

2011-20 **Thomas Grubinger, Achim Zeileis, Karl-Peter Pfeiffer:** evtree: Evolutionary learning of globally optimal classification and regression trees in R

2011-19 **Wolfgang Rinnergschwentner, Gottfried Tappeiner, Janette Walde:** Multivariate stochastic volatility via wishart processes - A continuation

2011-18 **Jan Verbesselt, Achim Zeileis, Martin Herold:** Near Real-Time Disturbance Detection in Terrestrial Ecosystems Using Satellite Image Time Series: Drought Detection in Somalia

2011-17 **Stefan Borsky, Andrea Leiter, Michael Pfaffermayr:** Does going green pay off? The effect of an international environmental agreement on tropical timber trade

2011-16 **Pavlo Blavatskyy:** Stronger Utility

2011-15 **Anita Gantner, Wolfgang Höchtl, Rupert Sausgruber:** The pivotal mechanism revisited: Some evidence on group manipulation

2011-14 **David J. Cooper, Matthias Sutter:** Role selection and team performance

2011-13 **Wolfgang Höchtl, Rupert Sausgruber, Jean-Robert Tyran:** Inequality aversion and voting on redistribution

2011-12 **Thomas Windberger, Achim Zeileis:** Structural breaks in inflation dynamics within the European Monetary Union

2011-11 **Loukas Balafoutas, Adrian Beck, Rudolf Kerschbamer, Matthias Sutter:** What drives taxi drivers? A field experiment on fraud in a market for credence goods

2011-10 **Stefan Borsky, Paul A. Raschky:** A spatial econometric analysis of compliance with an international environmental agreement on open access resources

2011-09 **Edgar C. Merkle, Achim Zeileis:** Generalized measurement invariance tests with application to factor analysis

2011-08 **Michael Kirchler, Jürgen Huber, Thomas Stöckl:** Thar she bursts - reducing confusion reduces bubbles *modified version forthcoming in* *American Economic Review*

2011-07 **Ernst Fehr, Daniela Rützler, Matthias Sutter:** The development of egalitarianism, altruism, spite and parochialism in childhood and adolescence

2011-06 **Octavio Fernández-Amador, Martin Gächter, Martin Larch, Georg Peter:** Monetary policy and its impact on stock market liquidity: Evidence from the euro zone

2011-05 **Martin Gächter, Peter Schwazer, Engelbert Theurl:** Entry and exit of physicians in a two-tiered public/private health care system

2011-04 **Loukas Balafoutas, Rudolf Kerschbamer, Matthias Sutter:** Distributional preferences and competitive behavior *forthcoming in* *Journal of Economic Behavior and Organization*

2011-03 **Francesco Feri, Alessandro Innocenti, Paolo Pin:** Psychological pressure in competitive environments: Evidence from a randomized natural experiment: Comment

2011-02 **Christian Kleiber, Achim Zeileis:** Reproducible Econometric Simulations

2011-01 **Carolin Strobl, Julia Kopf, Achim Zeileis:** A new method for detecting differential item functioning in the Rasch model

2010-29 **Matthias Sutter, Martin G. Kocher, Daniela Rützler and Stefan T. Trautmann:** Impatience and uncertainty: Experimental decisions predict adolescents' field behavior

2010-28 **Peter Martinsson, Katarina Nordblom, Daniela Rützler and Matthias Sutter:** Social preferences during childhood and the role of gender and age - An experiment in Austria and Sweden *Revised version forthcoming in* *Economics Letters*

2010-27 **Francesco Feri and Anita Gantner:** Baragining or searching for a better price? - An experimental study. *Revised version accepted for publication in* *Games and Economic Behavior*

2010-26 **Loukas Balafoutas, Martin G. Kocher, Louis Putterman and Matthias Sutter:** Equality, equity and incentives: An experiment

2010-25 **Jesús Crespo-Cuaresma and Octavio Fernández Amador:** Business cycle convergence in EMU: A second look at the second moment

2010-24 **Lorenz Goette, David Huffman, Stephan Meier and Matthias Sutter:** Group membership, competition and altruistic versus antisocial punishment: Evidence from randomly assigned army groups

2010-23 **Martin Gächter and Engelbert Theurl:** Health status convergence at the local level: Empirical evidence from Austria *(revised Version March 2011)*

2010-22 **Jesús Crespo-Cuaresma and Octavio Fernández Amador:** Buiness cycle convergence in the EMU: A first look at the second moment

2010-21 **Octavio Fernández-Amador, Josef Baumgartner and Jesús Crespo-Cuaresma:** Milking the prices: The role of asymmetries in the price transmission mechanism for milk products in Austria

2010-20 **Fredrik Carlsson, Haoran He, Peter Martinsson, Ping Qin and Matthias Sutter:** Household decision making in rural China: Using experiments to estimate the influences of spouses

2010-19 **Wolfgang Brunauer, Stefan Lang and Nikolaus Umlauf:** Modeling house prices using multilevel structured additive regression

2010-18 **Martin Gächter and Engelbert Theurl:** Socioeconomic environment and mortality: A two-level decomposition by sex and cause of death

2010-17 **Boris Maciejovsky, Matthias Sutter, David V. Budescu and Patrick Bernau:** Teams make you smarter: Learning and knowledge transfer in auctions and markets by teams and individuals

2010-16 **Martin Gächter, Peter Schwazer and Engelbert Theurl:** Stronger sex but earlier death: A multi-level socioeconomic analysis of gender differences in mortality in Austria

2010-15 **Simon Czermak, Francesco Feri, Daniela Rützler and Matthias Sutter:** Strategic sophistication of adolescents - Evidence from experimental normal-form games

2010-14 **Matthias Sutter and Daniela Rützler:** Gender differences in competition emerge early in live

2010-13 **Matthias Sutter, Francesco Feri, Martin G. Kocher, Peter Martinsson, Katarina Nordblom and Daniela Rützler:** Social preferences in childhood and adolescence - A large-scale experiment

2010-12 **Loukas Balafoutas and Matthias Sutter:** Gender, competition and the efficiency of policy interventions

2010-11 **Alexander Strasak, Nikolaus Umlauf, Ruth Pfeifer and Stefan Lang:** Comparing penalized splines and fractional polynomials for flexible modeling of the effects of continuous predictor variables

2010-10 **Wolfgang A. Brunauer, Sebastian Keiler and Stefan Lang:** Trading strategies and trading profits in experimental asset markets with cumulative information

2010-09 **Thomas Stöckl and Michael Kirchler:** Trading strategies and trading profits in experimental asset markets with cumulative information

2010-08 **Martin G. Kocher, Marc V. Lenz and Matthias Sutter:** Psychological pressure in competitive environments: Evidence from a randomized natural experiment: Comment

2010-07 **Michael Hanke and Michael Kirchler:** Football Championships and Jersey sponsors' stock prices: An empirical investigation

2010-06 **Adrian Beck, Rudolf Kerschbamer, Jianying Qiu and Matthias Sutter:** Guilt from promise-breaking and trust in markets for expert services - Theory and experiment

2010-05 **Martin Gächter, David A. Savage and Benno Torgler:** Retaining the thin blue line: What shapes workers' intentions not to quit the current work environment

2010-04 **Martin Gächter, David A. Savage and Benno Torgler:** The relationship between stress, strain and social capital

2010-03 **Paul A. Raschky, Reimund Schwarze, Manijeh Schwindt and Ferdinand Zahn:** Uncertainty of governmental relief and the crowding out of insurance

2010-02 **Matthias Sutter, Simon Czermak and Francesco Feri:** Strategic sophistication of individuals and teams in experimental normal-form games

2010-01 **Stefan Lang and Nikolaus Umlauf:** Applications of multilevel structured additive regression models to insurance data

University of Innsbruck

Working Papers in Economics and Statistics

2011-23

Gerhard Reitschuler, Rupert Sendlhofer

Fiscal policy, trigger points and interest rates: Additional evidence from the U.S.

Abstract
We empirically investigate whether the relationship between interest rates and public deficits/debt may be nonlinear for the U.S. Using threshold estimation, we find evidence of level-dependent effects on interest rates, implying a significant effect of projected deficits and debt in the U.S. only if the deficit surpasses approximately 5% of GDP.

ISSN 1993-4378 (Print)
ISSN 1993-6885 (Online)