Fiscal Policy in the US: Ricardian After All?

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ABSTRACT

Historical data on US debt and primary surplus suggest the existence of different fiscal regimes which imply that, from time to time, US fiscal policy may have violated the government's intertemporal budget constraint. But does evidence of locally unsustainable regimes eventually jeopardize the global sustainability of US public debt? We apply a Regime-Switching Model-Based Sustainability test which derives sufficient conditions on a regime-switching fiscal policy feeback rule such that fiscal policy can globally be sustainable while allowing for persistent unsustainable regimes. We find significant evidence of a globally Ricardian US fiscal policy, despite periodic and persistent unsustainable fiscal regimes. This conclusion remains valid after controlling for the reverse causality between the primary balance and the output gap.

KEY WORDS

Fiscal rules, Fiscal regimes, Public debt sustainability, Time-varying parameters, Markov-switching models, Model-Based Sustainability.

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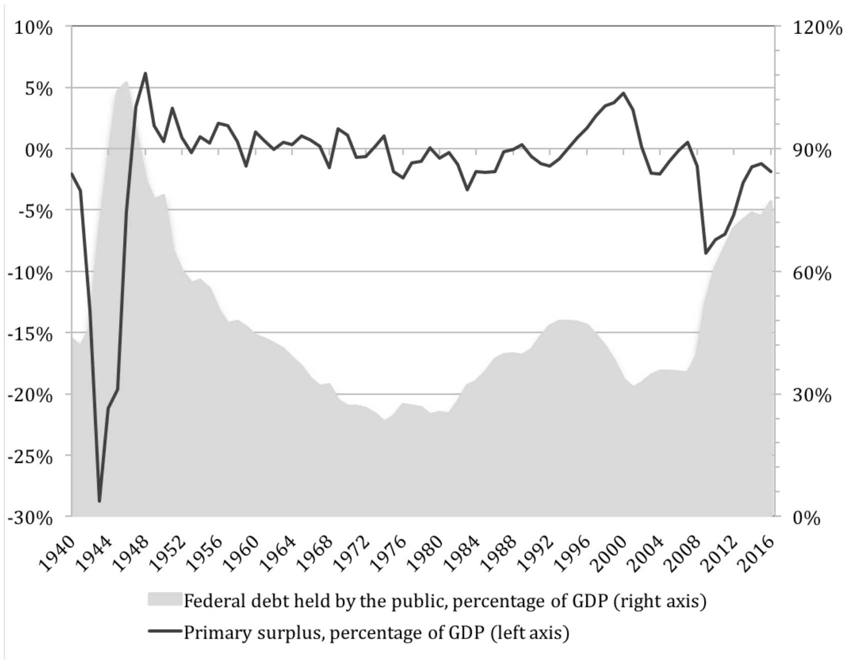
1 Introduction

Following the Global Financial Crisis and the Great Recession, countercyclical fiscal policies led to substantial increases in public debt which have finally raised concerns about fiscal sustainability in most OECD countries . The US economy makes no exception in this context as the data of figure 1 show with the sharp increase in public debt-to-GDP ratio and persistent primary deficits, eight years after the Great Recession. At first glance, historical data suggest two distinct fiscal regimes in the US fiscal policy. Indeed, we observe several episodes characterized by an increasing public debt without clear improvement of the primary surplus, which would signal an unsustainable fiscal policy, but also episodes of increasing primary surplus following public debt build-ups. For instance, in the early 1980s, primary deficits and debts respectively increased in proportion to GDP whereas they fell quite substantially in the early 1990s.

Figure 1: Federal debt and primary federal surplus in the US (1940-2016)



Existence of unsustainable fiscal regimes may raise two legitimate concerns about the sustainability of US fiscal policy: first, how long can necessary fiscal adjustments be delayed without threatening the long-run sustainability of public debt? Second, are sustainable fiscal regimes sufficiently tight and frequent to ensure the long-run sustainability of US public debt?

This paper investigate these two questions simultaneously and also provides an answer to the related question: does evidence of unsustainable regimes in US fiscal policy eventually jeopardize the long-run sustainability of public debt? Hence, we apply to US fiscal annual data from 1940 to 2016 the Regime-Switching MBS test developed in a companion paper. Extending Bohn (1998)'s framework to regime-switching fiscal policy rule, Aldama and Creel (2017) derive sufficient conditions on a regime-switching fiscal policy feeback rule such that fiscal policy would *globally* be sustainable while allowing for persistent unsustainable regimes.

We follow a three-step empirical strategy. First, we estimate constant-parameter fiscal policy rules. We notably control for non-linearities using a quadratic specification of Bohn's fiscal rule, and potential endogeneity bias due to reverse causality between primary surplus and output gap. These baseline regressions do not give significant evidence of a sustainable or Ricardian fiscal policy in the US, i.e. a strictly and significant positive response of primary balance to lagged public debt. Still, these results may be triggered by the fundamental instability in the relationship between primary surplus and lagged public debt, namely *fiscal regimes*.

Hence, in a second-step, we estimate a two-state Markov-switching fiscal policy rule in order to account for differentiated responses of primary surplus to public debt. We find significant evidence of a sustainable regime that diplays a positive and strongly significant feedback effect of public debt while the other regime is characterized by a non-significantly feedback effect. Using estimated Markov-switching fiscal rule, we directly tests the sustainability conditions developed in Aldama and Creel (2017). Our results indicate that US fiscal policy have been globally sustainable or Ricardian, despite persistent unsustainable fiscal regimes.

Finally, we address the question of endogeneity in the output gap in the Markov-switching dynamic regression. We build a measure of expected output gap using an auxiliary regression. Then, we replace the output gap by its expectation in the Markov-switching fiscal policy rule. Our results indicate that using *expected* rather than *actual* output gap significantly reduces the instability of the fiscal policy rule, particularly in terms of regime persistence. We also find that US fiscal policy may have been Ricardian from the early 1960s to the late 2000s and the Great Recession.

The paper is organized as follows. Section 2 briefly reviews the literature and presents the methodological framework. Section 3 describes the dataset. Section 4 presents the empirical results. Section 5 concludes.

2 Methodological framework

A first approach to fiscal sustainability analysis consists in unit-root and stationarity tests or cointegration tests on fiscal variables without an explicit modelling of fiscal policy behavior. Seminal investigations in this area are Hamilton and Flavin (1986) and Wilcox (1989) for unit-root and stationarity tests or Trehan and Walsh (1988, 1991) and Quintos (1995) for the use of cointegration analysis on various components of public finances. Following their lead, Afonso and Jalles (2016) compute panel unit-root tests and cointegration tests on revenues, spending, primary deficits and debts of a group of OECD countries. They find that public debts are not sustainable. A recent study on US data by Chen (2016) uses quantile cointegration and shows that fiscal sustainability has been broadly fulfilled from 1960 to 2010. In the vein opened by Quintos (1995), Chen (2016) studies nonlinearities in the relationship between fiscal instruments. These nonlinearities are central to the understanding of the evolution of public debts and deficits. Both are related to the business cycles and also to changes in the fiscal legislation. A change in the debt ceiling may well change the evolution of tax policy or that of public spending. Chen (2016) concludes that the higher public spending the lower the sustainability of US public finances.

Another way of dealing with fiscal sustainability has hinged on the dynamic properties of fiscal shocks on real GDP and debt-to-GDP. In a recent contribution with OECD data, Auerbach and Gorodnichenko (2017) use local-projections to study the asymmetric and nonlinear effects of fiscal policy shocks on debt-to-GDP ratio, short-term and long-term interest rates, CDS spreads, real GDP and inflation during expansions or recessions and in a low-debt environment or a high-debt environment. They show that government spending shocks can have an important positive effect on growth in recessions and can lead to a reduction in public debt-to-GDP ratio, hence increasing fiscal sustainability. Moreover, when controlling for the level of public debt, Auerbach and Gorodnichenko do not find any significant evidence of strong penalties for fiscal stimulus when public debt-to-GDP ratio exceeds 100%.

Another strand of the fiscal sustainability literature builds on the explicit modeling behavior of governments and opposes strong criticisms to the econometric analyses mentioned above (Bohn, 1995, 2007). By depicting fiscal policy feedback rule, Bohn (1998) argues that a significantly positive reaction of a fiscal instrument –usually primary balance-to-GDP or tax receipts-to-GDP– to lagged public debt-to-GDP ratio ensures fiscal sustainability. Furthermore, if fiscal instrument's response to lagged public debt is larger than the real interest rate[1], then fiscal policy follows a debt-stabilizing rule, see Bohn (1998), Mendoza and Ostry (2008), Daniel and Shiamptanis (2013). Bohn and Mendoza and Ostry both conclude that US fiscal policy and public debt were sustainable. In addition to strictly linear specifications, Bohn (1998) estimate nonlinear specifications of fiscal policy rules, including quadratic and cubic terms of debt-to-GDP ratios. His results indicate a significant and positive feedback effect of quadratic debt on primary surplus, but a non-significant negative cubic term, showing an "increasing marginal response of surpluses to changes in debt". In an attempt to shed light on these nonlinearities, Ghosh et al. (2013b,a) introduce the concept of "fiscal fatigue" in fiscal policy behavior. According to them, the reaction of the primary surplus may be "flatter" at high levels of public debt. Using the fiscal fatigue property of cubic fiscal policy rules, they propose a method to compute maximum debt limits depending on policy behavior and risk-neutral lenders. After having estimated a cubic fiscal policy rule on a panel-data of OECD countries, they estimate country-specific debt limits under two scenarios –historical vs projected– for the growth-adjusted real interest rate. Their results suggest that most of OECD countries still have large fiscal spaces.

Alternatively to quadratic or cubic fiscal policy rules, the literature also turned towards time-varying and regime-switching specifications because of multiple evidence of structural breaks and regime shifts in standard constant-parameter specifications[2]. Favero and Monacelli (2005) investigate the instability of monetary and fiscal policy rules using Markov-switching dynamic regressions. They notably challenge the common wisdom of a continuously *passive* or *Ricardian* fiscal policy in the US after WWII. They note, in addition, that regime-switching fiscal rules are better fitting fiscal policy behavior than constant-parameter specifications. Contributing to the so-called Fiscal Theory of Price-Level, Chung et al. (2007), Davig and Leeper (2007, 2011), Bianchi (2012) also estimate monetary and fiscal Markov-switching policy rules and provide

[1] Generally adjusted for the real GDP growth rate, when using GDP-scaled fiscal variables.

[2] For monetary policy, see Clarida et al. (2000), Auerbach (2002), Lubik and Schorfheide (2004) among others.

evidence of passive fiscal policy regimes. Other contributions to the literature on regime-switching fiscal policy rules are Burger and Marinkov (2012) and Afonso and Toffano (2013). Recently, Nguyen et al. (2017) estimate the US fiscal rule using a time-varying parameter model and show that fiscal sustainability was achieved until 2005. Since then, they argue that US fiscal policy is no longer sustainable.

Empirical studies on time-varying and regime-switching fiscal policy rules generally and succesfully identify sub-periods during which the government does not stabilize public debt, and sometimes even displays a negative feedback effect of lagged public debt on primary surplus. However, they do not conclude whether the time-varying or regime-switching feature of fiscal policy threatens (or not) the long-run sustainability of public debt. In the empirical part of this paper, we will hinge on the recent test by Aldama and Creel (2017) to estimate long-run fiscal sustainability. In light of the discussion about peaks and troughs in public debt's evolution (see figure 1), the point of departure is that a locally or periodically unsustainable fiscal policy may not necessarily threaten the global or long-run sustainability of public debt. In particular, under sufficient conditions on regime-specific response of primary surplus to lagged public debt and on expected durations of regimes, (i) the No-Ponzi Game (NPG) condition or (ii) the Debt-Stabilizing condition may hold on the entire period despite periodically unsustainable policies.

NPG condition holds when

$$\gamma_S > |\gamma_{NS}| \frac{d_{NS}}{d_S} \tag{1}$$

with γ_S and γ_{NS} being the respective responses of the primary surplus to public debt in the sustainable regime (S) and to the non-sustainable regime (NS), and with d_S and d_{NS} the respective average duration of the sustainable and unsustainable regimes.

The NPG condition requires that the initial public debt-to-GDP ratio would be backed by the sum of future expected and discounted real primary surpluses-to-GDP. The NPG condition *per se* does not impose any stationarity restriction, see Bohn (2007). Then an ever-increasing public debt-to-GDP ratio will eventually reach the fiscal limit on the level of primary surplus governments can run (Daniel, 2014, Daniel and Shiamptanis, 2013). As a consequence a stronger sustainability constraint requires a *stable* public debt-to-GDP ratio around a long-run value with a sufficient safety margin with respect to the fiscal limit.

The Debt-Stability condition therefore holds when

$$\gamma_S > |\gamma_{NS}| \frac{d_{NS}}{d_S} + \frac{r-y}{1+y} \frac{d_S + d_{NS}}{d_S} \tag{2}$$

where r and y are the real interest rate and the growth rate of real GDP.

It must be stressed that the Debt-Stabilizing condition may not be stricter than the NPG condition. First, the Debt-Stabilizing condition would be looser than the NPG condition if the average real interest rate on public debt r were lower than the growth rate of real GDP y – which *does not imply* that the economy is dynamically inefficient. Abel et al. (1989) have shown that, in a stochastic economy with risk-free and risky assets, the correct theoretical condition for dynamic efficiency is that the *risky* interest rate must be larger than the growth rate of output; not the safe rate. Regarding empirical assessment of dynamic efficiency, Abel et al. address the difficulty of measuring the actual rate of return on risky capital: they suggest to test whether investment is lower than capital income at aggregated level (dynamic efficiency) or not (dynamic inefficiency). They found that 7 advanced OECD economies including the US were dynamically efficient at the end of the 1980s; Geerolf (2013) recently updated their empirical work and overturned their results. He finds that OECD advanced economies could have over-accumulated capital. Second, if the economy is actually dynamically efficient, hence the correct sustainability condition is the NPG condition rather than a Debt-Stabilizing condition. The reason is the following: a government could simultaneously stabilize its debt *and* run a Ponzi Scheme against its creditors which would be a source of sub-optimality for rational creditors.

3 Dataset

We use historical data on federal debt, expenditures, receipts, primary budget balance as well as nominal and real GDP and GDP implicit deflator from the Office of Management and Budget. Our dataset covers years ranging from 1940 to 2016.[3]

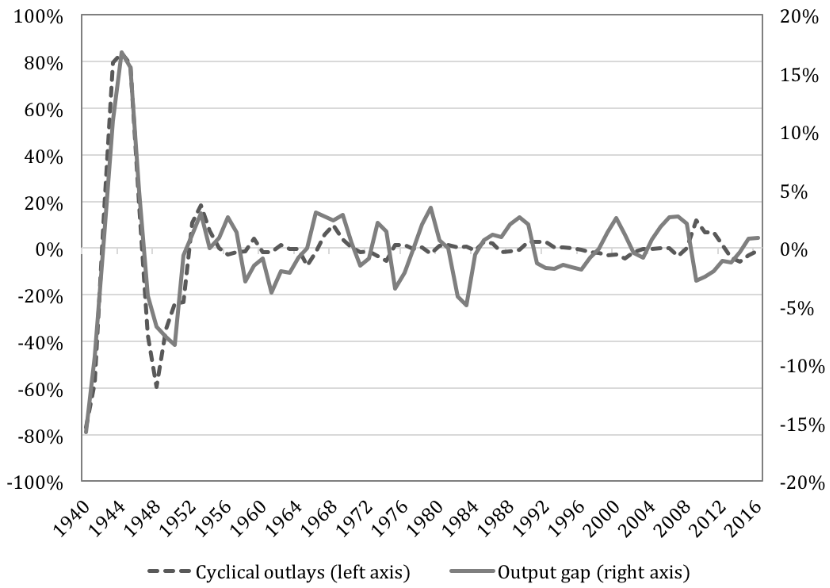
Following most studies on US fiscal policy, we use the federal debt *held by the public* as a measure of consolidated gross public debt rather than total gross federal debt; this choice is usually motivated by the fact that total gross federal debt includes intragovernmental obligations to social security and other trusts funds, see Bohn (2008). We measure the nominal interest rate on public debt using the ratio of net interest charge on public debt held by the public, as in Bohn (1998, 2008). Hence, real interest rate will be calculated as the *ex post* real rate using GDP implicit deflator.

We follow the literature on Model-Based Sustainability analysis (Bohn, 1998, Mendoza and Ostry, 2008) and use the output gap and a measure of cyclical real public spending as regressors in the fiscal policy rule. Congressional Budget Office's estimates of potential real GDP are not available for years prior to 1949, hence we use a standard HP filtered output gap measure taking the cyclical component of log real GDP. Similarly, cyclical real public spending is also defined as the cyclical component of log real public spending. When using the HP filter, we choose a smoothing parameter λ equal to 6.25 rather than 100, according to Ravn and Uhlig (2002)'s rule.[4] Figure 2 describes the series obtained.

[3] Data are available at `https://www.whitehouse.gov/omb/budget/Historicals`.

[4] Ravn and Uhlig show that filter parameter should be adjusted by multiplying it with the fourth power of the observation frequency ratio. For instance, considering annual and quarterly data of a same time series, choosing a smoothing parameter $\lambda = 100$ on annual data produces inconsistent HP-filtered trend with respect to the trend obtained on quarterly data with $\lambda = 1600$.

Figure 2: HP filtered output gap and cyclical real public spending (1940-2016)



4 Empirical results

We follow a three-step empirical strategy. First, we estimate constant-parameter fiscal policy rules and perform standard Model-Based Sustainability tests. In particular, we estimate fiscal policy rules using the IV estimator to control for a reverse causality bias between primary surplus and output gap. Strikingly, the constant-parameter estimates do not allow to conclude to the sustainability of US public debt, even after controlling for a potential endogeneity bias in the output gap. Second, we estimate a two-state Markov-switching fiscal policy rule. We are able to conclude in favour of global sustainability despite periodic violations of the NPG and Debt-Stabilizing conditions. Third, we estimate an alternative specification of the Regime-switching fiscal policy rule in which we replace the output gap by its expected level, obtained from an auxiliary first-step regression and confirm the main result of the paper.

4.1 Standard Model-Based Sustainability Tests

We estimate the following fiscal policy rule

$$s_t = \alpha + \gamma b_{t-1} + \alpha_x x_t + \alpha_g \tilde{g}_t + u_t \tag{3}$$

where s_t is the primary surplus-to-GDP ratio, b_{t-1} is the end-of-period public debt-to-GDP ratio, x_t is the output gap and $\tilde{g}_t$ is cyclical real public spending. Estimates of linear fiscal policy rules generally display a strong auto-correlation in the residuals hence we estimate a model with first-order autoregressive residuals $u_t = (1-\rho L)^{-1}\varepsilon_t$ with ε_t i.i.d. $\mathcal{N}(0,\sigma^2)$. Thus, we estimate equation (3) using non-linear least square (NLS). In order to control for the reverse causality bias between primary surplus and output gap, we also estimate equation (3) using instrumental variables. We use two lags of output gap and lagged primary surplus as instruments.

Columns (1) and (3) of table 1 show the results for NLS and IV estimates of equation (3). First, we do not find any significant evidence of a stricly positive feedback effect of public debt on primary surplus. Hence, standard MBS analysis would conclude to the unsustainability of US fiscal policy all over the period: large build-ups of public debt do not seem positively correlated with a significant increase of primary surplus between 1942 and 2016. Regarding former evidence of a sustainable US fiscal policy (Bohn, 2008), these results should *probably* be interpreted as evidence of instability in coefficient estimates of linear fiscal policy rules rather than evidence of unsustainable fiscal policy.[5] Second, IV estimates display a positive reaction of primary surplus to lagged debt but still non-significant. This result suggests that accounting for the potential reverse causality bias between primary surplus and output gap does not significantly impact the estimates of primary surplus's correlation to public debt.

We also estimate a quadratic specification of the fiscal policy rule

$$s_t = \alpha + \gamma_1 b_{t-1} + \gamma_2 b_{t-1}^2 + \alpha_x x_t + \alpha_g \tilde{g}_t + u_t \tag{4}$$

both using NLS and IV estimators, to account for potential non-linearities in the relationship between primary surplus and public debt. A positive coefficient associated to squared debt-to-GDP ratio would indicate that the response of primary surplus *increases* with the level of public debt whereas a negative coefficient would testify for "fiscal fatigue", both suggesting non-linearities in primary surplus-public debt regressions. In table 1, quadratic term is never statistically different from zero whatever the estimation method.

Table 1: Standard Model-Based Sustainability Tests (1942-2016)

Dependent variable: s_t	(1) NLS	(2) NLS	(3) IV	(4) IV
Constant	-0.0077	0.0119	-0.0352	0.0173
	(0.0181)	(0.0316)	(0.0450)	(0.0711)
Lagged debt b_{t-1}	0.0049	-0.0720	0.0668	-0.1148
	(0.0377)	(0.1047)	(0.0990)	(0.2358)
Quadratic lagged debt b_{t-1}^2		0.0650		0.1255
		(0.0770)		(0.1567)
Output gap x_t	0.3372***	0.3435***	0.1552	0.2707
	(0.0812)	(0.0816)	(0.2566)	(0.2154)
Cyclical government spending g_t	-0.2394***	-0.2353***	-0.1753***	-0.1921***
	(0.0187)	(0.0183)	(0.0573)	(0.0409)
Adjusted R^2	0.93	0.93	0.92	0.92
Nb. of obs	75	75	75	75
Durbin-Watson stat	2.22	2.29	2.23	2.36

Notes: standard errors are reported in parenthesis. Reported estimates are significant at 1% level (***), 5% level (**) or 10% level (*). All models control for first-order serially correlated residuals. Equations (3)-(4) are estimated by IV estimators. We use lagged values of output gap x_{t-1}, x_{t-2} and lagged primary surplus s_{t-1} as instruments.

[5] Reasons for the differences between this first set of results and former empirical results on US fiscal sustainability drawing on fiscal rules (Bohn, 1998, 2008) are twofold. First, the sample are not similar. Bohn (2008) uses data from 1791 to 2012 (or 2003). Second, Bohn uses military spending as a proxy for cyclical government spending.

4.2 Regime-Switching Model-Based Sustainability Tests

Based on constant-parameter estimates of fiscal policy rules, linear and non-linear, we do not find significant evidence in favor of a sustainable (or Ricardian) fiscal policy in the US between 1942 and 2016. In this section, we argue that these results may be driven by the instability, i.e. regime-switching properties, of fiscal policy rules' estimates.

We estimate the following Markov-switching fiscal rule in equation (5) by direct maximization of the log likelihood, following Hamilton (1989):

$$s_t = \alpha(z_t) + \gamma(z_t)b_{t-1} + \alpha(z_t)_x x_t + \alpha(z_t)_g \tilde{g}_t + u_t \tag{5}$$

where z_t is an unobserved two-state Markov process with constant transition probabilities. We estimate our model with first-order autocorrelated residuals $u_t = (1-\rho L)^{-1}\sigma\varepsilon_t$ with ε_t i.i.d. $\mathcal{N}(0,1)$ and regime-invariant standard error of residuals σ. We use 10 000 random draws of initial values for the ML algorithm in order to avoid a local maximum and reduce the dependence of final results on initial values. We also define the long-run estimate α of regime-switching parameters using ergodic probabilities (π_1, π_2)

$$\alpha \equiv \alpha_1\pi_1 + \alpha_2\pi_2 \tag{6}$$

as well as its estimated standard-deviation

$$\sigma_\alpha \equiv \sqrt{(\sigma_{\alpha_1}\pi_1)^2 + (\sigma_{\alpha_2}\pi_2)^2 + 2\,\mathrm{Cov}(\alpha_1,\alpha_2)} \tag{7}$$

We report estimation results in table 2 and smoothed and filtered probabilities in figure 3.

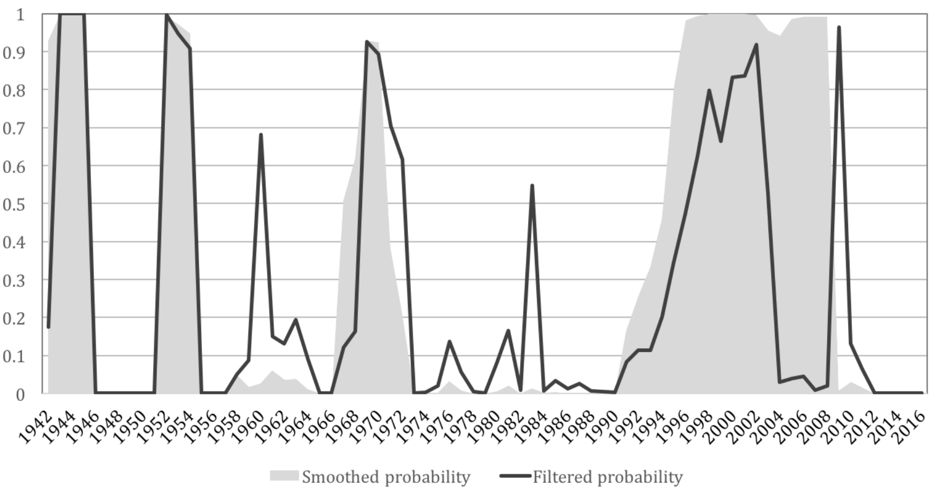
Table 2: Estimated baseline Markov-switching fiscal rule (1942-2016)

Dependent variable: s_t	Regime 1	Regime 2	Long-run estimates
Constant	-0.0189	-0.0245*	-0.0207*
	(0.0122)	(0.0127)	(0.0113)
Lagged debt b_{t-1}	0.0221	0.0865***	0.0423**
	(0.0219)	(0.0242)	(0.0205)
Output gap x_t	0.2871***	0.8671***	0.4690***
	(0.0545)	(0.1158)	(0.0528)
Cyclical government spending g_t	-0.1758***	-0.4137***	-0.2504***
	(0.0130)	(0.0239)	(0.0105)
Regime properties	Transition prob. p_{ii}	Ergodic prob. π_i	Expected duration d_i
i=1	0.92	0.69	12.47
i=2	0.82	0.31	5.70
Durbin-Watson statistic	1.76	Log Likelihood	241.5045

Notes: standard errors are reported in parenthesis. Reported estimates are significant at 1% level (***), 5% level (**) or 10% level (*). The model control for regime-invariant first-order serially correlated residuals.

First, our estimated Markov-switching fiscal policy rule identifies two regimes. We find a strongly significant positive response of primary surplus to lagged public debt in regime 2 which we label *sustainable*, while the response of primary surplus to lagged public debt is non-significant but positive in regime 1, which we label *unsustainable*. Second, the sustainable regime appear less persistent than the unsustainable one. Furthermore, estimated prob-

Figure 3: Baseline model, estimated probabilities of sustainable regime



abilities of the sustainable regime suggests that US fiscal policy have periodically been non-Ricardian since 1942, particularly from the early 1970s to the early 1990s. Indeed, the sustainable regime has an expected duration of 5.7 years against 12.5 years for the unsustainable one. This evidence of recurring and persistent regime changes may explain *a posteriori* why constant-parameter estimates of fiscal policy rules (in section 4.1) could not identify a significant positive reaction of primary surplus to lagged public debt. Finally, long-run estimate of the feedback effect of public debt on primary surplus is significantly positive, which overturns former results and make them consistent with former results by (Bohn, 1998, 2008).

Given γ_{NS} is not statistically different from zero, the NPG condition depends exclusively on the sign of γ_S. The Debt-Stabilizing condition includes the growth-adjusted real interest rate $(r-y)/(1+y)$ and implies to choose an adequate measure for it. Bai-Perron regressions allowing for multiple breaks suggest significant different average growth-adjusted real rates by sub-periods in the US, see figure 4 and table 3. Hence, we present both full-sample and sub-sample tests for the Debt-Stabilizing condition, using estimated average growth-adjusted real rates. Finally, we test NPG and Debt-Stabilizing conditions using one-sided Student tests (table 4).

Table 3: Average growth-adjusted real interest rate

	1941-1952	1953-1981	1982-2016	1941-2016
Estimated average	-0.0806	-0.0315	0.0036	-0.0231
Robust standard-error	(0.0121)	(0.0078)	(0.0071)	(0.0079)

Notes: sub-sample averages are determined using a Bai-Perron breakpoints regression; full-sample (1941-2016) average is obtained from a simple OLS regression. HAC robust standard-errors are reported in parenthesis.

All tests conclude that the estimated Markov-switching fiscal policy rule meets both No-Ponzi Game and Debt-Stabilizing conditions. Regarding the latter condition, this is true whatever the period considered to estimate the long-run growth-adjusted real rate. In particular, our results suggest that US fiscal policy has not used the fiscal rooms for maneuver stemming from negative growth-adjusted real rates to run a Ponzi Scheme. Finally, despite recurring and persistent unsustainable (or non-Ricardian) regimes, we find evidence of a globally sustainable

Figure 4: Growth-adjusted real interest rate (1941-2016)

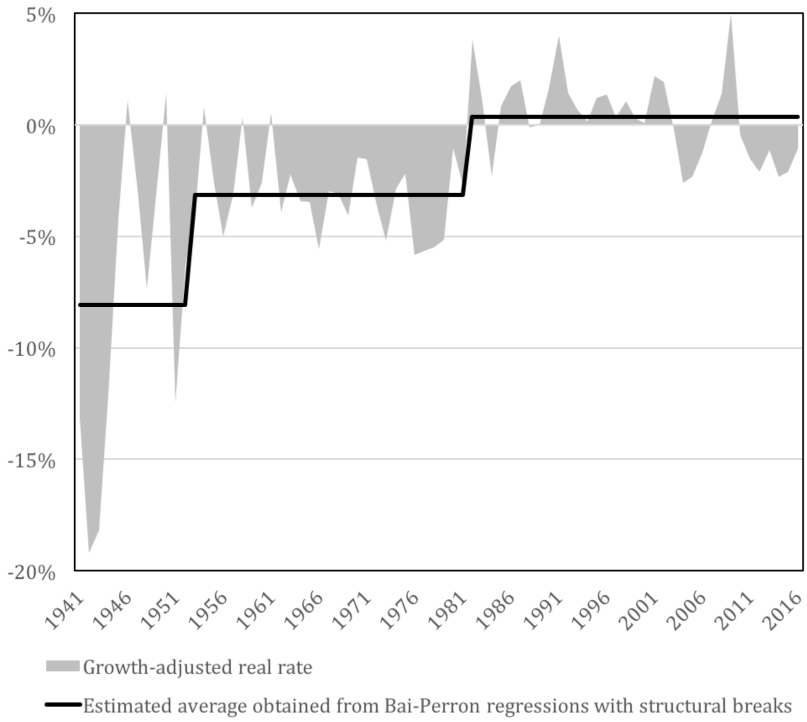


Table 4: Regime-switching MBS tests results

	NPG condition	Debt-Stabilizing condition			
	Full-sample	1941-2016	1941-1952	1953-1981	1982-2016
t-stat	3.5768	4.5327	6.9120	4.8798	3.4293
Unilateral p-value	0.0003	0.0000	0.0000	0.0000	0.0005

Notes: these student tests assume that γ_{NS} is virtually equal to zero from estimates obtained in table 2.

fiscal policy in the US: sustainable regimes are *sufficiently* tight and *sufficiently* frequent to ensure that public debt will be backed by future expected present-value primary surpluses.

4.2.1 Alternative specification

As such, results reported in table 4 show that the fulfilment of the Debt-Stabilizing condition is robust to different sub-periods and different values of the growth-adjusted real interest rate. In the baseline model however, we do not control for the potential reverse causality bias between primary surplus and output gap. Consequently, we report an alternative specification in which we use a measure of expected output gap that we build from a preliminary-step regression.

We regress the output gap on its two consecutive lags, plus the first lag of primary balance, the second lag of the debt to GDP ratio and cyclical outlays. Estimates of the first-stage regression are reported in appendix A. Then, we compute the expected output gap as the fitted values from the previous regression and use it as an exogenous regressors in the following Markovswithcing fiscal policy rule:

$$s_t = \alpha(z_t) + \gamma(z_t) b_{t-1} + \alpha(z_t)_x \mathbb{E}_{t-1} x_t + \alpha(z_t)_g \tilde{g}_t + u_t \tag{8}$$

with first-order serially correlated residuals, following the same procedure as for equation (5) except that we use a Huber-White robust variance-covariance estimator because of the presence of a generated regressor.[6] We report RS-MBS results in table 5. The distinction between the two fiscal regimes is much less visible than in the baseline. The first regime is weakly sustainable –it was unsustainable in the baseline– whereas the second regime is strongly sustainable. Also in contrast with the baseline, there is much less volatility in fiscal regimes. It can be seen in the average duration of regimes –they are substantially higher than in the baseline– and in the smoothed probabilities of sustainable regime. Figure 5 shows that, except before 1950 and after 2009, US public finances are characterized by a sustainable regime. A striking result though relates to the long-run estimate of the fiscal policy rule. The long-run sensitivity of the primary surplus to lagged debt is very close to what was achieved in the baseline. Both specifications –with and without corrections for potential reverse causality between the primary surplus and the output gap– lead us to conclude to global US debt sustainability. The alternative specification with correction displays a greater stability of the fiscal policy rule and a strongly persistent sustainable regime with respect to the baseline model.

Table 5: Estimated Markov-switching fiscal rule with expected output gap (1943-2016)

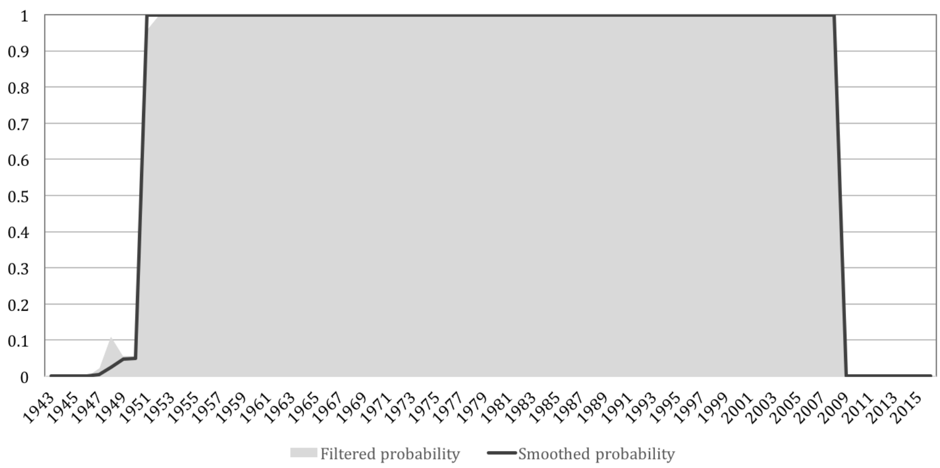
Dependent variable: s_t	Regime 1	Regime 2	Long-run estimates
Constant	-0.0736***	-0.0254**	-0.0380
	(0.0188)	(0.0108)	(0.0113)
Lagged debt b_{t-1}	0.0658*	0.0655***	0.0656**
	(0.0354)	(0.0218)	(0.0226)
Expected output gap $\mathbb{E}_{t-1} x_t$	0.6799***	0.4091***	0.4799***
	(0.1655)	(0.0704)	(0.0680)
Cyclical government spending g_t	-0.2813***	-0.1523***	-0.1860***
	(0.0291)	(0.0179)	(0.0161)
Regime properties	Transition prob. p_{ii}	Ergodic prob. π_i	Expected duration d_i
i=1	0.92	0.26	11.94
i=2	0.97	0.74	33.75
Durbin-Watson statistic	1.32	Log Likelihood	240.5754

Notes: Huber-White robust standard errors are reported in parenthesis. Reported estimates are significant at 1% level (***), 5% level (**) or 10% level (*). The model control for regime-invariant first-order serially correlated residuals.

These findings suggest that ignoring both regime-switching and reverse causality bias between primary balance and output gap may lead to underestimate the long-run response of primary balance to public debt and, as a result, to too conservative conclusions about fiscal sustainability.

[6] Using generated regressors in the second-step (Markov-switching) regression generally imply heteroscedasticity in residuals, hence we use a Huber-White variance-covariance estimator following the usual practice in empirical studies with generated regressors. While point estimates would likely be unbiased under the assumption of valid instruments, the use of Huber-White estimator would not yield a full-correction of estimated standard-errors from the bias induced by generated regressors. Hence parameters' significance should be interpreted with caution and, accordingly we do not run RS-MBS global sustainability tests.

Figure 5: Model with expected output gap: estimated probabilities of sustainable regime



5 Conclusions

This paper investigates the global (or long-run) sustainability of US public debt. The ups and downs of public debt raise two concerns: first, how long is it possible to postpone fiscal consolidation before public debt becomes unsustainable? And when fiscal consolidation occurs, is it tight enough to ensure long-run fiscal sustainability? We draw on Aldama and Creel (2017) and test the sufficient conditions on regime-switching fiscal policy feedback rules that permit to achieve a No-Ponzi Game and a Debt-Stabilizing condition. When these conditions are met, global sustainability is ensured despite persistent unsustainable fiscal regimes.

The main outcome of the paper is that fiscal policy in the US has been globally sustainable since 1940. On average, a 12-year period of fiscal consolidation's postponement does not preclude global fiscal sustainability, provided periods of fiscal consolidation last almost 6 years on average and embed a sharp reaction of primary balance towards lagged public debt (the semi-elasticity is equal to 8.7%). Introducing the possibility of an instability in the relationship between primary balance and public debt via fiscal regimes enables to highlight periods of sustainability and unsustainability and gives contrasting results *vis-à-vis* those obtained with a linear (or non-linear) fiscal feedback rule without regime switches, for which we found no evidence of fiscal sustainability.

Future research on US fiscal sustainability may go in two mutually non-exclusive directions. First, the use of quarterly data may reinforce the tests' statistical properties. The limitation with the use of quarterly data relates to public debt. Usually, they are only genuinely annual in that they reflect the annual flows of deficits and annual revaluations. In the US case, it should be possible however to use genuine public debt quarterly data, i.e. data which have not been transformed into quarterly data *a posteriori*. Second, the estimations of global sustainability abstract from the monetary regime and from a comprehensive macro feedback. As for the latter, we show that the main outcome of the paper remains valid after controlling for the reverse causality between the primary balance and the output gap. Introducing more macro feedbacks, like inflation dynamics and a monetary policy rule, could be done in a larger macro framework, like a dynamic stochastic general equilibrium model as advised recently by Leeper and Li (2017). It would permit to better highlight the endogeneity of fiscal policy to the macro context and to embed the test of global sustainability into a comprehensive framework.

References

Abel, Andrew B., N. Gregory Mankiw, Lawrence H. Summers, and Richard J. Zeckhauser, "Assessing Dynamic Efficiency: Theory and Evidence," *Review of Economic Studies*, 1989, *56* (1), 1–19.

Afonso, António and João Tovar Jalles, "The elusive character of fiscal sustainability," *Applied Economics*, January 2016, *0* (0), 1–14.

— **and Priscilla Toffano**, "Fiscal regimes in the EU," Working Paper Series 1529, European Central Bank 2013.

Aldama, Pierre and Jérôme Creel, "Why Fiscal Regimes Matter for Fiscal Sustainability: An Application to France," INFER Working Paper 2017-01 2017.

Auerbach, Alan J., "Is there a role for discretionary fiscal policy?," *Proceedings - Economic Policy Symposium - Jackson Hole*, 2002, pp. 109–150.

— **and Yuriy Gorodnichenko**, "Fiscal Stimulus and Fiscal Sustainability," Working Paper 23789, National Bureau of Economic Research September 2017. DOI: 10.3386/w23789.

Bianchi, Francesco, "Regime Switches, Agents' Beliefs, and Post-World War II U.S. Macroeconomic Dynamics," *The Review of Economic Studies*, September 2012, p. rds032.

Bohn, Henning, "The Sustainability of Budget Deficits in a Stochastic Economy," *Journal of Money, Credit and Banking*, February 1995, *27* (1), 257–271.

— , "The Behavior Of U.S. Public Debt And Deficits," *The Quarterly Journal of Economics*, 1998, *113* (3), 949–963.

— , "Are stationarity and cointegration restrictions really necessary for the intertemporal budget constraint?," *Journal of Monetary Economics*, 2007, *54* (7), 1837–1847.

— , "The Sustainability of Fiscal Policy in the United States," in "Sustainability of Public Debt," MIT Press, 2008, pp. 15–49.

Burger, Philippe and Marina Marinkov, "Fiscal rules and regime-dependent fiscal reaction functions," *OECD Journal on Budgeting*, 2012, *12* (1), 1–29.

Chen, Pei-Fen, "US Fiscal Sustainability and the Causality Relationship between Government Expenditures and Revenues: A New Approach Based on Quantile Cointegration," *Fiscal Studies*, June 2016, *37* (2), 301–320.

Chung, Hess, Troy Davig, and Eric M. Leeper, "Monetary and Fiscal Policy Switching," *Journal of Money, Credit and Banking*, 2007, *39* (4), 809–842.

Clarida, Richard, Jordi Galí, and Mark Gertler, "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory," *The Quarterly Journal of Economics*, February 2000, *115* (1), 147–180.

Daniel, Betty C., "A graceful return of the drachma," *European Economic Review*, October 2014, *71*, 228–243.

_ **and Christos Shiamptanis**, "Pushing the limit? Fiscal policy in the European Monetary Union," *Journal of Economic Dynamics and Control*, 2013, *37* (11), 2307–2321.

Davig, Troy and Eric M. Leeper, "Fluctuating Macro Policies and the Fiscal Theory," NBER Chapters, National Bureau of Economic Research, Inc 2007.

_ **and** _ , "Monetary-fiscal policy interactions and fiscal stimulus," *European Economic Review*, 2011, *55* (2), 211–227.

Favero, Carlo A. and Tommaso Monacelli, "Fiscal Policy Rules and Regime (In)Stability: Evidence from the U.S.," SSRN Scholarly Paper ID 665506, Social Science Research Network, Rochester, NY January 2005.

Geerolf, François, "Reassessing Dynamic Efficiency," Working Paper November 2013.

Ghosh, Atish R., Jonathan D. Ostry, and Mahvash S. Qureshi, "Fiscal space and sovereign risk pricing in a currency union," *Journal of International Money and Finance*, April 2013, *34*, 131–163.

_ **, Jun I. Kim, Enrique G. Mendoza, Jonathan D. Ostry, and Mahvash S. Qureshi**, "Fiscal Fatigue, Fiscal Space and Debt Sustainability in Advanced Economies," *The Economic Journal*, 2013, *123* (566), F4–F30.

Hamilton, James D., "A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle," *Econometrica*, 1989, *57* (2), 357–84.

Hamilton, James D and Marjorie A Flavin, "On the Limitations of Government Borrowing: A Framework for EmpiricalTesting," *American Economic Review*, 1986, *76* (4), 808–19.

Leeper, Eric M. and Bing Li, "Surplus–debt regressions," *Economics Letters*, 2017, *151* (C), 10–15.

Lubik, Thomas A. and Frank Schorfheide, "Testing for Indeterminacy: An Application to U.S. Monetary Policy," *American Economic Review*, 2004, *94* (1), 190–217.

Mendoza, Enrique G. and Jonathan D. Ostry, "International evidence on fiscal solvency: Is fiscal policy "responsible"?," *Journal of Monetary Economics*, 2008, *55* (6), 1081–1093.

Nguyen, Thanh Dat, Sandy Suardi, and Chew Lian Chua, "The Behavior of U.s. Public Debt and Deficits During the Global Financial Crisis," *Contemporary Economic Policy*, January 2017, *35* (1), 201–215.

Quintos, Carmela E, "Sustainability of the Deficit Process with Structural Shifts," *Journal of Business & Economic Statistics*, 1995, *13* (4), 409–17.

Ravn, Morten and Harald Uhlig, "On adjusting the Hodrick-Prescott filter for the frequency of observations," *The Review of Economics and Statistics*, 2002, *84* (2), 371–375.

Trehan, Bharat and Carl E Walsh, "Common trends, the government's budget constraint, and revenue smoothing," *Journal of Economic Dynamics and Control*, 1988, *12* (2-3), 425–444.

— **and Carl E. Walsh**, "Testing Intertemporal Budget Constraints: Theory and Applications to U.S. Federal Budget and Current Account Deficits," *Journal of Money, Credit and Banking*, 1991, *23* (2), 206–23.

Wilcox, David W., "The Sustainability of Government Deficits: Implications of the Present-Value Borrowing Constraint," *Journal of Money, Credit and Banking*, 1989, *21* (3), 291–306.

A Expected output gap estimates

The first-stage equation is:

$$x_t = \phi_0 + \rho_1 x_{t-1} + \rho_2 x_{t-2} + \phi_1 s_{t-1} + \phi_2 b_{t-2} + \phi_3 \tilde{g}_t + \varepsilon_t \tag{9}$$

We report OLS estimates of equation (9) in table 6. Then, we define the expected output gap $\mathbb{E}_{t-1}\, x_t$ by the fitted values $\hat{x}_t$ obtained from estimated equation (9).

Table 6: Estimated equation for expected output gap

Dependent variable: Output gap x_t	Estimates
Constant	0.0027
	(0.0058)
x_{t-1}	0.7976***
	(0.1191)
x_{t-2}	-0.4360***
	(0.0951)
s_{t-1}	-0.1001*
	(0.0680)
b_{t-2}	-0.0074
	(0.0123)
$\tilde{g}_t$	0.0494*
	(0.0243)
Adjusted R^2	0.7961
Durbin-Watson stat	2.1256

Notes: standard errors are reported in parenthesis. Reported estimates are significant at 1% level (***), 5% level (**) or 10% level (*).

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