Could fiscal dominance have reduced high public debt during the seven-year post financial crisis?

Gilles Dufrénot,[a,b] Fredj Jawadi,[c] Guillaume A. Khayat[a]

[a] Aix-Marseille Univ. (Aix-Marseille School of Economics), CNRS, EHESS and Centrale Marseille, France.
[b] CEPII, France.
[c] University of Evry & EconomiX, France. Corresponding author, Email: fredj.jawadi@univ-evry.fr

Abstract

The main contribution of this paper is to examine the conditions under which fiscal dominance could have helped reduce the high public debt ratios that built up in industrialized countries during the seven years of the post financial crisis. To this end, we propose a simple model of an open economy, where the central bank trades off between stabilizing the business cycle and targeting inflation to a level that would stabilize the public debt ratio. Fiscal dominance is successful in lowering debt ratios when output is reactive enough to unconventional monetary policy and if the expectations of future inflation are well anchored to the debt-stabilization inflation target. We then lay out some empirical evidence that the conditions derived from our model were unevenly applied across industrialized countries (Japan, the United Kingdom, the United States and the Eurozone). The results apply whether a government is Ricardian or non-Ricardian.

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Keywords

Fiscal dominance, debt sustainability, unconventional monetary policy

1. Introduction

A major consequence of the 2008 financial crisis was the sharp rise in public debt ratios in industrialized countries. Given the strong Keynesian effects of fiscal consolidation during economic downturns, fiscal policies were unable to bypass constraints to rapidly lower the high levels of sovereign debt. In this context, economic policy debates brought back to the agenda the idea that monetary policy could come to the rescue of fiscal policy through the practice of fiscal dominance. The idea is that monetary policy can influence the factors affecting the dynamics of public debt ratio other than primary deficits: i.e., the effective real interest rate paid on sovereign debt and the real GDP growth rate. Fiscal dominance, sometimes referred to as unconventional fiscal policy, is aimed at shaping the interest rate/growth rate differential in such a way as to make public debt sustainable. Monetary policy is responsible for achieving this objective. Indeed, the aim is to make the real interest rates anticipated in the future strongly negative by causing inflation expectations.

This paper proposes a stylized model of an open economy where a central bank uses unconventional monetary policy to fight both economic stagnation and debt unsustainability. We assume that a binding zero lower bound and monetary policy is described by a quantitative easing policy (purchase of a fraction of newly issued government bonds).

The model's novelty comes from the way we construct fiscal dominance. Unlike some previous papers, the central bank does not monetize public deficits through seignorage. Changes in long-term interest rates (which matter for investment) occur as a result of purchases and sales of sovereign bonds by the monetary authorities. Changes in nominal interest rates modify the cost of public debt. After an increase in the nominal rate, the central bank has an explicit objective regarding rising inflation. To sway agents' expectations, the rule for setting the inflation target is transparent: whenever the debt ratio moves above the level that would stabilize it, the monetary authorities have a higher inflation target and make this intention credible with an unconventional expansionary policy. Conversely, when the nominal rates fall and reduce the debt ratio, the inflation target is lowered.

While a large body of the literature on unconventional monetary policies focuses on the transmission channels of the real economy and the financial markets, our study examines their impact on the dynamics of inflation as an element determining public finance solvency. Indeed, inflation affects several key determinants of public debt ratios and leads to a decrease in the real interest rate, which is needed to stimulate production. Moreover, depending on the degree of inflation expectations anchoring, it helps to accelerate the convergence of debt ratios towards their sustainable level in the medium term, when fiscal policy hits a fiscal limit. Finally, "inflation tax" helps to offset the negative effects on the cost of debt that follows currency depreciations in open economies.

We find three main conditions for a fiscal dominance strategy to be successful in terms of stabilizing debt ratio over time. First, the impact of unconventional monetary policy on output needs to be high enough. This means that the QE policy must induce significant changes in the exchange rate and in the long-term interest rate. Second, inflation expectations need to be anchored to the debt-stabilizing inflation rate for rapid convergence of the debt ratio to its medium-term value. Third, the interest rate-growth differential can occasionally be positive if the fiscal policy is Ricardian, but must always be negative if the fiscal policy is non-Ricardian.

Following the theoretical model, we empirically examine whether these conditions have been fulfilled in certain major industrialized countries. This shows us whether fiscal dominance strategies could have been successful in stabilizing sovereign debt had they been used in Japan, the United Kingdom, the United States or the Euro area after 2008. Our empirical findings highlight several factors. First, fiscal policy alone could not have achieved debt solvency given the fact that the primary balance required to stabilize debt ratio was below the historical primary balance. Second, although the effective cost of public debt has been declining in all countries, there are differences among them in terms of the speed and magnitude of the decline. A comparison of the long-term interest rate with the estimated natural rate of the economies suggests that unconventional monetary policy has been less expansionary in the Eurozone. In spite of this difference, we find that the situation that best characterizes these countries is one of ‘strong’ fiscal dominance whereby monetary policy determines the sustainability as well as the convergence of the debt ratios.

Our paper relates to two strands of the literature that have seen new developments since the Great recession of 2008.

The first strand concerns the recent literature on fiscal dominance. Older theories sought to develop a new approach to the determination of general price level, competing with the quantity theory of money.[1] More recent analyses have focused on the determination of macroeconomic equilibria when monetary policy is allowed to respond to fiscal development, or when Treasuries face fiscal limits.[2] There seems to be a consensus that a side effect of unconventional monetary policies is a disguised form of financial repression, given the very low level of long-term rates (see, for instance, Aizenman and Marion, 2010; Reinhart and Sbrancia, 2015). However, since nominal rate cuts are themselves limited, real interest rates could be reduced further through inflation. This last aspect has been little discussed in the literature to date. The present paper attempts to contribute to the debate by examining some of the conditions in which inflation could improve the solvency of public finances.

The second strand is the literature on public debt overhang. Reinhart et al. (2012) argued that such situations occur when public debt-to-GDP ratios exceed 90% for at least five years. The current context of secular stagnation has raised a controversial debate about how central banks and governments should react to deal with high public debt levels. When central banks cannot reduce the interest rate below the zero lower bound, an alternative policy could be to replace physical currency by electronic currency (see Rogoff, 2014). Other strategies historically used for dealing with high debt are “debt liquidation” through inflation, financial repression or outright default (Reinhart et al., 2015; Reinhart and Rogoff, 2014; Lo and Rogoff, 2015). Governments can also fend off large structural deficits (by increasing the primary surplus or reducing public spending) in order to enlarge their fiscal space Mauro et al., 2013).

Our paper seeks to contribute to this literature. In our view, fiscal buffers are hard to maintain with the conjunction of the following three factors, typical of the current secular stagnation situation in industrialized countries: low natural interest rates, disinflationary pressures and declining potential growth.[3] Fiscal consolidation does not necessarily lead to the collapse of public debt ratios because of a negative feedback loop between debt buildups and initial low growth rates. Indeed, high debt has growth-reducing effects, and in turn low growth rates have a cumulative impact on the rise of debt through a decrease in the interest rate-growth differential.

[1] The literature is abundant. A selection of seminal papers includes Leeper (1991), Sargent and Wallace (1981), Sargent (1982), Sims (1994), Woodford (1996).

[2] See Bank of International Settlements (2012), Davig et al. (2011), Correia et al. (2012), Kumhoff (2008), Schmitt-Grohé and Uribe (2007), Turner (2011), Woodford (2001).

[3] For an overview of the economics of secular stagnation, the reader can refer to the American Economic Review (2015) or to the book edited by Baldwin and Teulings (2014).

We want to examine whether a monetary policy, under fiscal dominance, could help to restore sustainable sovereign debt levels.

The remainder of the paper is organized as follows. Section 2 presents a simple model of an open economy where the central bank's unconventional monetary policy is established under fiscal dominance. Section 3 discusses the asymptotic stability of inflation rate dynamics and the debt ratio. In Section 4, we question whether certain major industrialized countries have historically satisfied some of the conditions for the success of fiscal dominance in dealing with public debt sustainability. Finally, Section 5 concludes.

2. The model

We propose a variant of a standard open economy Keynesian model. The economy is stuck at the zero lower bound and monetary policy is implemented through unconventional monetary policy (quantitative and qualitative easing). Prices and the exchange rate are flexible. The central bank trades off between the sustainability of sovereign debt and output stability. The government issues sovereign debt held by the domestic central bank or by foreign investors. It may be Ricardian (if the primary deficit ratio is reduced when the sovereign debt ratio increases) or non-Ricardian.

The model is written using log-linearized equations.

2.1. Debt and fiscal dominance in an open economy

2.1.1. The dynamics of the debt ratio

The world economy is summarized by two countries: the home country h and the foreign country *f*. The asset markets consist of sovereign bonds. The government in the home country issues new nominal bonds to finance its deficit. A fraction of these new bonds is bought by the domestic central bank, and the remaining fraction is held by a foreign central bank. Similarly, the foreign government issues new foreign bonds held by the foreign central bank and by the home country's central bank.

The domestic and foreign bonds are imperfectly substitutable.

Formally, let us define the following variables.

$0 < \lambda_t^h < 1$: share of local denominated government debt,

$\lambda_t^f = 1 - \lambda_t^h$: share of foreign denominated government debt,

i_t^L: yield of local currency-denominated sovereign debt

i_t^{Lf}: yield of foreign currency denominated debt

i_t: nominal effective interest rate,

$\varepsilon_t = \frac{s_t - s_{t-1}}{s_{t-1}} = \frac{\Delta s_t}{s_{t-1}}$: rate of change of the nominal exchange rate ($\varepsilon_t > 0$ means a depreciation),

D_t, B_t: outstanding nominal sovereign debt and primary balance,

$0 < \theta^h < 1$: share of the non-tradable sector, $0 < \theta^f < 1$: share of the tradable sector,

μ_t^h, μ_t^f: real growth rate of the non-tradable/tradable sector,

π_t^h, π_t^f: domestic/foreign interest rate,

d_t, b_t: debt and primary balance ratios (share of GDP),

The government incurs primary deficits and issues non-contingent long-term sovereign bonds to domestic and foreign investors. In both countries, the central banks are assumed to be borrowers of a last resort. We therefore make no difference between private investors and central banks.

The outstanding nominal debt evolves as follows:

$$D_t = \left[1 + \lambda_t^h i_t^L + \lambda_t^f (i_t^{Lf} + \varepsilon_t + \varepsilon_t i_t^{Lf})\right] D_{t-1} - B_t \quad (1)$$

Defined as

$$i_t = \hat{\imath}_t + \varepsilon_t \lambda_t^f \left(1 + i_t^{Lf}\right), \ \hat{\imath}_t = \lambda_t^h \ \ i_t^L + \lambda_t^f i_t^{Lf} \quad (2)$$

The effective nominal interest rate paid on sovereign debt has two components. The first component is the weighted average of domestic and foreign interest rates. The second component is the exchange rate-induced gains or losses in foreign debt service obligations.

Nominal GDP can be decomposed into the GDP of the non-tradable sector and the tradable sector:

$$p_t y_t = p_t^h y_t^h + s_t p_t^f y_t^f \quad (3)$$

where p_t^h, p_t^f are domestic and foreign prices, and y_t^h, y_t^f are domestic and foreign outputs. By denoting the shares of the tradable and non-tradable sectors (defined in the previous period) as

$$\theta^h = \frac{p_{t-1}^h y_{t-1}^h}{p_{t-1} y_{t-1}}, \ \theta^f = 1 - \theta^h \quad (4)$$

we have

$$\pi_t = \hat{\pi}_t + \varepsilon_t \theta^f \left(1 + \pi_t^f\right), \ \hat{\pi}_t = \theta^h \pi_t^h + \theta^f \pi_t^f \quad (5)$$

The effective inflation rate is defined as the weighted average of domestic and foreign inflations and the exchange rate-induced gains and losses in the tradable goods sector.

Equation (1) can be rewritten in terms of ratio of GDP as follows:

$$\Delta d_t = \frac{(\rho_t - \mu_t)}{(1+\mu_t)} d_{t-1} - b_t, \;\; \rho_t = \frac{(\hat{\imath}_t - \hat{\pi}_t) + \varepsilon_t\left[\lambda_t^f\left(1+i_t^{Lf}\right) - \theta^f\left(1+\pi_t^f\right)\right]}{1+\hat{\pi}_t + \theta^f\left(1+\pi_t^f\right)} \quad (6)$$

where $\mu_t = \theta^h \mu_t^h + \theta^f \mu_t^f$. ρ_t is the effective real interest rate paid on the home country's sovereign debt. This equation is a generalization of the standard debt dynamics equation to an open economy. Under trade and financial autarky ($\lambda^h = \theta^h = 1$), we retrieve the standard debt equation of a closed economy.

We assume that the home and foreign countries' bond markets are imperfectly integrated and imperfect capital mobility holds, which implies that the domestic and foreign long-term rates do not equate ($i_t^L \neq i_t^{Lf}$). Under a floating exchange rate regime, we also assume that the condition of Uncovered Interest Rate Parity (UIRP) holds:

$$s_t = i_t^{Lf} - i_t^L + s_{t+1}^e - \varphi_t, \quad \varphi_t = -\psi\, nfa_t \quad (7)$$

s_{t+1}^e is the expectation made at time *t* of the nominal exchange rate at time *t+1* (assumed to be exogenous). φ_t is the exchange rate risk premium which depends on net foreign assets (nfa_t), defined as the difference between the holding of foreign bonds by the home country and the holding of domestic bonds by the foreign country (as a share of GDP). $\psi > 0$ is a parameter.

If the foreign country holds more of the home country's sovereign bonds (or if the domestic central bank reduces the amount of newly issued domestic sovereign bonds in its balance-sheet), this deteriorates the home country's external financial position (decrease in net foreign assets) and causes an increase in the exchange rate risk premium.

2.1.2. Fiscal dominance

If, over a given period, the effective real interest rate ρ_t is higher than the growth rate μ_t, then the first-term in the right-hand side of Equation (6) is positive and implies a higher debt ratio. The equation indicates that, to stabilize this ratio, a government needs to reduce deficit or improve the fiscal balance over this period.

However, debt as a share of GDP could still increase. The reasons are threefold. First, the debt dynamics shows a sensitivity to initial conditions. When a country starts a given period with a high debt ratio, it takes time before a reduction is observed in the debt ratio. Second, the empirical literature suggests that fiscal consolidation policies have strong Keynesian effects, especially in times of recession (see Auerbach and Gorodnichenko, 2013; Blanchard and Leigh, 2013; Jorda and Taylor, 2013; Fazzari et al., 2015). Third, the economic growth theory suggests that when an economy deviates from the golden rule, with an interest rate higher than economic growth, a problem of dynamic efficiency occurs. Indeed, capital accumulation is low, and a higher aggregate demand can be obtained at this time, but at the expense of a reduction in the income available for future generations. To drive the economy along an efficient path, the government needs to reduce debt until the interest rate drops and stimulates the expansion of output, thereby leading to an increase in capital accumulation. Meanwhile, in a context of moderate economic growth experienced by some industrialized countries, the return to capital is not high enough to motivate higher capital investment. In this context, dynamic inefficiencies are likely to persist (with $\mu_t < \rho_t$) due to the combination of a low inflation rate, low economic growth and low investment.

As a consequence, governments cannot necessarily build on fiscal consolidation strategies to avoid an upward trend debt trajectory over a long period and might instead prefer a fiscal dominance scenario. Fiscal dominance refers to a situation whereby the central banks seek to deflate the real value of debt through high inflation rates and low nominal interest rates. This strategy is sometimes referred to as "debt liquidation". Though the idea is ancient in the literature (innate to the fiscal theories of price level), it was considered to be inconsistent with the independence of central banks during the years of the Great moderation. It has re-emerged since the Great recession of 2008, however (Turner, 2011; Blommestein and Turner, 2012; Reinhart and Sbrancia, 2015).

In this regard, central banks may be preoccupied with sovereign debt management, and seek to stabilize debt ratios for several reasons:

i) to avoid debt distress and the negative effects of potential future defaults on economic activity;
ii) to avoid sharp increases in taxes or sharp decreases in public spending that tend to drive recession. When the fiscal policy's room for manoeuver is limited, fiscal dominance can help immunize against fiscal shocks (for instance, a sharp increase in taxes during recessions);[4]
iii) to affect the maturity structure of bonds held by the private sector (portfolio rebalancing effect) in such a way as to induce wealth effects and boost private sector spending;
iv) during recessions, commercial banks get rid of their public bond assets (especially when the initial debt level is high, the fear of default increases). This increases the deflation risk of these assets' prices in the bond markets and raises the long-run interest rate. To avoid such effects, central banks are inclined to be borrowers of last resort.

We define fiscal dominance as a situation in which the central bank does not seek to prevent the occurrence of high inflation rates (the concern today would rather be how to avoid potential deflationary episodes), but seeks to achieve stable paths for the sovereign debt ratio.

If we define $R_t = \frac{(\rho_t - \mu_t)}{(1+\mu_t)}$, a recursive solution of Equation (6) is:

[4] For the standard approach of fiscal insurance strategies by governments and the fact that they make sovereign debt more sustainable, see Borenzstein and Mauro (2004), Marcet and Scott (2009), Missale (2012).

$$d_t = \frac{d_{t+\tau}}{\prod_{\upsilon=1}^{\tau}(1+R_{t+\upsilon-1})} + \sum_{\upsilon=0}^{\tau} \frac{b_{t+\tau}}{\prod_{\upsilon=1}^{\tau}(1+R_{t+\upsilon-1})}. \tag{8}$$

The transversality condition that guarantees the sustainability of sovereign debt is:

$$\lim_{\tau\to+\infty} d_t \frac{\prod_{\upsilon=1}^{\tau}(1+\varrho_{t+\upsilon-1})}{\prod_{\upsilon=1}^{\tau}(1+R_{t+\upsilon-1})}=0 \text{ or } \prod_{\upsilon=1}^{\tau}(1+\varrho_{t+\upsilon-1}) < \prod_{\upsilon=1}^{\tau}(1+R_{t+\upsilon-1}), \tag{9}$$

where ϱ_t is the growth rate of the debt ratio between time *t-1* and *t*.

Debt is sustainable if the long-run value of the debt growth rate (defined as the 'compound' gross growth rates of short-term debts) is lower than the compound interest rate differentials. Whatever the level of the debt ratio (either defined exogenously or decided by a Ricardian government), the central bank needs to adjust both the nominal interest rate and the inflation rate (for a given foreign nominal interest rate and inflation rate) to ensure the debt sustainability.

Suppose that, in a context of secular stagnation, the government does not pay off its debt and decides to systematically roll it over. This could lead to a bubble in the sovereign debt market (a situation of permanent indebtedness). To discard bubbly sovereign assets, the central bank should drive inflation expectations in such a way that the observed inflation rate satisfies the transversality condition. In a context of secular stagnation characterized by low inflation rates or deflation, an increase in the inflation rate is not compensated by higher nominal rates on sovereign assets (because the inflation risk premium is low).

Therefore, the inequality in (9) implies that if the debt ratio increases at some point in time, the central bank should drive future inflation rate expectations in such a way that they rise enough and lead to an increase in the inflation rate to cover the government's net expenses plus the interest rate. Moreover, the monetary authorities need to act as borrowers of last resort since foreign holders of domestic debt are unlikely to postpone consumption forever. Indeed, a monetary policy that consists of purchasing higher amounts of domestic public debt (like unconventional monetary policies) prevents beliefs being formed by foreign debt holders regarding a future debt default. Unconventional monetary policies can thus be thought of as an early warning sign that the central bank wants to avert debt default by lowering the nominal value of total debt service.

If the transversality condition holds, then

$$d_t = \sum_{\upsilon=0}^{\tau} \frac{b_{t+\tau}}{\prod_{\upsilon=1}^{\tau}(1+R_{t+\upsilon-1})} \tag{10}$$

If the debt ratio increases and future primary surpluses are exogenous, then public debt sustainability can be expected if, at some point in time, the central bank acts in such a way that the interest rate (net of the economic growth rate) decreases, thereby increasing the present value of accumulated future primary surpluses. The stability of the debt-to-GDP ratio is sufficient condition to guarantee public debt sustainability.

Therefore, we assume that to achieve fiscal sustainability at time *t*, the central bank chooses an inflation rate target for which the debt ratio stabilizes at that period.

From Equation (6), the debt ratio is stabilized when $\Delta d_t = 0$. Solving the domestic inflation rate equation and denoting the solution π_t^{hT} (the upper index T means "target"), we obtain:

$$\pi_t^{hT} = \frac{1}{\theta^h(1+A_t)}\left\{-A_t B_t^f + \lambda_t^h \ \ i_t^L + C_t^f\right\} \tag{11}$$

where

$$A_t = \mu_t + \frac{b_t(1+\mu_t)}{d_{t-1}}, \quad B_t^f = 1 + \theta^f \pi_t^f + \theta^f(1+\pi_t^f) \tag{12a}$$

$$C_t^f = \lambda_t^f i_t^{Lf} - \theta^f \pi_t^f + \varepsilon_t\left[\lambda_t^f\left(1+i_t^{Lf}\right) - \theta^f(1+\pi_t^f)\right] \tag{12b}$$

Our modelling of fiscal dominance differs in three respects from the previous literature on the same issue.

First, we go beyond the usual assumption that domestic authorities choose to deflate only domestic currency-denominated debt. We see that an increase in i_t^L implies a higher inflation target for the debt ratio to remain sustainable. However, from the expression in C_t^f, we see that any increase in the real foreign debt service also implies a higher inflation target. Therefore, unlike some papers such as Sunder-Plassmann (2016) or Du and Schreger (2016), we assume that the denomination of sovereign debt does not affect the central bank's incentive to deflate or not the real value of debt.

Second, issuing bonds in foreign or domestic currency are not alternative policies. While the central bank can decide to reduce the amount of domestic sovereign debt in its balance sheet (which implies more foreign currency-denominated debt), it may still choose the option of debt liquidation through inflation.

Third, there is no inflation premium, in the sense that debt deflation is not compensated by an increase in the nominal yield.

2.2. Unconventional monetary policy

Monetary policy focuses on attaining both output stability and sovereign debt sustainability. We assume that the zero lower bound (ZLB) is binding, so the short-term rate cannot be used as a policy instrument. Instead, the central bank resorts to two types of policies: *i)* unconventional monetary policy (quantitative or qualitative easing) by buying or selling newly issued domestic/foreign bonds from its balance sheet; *ii)* it communicates on its inflation target in order to change private sector expectations of future inflation rates.

Unconventional monetary policies therefore aim at impacting the long-run nominal interest rate i_t^L, while the forward guidance policy through announcements of π_t^{hT} is used to alter inflation expectations. This policy takes place in a context of fiscal dominance because π_t^{hT} is the inflation rate for which the debt ratio is stabilized at time t.

Formally, these policies are described as follows.

The stock of home sovereign bonds held by the domestic central bank is the sum of the stock initially held and the amount of newly issued bonds: $\lambda_t^h d_{t-1} + \lambda_t^h \Delta d_t = \lambda_t^h \quad d_t$ (debts are expressed as ratios of GDP).

Let us denote λ_t^{hf} as the share of foreign bonds held by the domestic central bank, d_t^f the foreign country's debt ratio at time *t* (as a share of the domestic GDP), λ_t^f the share of home bonds held by the foreign central bank (also expressed as a ratio of the domestic GDP), and $M0_t$ the assets of commercial banks that consist entirely of reserves (monetary base-to-GDP ratio).

On the asset side, the domestic central bank's balance sheet has two elements:

- Domestic sovereign bonds: $= \lambda_t^h \quad d_t$,

- Net foreign assets: $nfa_t = \lambda_t^{hf} \quad s_t d_t^f - \lambda_t^f d_t$, and $\lambda_t^f = 1 - \lambda_t^h$.

On the liability side, the only element is the monetary base that consists of commercial banks' reserves used to extend credit to the private home sector. The central bank's balance sheet is written:

$$bal_t = \underbrace{\lambda_{t-1}^h d_{t-1}}_{\substack{Share\ of\ public\ debt \\ held\ by\ the\ CB \\ at\ time\ t-1}} + \underbrace{\lambda_t^h \Delta d_t}_{\substack{Share\ of\ new\ bonds \\ issued\ held\ by\ the \\ CB\ at\ time\ t \\ (QE\ policy)}} + \underbrace{(\lambda_t^{hf} \quad s_t d_t^f - \lambda_t^f d_t)}_{Net\ foreign\ assets} = M0_t \qquad (13)$$

The quantity of reserves demanded by commercial banks is assumed to be exogenous and is inelastic to the long-term rate (they depend on the short-term rate which is set at zero under the ZLB). In the left-hand side of equation (13), the reserves supply has an impact on the domestic long-term rate through several channels (portfolio rebalancing effect, signal effect).

The central bank either increases the size of its balance sheet by purchasing the new bonds issued by the domestic government (quantitative easing) or by buying more foreign bonds. In either case, an increase in the supply of reserves raises the price of bonds, thereby reducing the domestic long-term interest rate. The latter is written as:

$$i_t^L = -\eta(bal_t) + u_t^L, \ \eta > 0. \qquad (14)$$

u_t^L is a noise.

Equation (11) results from the following assumptions. First, we consider a standard relationship between the long and short-term rates, the former being an average of current and expected future short-term rates:

$$i_t^L = \gamma(i_t^S) + (1-\gamma)(i_t^{Se}). \qquad (15)$$

For the purpose of simplicity, the premium component is assumed to be nil and the second term captures the average of all expected future short-term rates. In a context of ZLB, we have $i_t^S = 0$.

Second, from the macro-finance literature, the forecasted future short-term rate can be expressed as a linear function of state vectors that capture changes in the underlying macroeconomic and financial fundamentals, provided that the price of risk has an affine structure (which is a standard assumption in the literature; see Duffie and Kan, 1996; Ang and Piazzesi, 2003; Rudebusch and Wu, 2008). We assume that the expected short-term rate depends on the central bank projections of sovereign debt holdings (like the LSAP programme). ε_t^L is a noise component that captures an interest rate shock.

Inflation forecasts are defined by:

$$\pi_{t+1}^{he} = \chi\pi_t^{hT} + (1-\chi)\pi_{t-1}^h, \ 0 < \chi < 1 \qquad (16)$$

The recent literature suggests that *i)* inflation expectations are a reflection of credible monetary policy (Mehrotra and Yetman, 2014) and that *ii)* they are positively related to unconventional monetary policy measures (Boleva et al., 2016). Inflation forecasts are considered to reflect credible monetary policy. When expectations are not well anchored, χ is small. The novel assumption here concerns the introduction of fiscal dominance, since we assume that the targeted inflation π_t^{hT} is the inflation rate that stabilizes the sovereign debt ratio.

When the central bank buys debt to finance higher deficits (decrease in b_t), output increases (multiplier effect) and in turn the rate of inflation increases. All things being equal, this reduces the effective exchange rate paid on sovereign debt (lower debt service). The current debt ratio shrinks and the central bank can target a lower inflation rate to achieve debt sustainability. Deficit financing therefore drives inflation expectations downward.

2.3. IS curve and aggregate supply

The microeconomic foundations of the IS curve and aggregate supply equation are not presented here. We consider their macroeconomic reduced form.

The IS curve in the domestic country is as follows:

$$y_t - \bar{y} = -\alpha\left(i_t^L - \pi_{t+1}^{he} - \overline{rr}^L\right) + \beta(e_t - \bar{e}\ ) - \delta b_t + v_t \qquad (17)$$

where $\alpha, \beta, \delta > 0$ are parameters, y_t is real domestic output, $\bar{y}$ is potential output, i_t^L is the nominal long-term interest rate, π_{t+1}^{he} is the private sector's forecast of the inflation rate at time *t+1*, made at time *t* in the home country, $e_t = s_t + p_t^* - p_t$ is the real exchange rate, p_t^*, p_t are foreign and domestic prices, b_t is the primary balance as share of GDP, $\overline{rr}^L$ is the natural interest rate and $\bar{e}$ is the average exchange rate over the period.

The domestic output gap is a function of the long-term interest rate gap defined as the real ex-ante interest rate minus the natural rate, while α is the sensitivity of the output gap to the long-term ex-ante real interest rate. We assume that real depreciation boosts production and that fiscal policies have a Keynesian effect. v_t is a demand shock.

Equation (17) characterizes the good markets and can be used to illustrate what happens in a context of secular stagnation, for instance. Output can remain stuck at levels well below its potential in three cases: *i)* the natural rate is so low that it is hard for the real long-term interest rate to reach its true level; *ii)* fiscal policy is excessively restrictive (this happens generally when the debt ratio is high); *iii)* the domestic currency is overvalued and lies above its long-run value. An expansive QE policy can help to cut the nominal rate and improve the country's competitiveness. A fiscal dominance policy can help alleviate the contractionary effects of fiscal consolidation policies to the extent that the monetary authorities publicly announce that they are ready to proceed with debt liquidation through inflation if necessary. Such a strategy is tantamount to loosening the government's budgetary constraints.

In the IS curve, the debt ratio does not enter as an explanatory variable in the right-hand side of the equation. This choice is motivated as follows: the holders of sovereign bonds are the commercial banks. They hold sovereign bonds for their own sake, in addition to being intermediaries between households and bond markets. In the first case, they do not necessarily expand credit to the private sector (firms and households) after a QE policy. Indeed, the recent empirical literature suggests that, though the level of reserve balances has increased significantly, money multipliers have remained weak in many industrialized countries. The reason is that increased reserves have led to higher loans in the financial sector (but not necessarily from the financial and banking sector to the real sector). In the case where banks sell bonds as households' 'agents', we assume that the wealth effects are not significant. This amounts to assuming that households are Ricardian: they know that the central bank may go through periods of expansionary monetary policy retrenchment and thereby smooth their consumption accordingly.

Therefore, the purchases and sales of sovereign bonds have an impact on output through a standard multiplier effect of changes in primary balances, and through the interest rate channel.

Aggregate supply is given by a standard Phillips curve equation of the form

$$\pi_t^h = \pi_{t+1}^{he} + \tau_1(y_t - \bar{y}) + \tau_2(e_t - \bar{e}\ \ ) + \mathrm{Z}_t, \tag{18}$$

where $\tau_1,\ \tau_2 > 0$ are parameters. Z_t is a noise that captures a supply shock. Current inflation depends on expectations of future inflation. Changes in the exchange rate modify import prices, which in turn imply changes in the cost of imported goods and wage compensation. Thus, firms react by changing their prices. The two other components (expectations of future inflation and output gap) are standard and stem from the combination of an augmented Phillips curve and Okun's law.

3. Monetary policy under fiscal dominance

3.1. The monetary authorities' optimal choice

We now introduce the central bank's loss function. This focuses on stabilizing the business cycle and the inflation rate, provided these goals do not conflict with the goal of retaining a sustainable level of debt ratio. The central bank endeavors to achieve its output and inflation targets (fiscal dominance stabilizing inflation is equivalent to stabilizing the debt ratio), and seeks λ_t^h that minimizes its lifetime loss function as:

$$\sum_{t=0}^{\infty} \beta^t L_t(y_t, \pi_t^h),\ L_t(y_t, \pi_t^h) = -0.5(y_t - \bar{y})^2 - 0.5\aleph_1\left(\pi_t^h - \pi_t^{hT}\right)^2 \tag{19}$$

subject to constraints (11), (17), (18). $\aleph_1>0$ is a parameter capturing the weight that the central bank places on the debt liquidation objective relative to the stabilization of output. $0 < \beta < 1$ is a constant discount factor.

The plan $\{y_t, \pi_t^h\}_{t\geq 0}$ is optimal if the first-order condition holds in each period *t*. The first-order condition is

$$\frac{\partial L_t}{\partial \lambda_t^h} = 0 \ \rightarrow (y_t - \bar{y}) = -\aleph_1 \frac{\frac{\partial(\pi_t^h - \pi_t^{hT})}{\partial \lambda_t^h}}{\frac{\partial(y_t - \bar{y})}{\partial \lambda_t^h}} \left(\pi_t^h - \pi_t^{hT}\right) \tag{20}$$

where

$$\frac{\partial(y_t - \bar{y})}{\partial \lambda_t^h} = \underbrace{-\alpha \frac{\partial i_t^L}{\partial \lambda_t^h}}_{(1)} + \underbrace{\alpha \frac{\partial \pi_{t+1}^{he}}{\partial \lambda_t^h}}_{(2)} + \underbrace{\beta \frac{\partial(e_t - \bar{e}\ \ )}{\partial \lambda_t^h}}_{(3)} \tag{21}$$

$$\frac{\partial i_t^L}{\partial \lambda_t^h} = -\eta[\Delta d_t + d_t] < 0 \tag{22a}$$

$$\frac{\partial \pi_{t+1}^{he}}{\partial \lambda_t^h} = \chi \frac{\partial \pi_t^{hT}}{\partial \lambda_t^h} = \frac{\chi}{\theta^h(1+A_t)} \left[(i_t^L - \varepsilon_t[1 + i_t^{Lf}]) + \underbrace{\lambda_t^h \frac{\partial i_t^L}{\partial \lambda_t^h}}_{(4)} + \underbrace{(\omega_t) \frac{\partial \varepsilon_t}{\partial \lambda_t^h}}_{(5)} \right] \tag{22b}$$

$$\omega_t = \lambda_t^f (1 + i_t^{Lf}) - (1 + A_t)\theta^h(1 + \pi_t^f) \tag{22c}$$

$$\frac{\partial \varepsilon_t}{\partial \lambda_t^h} = \frac{1}{s_{t-1}} \frac{\partial s_t}{\partial \lambda_t^h} = \frac{1}{s_{t-1}} \left[\underbrace{\frac{1}{(1 - \psi \lambda_t^{hf} d_t^f)}}_{(8)} \right] \left[\underbrace{-\frac{\partial i_t^L}{\partial \lambda_t^h}}_{(6)} \underbrace{- \psi \frac{\partial \lambda_t^f}{\partial \lambda_t^h} d_t}_{(7)} \right],\quad \frac{\partial(e_t - \bar{e}\ \ )}{\partial \lambda_t^h} = \frac{\partial s_t}{\partial \lambda_t^h} \tag{22d}$$

$$\frac{\partial(\pi_t^h - \pi_t^{hT})}{\partial \lambda_t^h} = (\chi - 1) \frac{\partial \pi_t^{hT}}{\partial \lambda_t^h} + \tau_1 \frac{\partial(y_t - \bar{y})}{\partial \lambda_t^h} + \tau_2 \frac{\partial(e_t - \bar{e}\ \ )}{\partial \lambda_t^h} \tag{23}$$

Finding an optimal value of the QE policy instrument λ_t^h is equivalent to obtaining a liaison between the output and inflation gaps. Whether or not such a liaison implies a trade-off depends on the sign of the derivatives (21) and (23).

Assume that the debt ratio at time *t* is above that of time *t-1* ($d_t > d_{t-1}$). The monetary authorities should expand output to stabilize it. By raising their newly issued bond holdings (increase in λ_t^h), they lower the long-term interest rate (expression (1) in Equation 21). This cut in nominal interest rates leads to a nominal and real depreciation of the domestic currency (expression (6) in Equation 22d). The impact is accentuated by a risk premium effect. Indeed, a higher λ_t^h is equivalent to a lower λ_t^f and thus to a decrease in home sovereign bond holdings by foreign investors. For unchanged amounts of the domestic country's foreign debt holding, this leads to an improvement in the net foreign assets position. The risk premium required for foreign investors to hold more domestic assets falls, and domestic currency depreciates further (this is captured by expression (7) in Equation 22d). The combination of the three effects on output is positive.

Nominal depreciation (increase in ε_t), ceteris paribus, leads to an increase in the real effective interest rate ρ_t. For the debt ratio to remain stable, the central bank needs to target a higher inflation rate (this is captured by term (5) in Equation 22b). However, at the same time, the expansive QE policy reduces the nominal domestic interest rate. This strengthens sovereign debt solvability and means that a lower inflation rate can be targeted (the effect is given by expression (4) in Equation 22b).

Although these have opposing effects on targeted inflation, this strategy is optimal for the central bank only if the first effect dominates; e.g., if the central bank raises its inflation target above the current inflation rate. The reason this is optimal is that our initial assumption $d_t > d_{t-1}$ is equivalent to $\pi_t^h < \pi_t^{hT}$.

Using similar arguments, if we assume that the current debt ratio is lower than that of the previous period, the central bank can lower output in order to stabilize the debt ratio and eventually target a lower inflation rate.

Overall, an optimal choice implies that there is a negative relationship between the output and debt (or inflation) gaps in Equation (20). When the debt ratio increases, the central bank must pursue an expansive QE policy. For such a strategy to be optimal, the exchange rate channel of the QE policy must be of a higher magnitude than the 'pure' nominal interest rate channel, and the share of foreign currency-denominated sovereign debt must also be high enough. Indeed, the higher the value of λ_t^f, the higher the effect of nominal depreciation on debt as reflected by the combination of expressions (5) and (7) in Equations 22b and 22d. This provides an incentive to use a debt liquidation strategy when the debt ratio increases.

As mentioned earlier, the standard exchange rate channel is amplified by the exchange rate risk premium channel when the domestic country's net foreign assets position improves. This implies that higher financial integration between home and foreign countries facilitates the simultaneous achievement of both goals, namely, output and debt stability, in the sense that they do not collide.

If instead, the world is characterized by financial autarchy ($\lambda_t^h \rightarrow 1$ and thus $\lambda_t^f \rightarrow 0$), then expressions (5) and (7) in Equations (22b) and (22d) become small. The 'pure' nominal interest rate effects dominate. The expansionary QE policy implies that a debt stabilization goal will be obtained by lowering the inflation target.

3.2. Dynamics of the inflation gap and debt ratio

3.2.1. Inflation gap

We first look at the implications of forcing inflation to reach an inflation rate that stabilizes the debt ratio when a sufficiently long period is considered.

Combining Equations (16), (18) and (20), we obtain

$$(1-\Gamma_t)\,(\pi_t^h-\pi_t^{hT}) = (\chi-1)\pi_t^{hT} + (1-\chi)\pi_{t-1}^h + \tau_2(e_t-\bar{e}) + Z_t \qquad (24)$$

where

$$\Gamma_t = -\tau_1 N_1 \frac{\Omega_{1t}}{\Omega_{2t}},\ \Omega_{1t} = \frac{\partial(\pi_t^h-\pi_t^{hT})}{\partial\lambda_t^h},\ \Omega_{2t} = \frac{\partial(y_t-\bar{y})}{\partial\lambda_t^h}.$$

By adding and subtracting $(1-\chi)\pi_{t-1}^h$ in the right-hand side, we get

$$\left(\pi_t^h-\pi_t^{hT}\right) = \Lambda_t\left(\pi_{t-1}^h-\pi_{t-1}^{hT}\right) + \Psi_t \qquad (25)$$

where

$$\Lambda_t = \frac{1-\chi}{1-\Gamma_t}, \qquad \Psi_t = -\Lambda_t\left(\pi_t^{hT}-\pi_{t-1}^{hT}\right) + \frac{\tau_2(e_t-\bar{e})+Z_t}{1-\Gamma_t}$$

Using forward recursion, we obtain

$$\left(\pi_t^h-\pi_t^{hT}\right) = \frac{\pi_{t+\tau}^h-\pi_{t+\tau}^{hT}}{\prod_{v=1}^{\tau}\Lambda_{t+v-1}} + \sum_{v=0}^{\tau}\frac{\Psi_{t+\tau}}{\prod_{v=1}^{\tau}\Lambda_{t+v-1}} \qquad (26)$$

The condition that $\pi_{t+\tau}^h = \pi_{t+\tau}^{hT}$ when $\tau \to \infty$ implies

$$\left(\pi_t^h-\pi_t^{hT}\right) = \sum_{v=0}^{\tau}\frac{\Psi_{t+\tau}}{\prod_{v=1}^{\tau}\Lambda_{t+v-1}} \qquad (27)$$

Using the aggregate supply equation, we rewrite Ψ_t as:

$$\Psi_t = -\Lambda_t \underbrace{\left(\pi_t^{hT}-\pi_{t-1}^{hT}\right)}_{\substack{Revision\ of\ the\\ central\ bank's\\ inflation\ target}} - \frac{\tau_1}{1-\Gamma_t}\underbrace{(y_t-\bar{y})}_{Output\ gap} - \frac{1}{1-\Gamma_t}\Big(\underbrace{\pi_{t+1}^{he}-\pi_t^{hT}}_{\substack{changes\ in\ inflation\\ rate\\ due\ to\ changes\ in\\ inflation\\ expectations}}\Big). \qquad (28)$$

Condition (27) means that when a sufficiently long timespan is considered, any discrepancy between the current inflation rate and the inflation targeted by the central bank at this point is liable to be eliminated over time through a revision of the central bank's target, changes in output, or changes in inflationary expectations. However, if these variables remain unchanged, the gap can still narrow if the successive discount rates $\Lambda_t - 1$, for $t > 0$ increase over time (or if the successive $|\Gamma_t|$ decreases).

For the sake of simplicity, we assume that $\tau_1 = N_1 = 1$ and therefore $|\Gamma_t| = \Omega_{1t}/\Omega_{2t}$. A decrease in Γ_t, at time *t* implies that conventional monetary policy (through changes in λ_t^h) impacts the output gap at a higher magnitude than the impact on inflation rate. It also implies that to close the inflationary gap, inflationary or deflationary pressure stemming from economic demands needs to be high enough, especially if the revision of the inflation target by the central bank to anchor inflation expectations is weak (Ω_{1t} small).

We now look at the conditions under which asymptotic *global* stability holds for Equation (25). We rewrite this equation as follows:

$$\left(\pi_t^h - \pi_t^{hT}\right)\left(1 - \frac{(1-\chi)}{1-\Gamma_t}B\right) = \frac{\tilde{\Psi}_t}{1-\Gamma_t} + \frac{Z_t}{1-\Gamma_t} \qquad (29)$$

where $\tilde{\Psi}_t = \tau_2(e_t - \bar{e}) - (1-\chi)(\pi_t^{hT} - \pi_{t-1}^{hT})$ and B is the backward shift operator defined by $B^i X_t = X_{t-i}$. Sufficient conditions for the global asymptotic stability of this equation's solution are as follows:[5]

Condition 1: $\frac{Z_t}{1-\Gamma_t}$ is bounded everywhere *t > 0.* We recall that $\Gamma_t = -\tau_1 N_1 \frac{\Omega_{1t}}{\Omega_{2t}}$, and Ω_{1t}, Ω_{2t} are respectively the partial derivatives of the inflation gap and output gap with respect to λ_t^h. Since Ω_{1t} and Ω_{2t} are positive and Z_t is defined on a finite support, the condition always holds.

Condition2: $\frac{\tilde{\Psi}_t}{1-\Gamma_t}$ is bounded everywhere *t>0.* Given the expression of $\tilde{\Psi}_t$ this amounts to saying that *i)* the real exchange rate dynamics must be mean-reverting around its mean (e_t is stationary); *ii)* revision of the inflation target by the central bank between two consecutive periods must also obey a stationary dynamic.

Condition 3: $\frac{(1-\chi)}{1-\Gamma_t} < 1$, nearly everywhere *t>0* (there are possible exceptions for a finite number of *t>0)*. This implies that the inflation gap could be locally unstable (in the sense that one could observe deviations between the inflation target and inflation expectations if the central bank does not succeed in driving agents' expectations in the right direction). In spite of this, the dynamic is globally stable if Condition 3 is not systematically violated. Parameter χ determines the speed of convergence of π_t^h to π_t^{hT}. Fast convergence is obtained for high values of the parameter towards 1 (e.g., when the expectations are anchored).

3.2.2. The debt ratio

We now look at the implications of a situation in which the debt ratio must be stabilized at finite values.

[5] These conditions are obtained using results from the theory of time-varying dynamical systems (see, amongst others, Boese, 2002; DaCunha, 2005; Grillenzoni, 1990).

Let us define

$$R_t = \begin{cases} R_t^h, if\ \pi_t^h \neq \pi_t^{hT} \\ R_t^{hT}, if\ \pi_t^h = \pi_t^{hT} \end{cases} \text{ and } d_t = \begin{cases} d_t^h, if\ \Delta d_t^h \neq 0 \\ d_t^{hT}, if\ \Delta d_t^h = 0 \end{cases}. \quad (30)$$

If $\pi_t^h = \pi_t^{hT}$, the debt ratio gap is written as

$$d_t^h - d_t^{hT} = \left(1 + R_t^h\right)d_{t-1}^h - b_t\left(\frac{1+R_t^{hT}}{R_t^{hT}}\right), \quad (31)$$

which implies

$$d_t^h - \frac{d_{t+\tau}^h}{\prod_{\upsilon=1}^{\tau}(1+\mathrm{R}_{t+\upsilon-1})} = \sum_{\upsilon=0}^{\tau} \frac{d_{t+\tau}^{hT}}{\prod_{\upsilon=1}^{\tau}(1+\mathrm{R}_{t+\upsilon-1})} + \sum_{\upsilon=0}^{\tau} \frac{b_{t+\tau}\left(\frac{1+R_{t+\tau}^{hT}}{R_{t+\tau}^{hT}}\right)}{\prod_{\upsilon=1}^{\tau}(1+\mathrm{R}_{t+\upsilon-1})}. \quad (32)$$

The discrepancy between the current debt ratio and (the present value of) the debt ratio in a given time $t + \tau$ can be reduced by successive revisions of the inflation targets between periods *t* and $t + \tau$, and/or by the successive fiscal balances over these periods.

It is straightforward that, if π_t^h asymptotically reaches π_t^{hT}, then d_t^h will reach d_t^{hT}, and the steady state value at which the debt ratio will be stabilized depends on the steady state values of both the primary surplus and the sequence of $(\mathrm{R}_t)_{t>0}$. An example of government spending and fiscal revenues leading to a steady state value of the debt ratio is:

- government spending (as share of GDP): $g_t = \left(1 - \alpha_g\right)\bar{g} + \alpha_g g_{t-1} + \varepsilon_{gt},\ t > 0,$
- fiscal policy (revenues as share of GDP): $tax_t = \alpha_t + \varepsilon_{taxt},\ t > 0.$

ε_{gt} and ε_{taxt} are noise components capturing fiscal shocks, $0 < \alpha_g < 1$, α_t are parameters. α_t represents lump-sum taxes.

Sufficient conditions for the asymptotic stability of the dynamics of Equation (31) are

Condition 1: $R_t^h < 0$ everywhere $t > 0$ and $-b_t$ is bounded nearly everywhere $t > 0$, or

Condition 2: $R_t^h < 0$ nearly everywhere $t > 0$ and $-b_t$ is bounded everywhere $t > 0$.

Both these conditions imply that during the transition to the steady state level of debt, either monetary policy or fiscal policy can be *locally* unstable. We illustrate this with the following example. Assume that the ratio of the primary balance in Equation (6) is obtained as follows:

Public spending as share of GDP is assumed to be constant over time and defined by g_t (exogenous). The tax-to-GDP ratio is assumed to be endogenous and constrained by an upper bound. The government cannot increase taxes above a given threshold $\widehat{tax}_t$:

$$tax_t = min\left[\overline{tax}_t + \theta_{tax}\left(d_t^h - d_t^{hT}\right), \widehat{tax}_t\right],\ \theta_{tax} > 0. \quad (33)$$

This illustrates the case of a Ricardian fiscal policy. The government increases taxes when the current debt ratio at time t is above the sustainable debt ratio, and decreases it otherwise. $\overline{tax}_t$ is the tax rate for which the debt ratio reaches its sustainable level. $\widehat{tax}_t$ is the tax rate that maximizes the total real tax income equal to $tax_t\, y_t$.

Using Equation (6), it is easy to see that $\overline{tax}_t = R_t^h d_{t-1} + g_t$. Using the IS curve and noting that $b_t = tax_t - g_t$, the expression of $\widehat{tax}_t$ is given by

$$\widehat{tax}_t = \frac{2\delta g_t + y_t}{3\delta} \tag{34}$$

There are two cases:

Case 1. $\overline{tax}_t > \widehat{tax}_t \Rightarrow R_t^h d_{t-1} > (y_t - \delta g_t)/3\delta$.

Case 2. $\overline{tax}_t \leq \widehat{tax}_t \Rightarrow R_t^h d_{t-1} \leq (y_t - \delta g_t)/3\delta$.

In the first case, the government cannot achieve a sustainable debt ratio through further tax increases because the constraint on the latter is binding. To relieve the constraint, the only possibility is a decrease in the left-hand side of the inequality, implying action by the central bank which must pursue a monetary policy that leads to a decrease in R_t^h. Since in Equation (31), R_t^h must be negative for the debt ratio dynamics to be asymptotically stable, the policy mix leads to an asymptotic solution of the debt ratio if the monetary policy is implemented in a context whereby the output gap is high enough. Moreover, Condition 1 implies that b_t must be bounded, which links the dynamics of public spending and fiscal revenue (this can be done in several ways, either by conditioning the fiscal revenue dynamics to previous debt ratios, as in this example, or by conditioning the spending growth rate to that of output or taxes).

In the second case, the fiscal policy can achieve the sustainable debt ratio without hitting the ceiling. R_t^h can increase at some point in time, and the policy mix (in terms of stabilizing the debt ratio) can be successful for any level of production.

We therefore have two cases. Under Condition 1, the monetary authorities' policy ensures both the sustainability and the convergence of the debt ratio. This situation can be considered as 'strong' fiscal dominance. It can happen even with a Ricardian government and stems from the fact that the tax (or spending) adjustment is constrained. This is likely to be the case when debt ratios are initially high (the higher d_{t-1}, the higher $\overline{tax}_t$). From (34), we infer that the likelihood of hitting the upper bound of the tax rate increases with low output or cuts in public spending, as occurs during times of fiscal consolidation.

Under Condition 2, the fiscal policy ensures debt ratio sustainability, while monetary policy actions aim at ensuring convergence towards sustainable debt. Such a situation can be referred to as 'weak' fiscal dominance.

4. Implications for industrialized countries

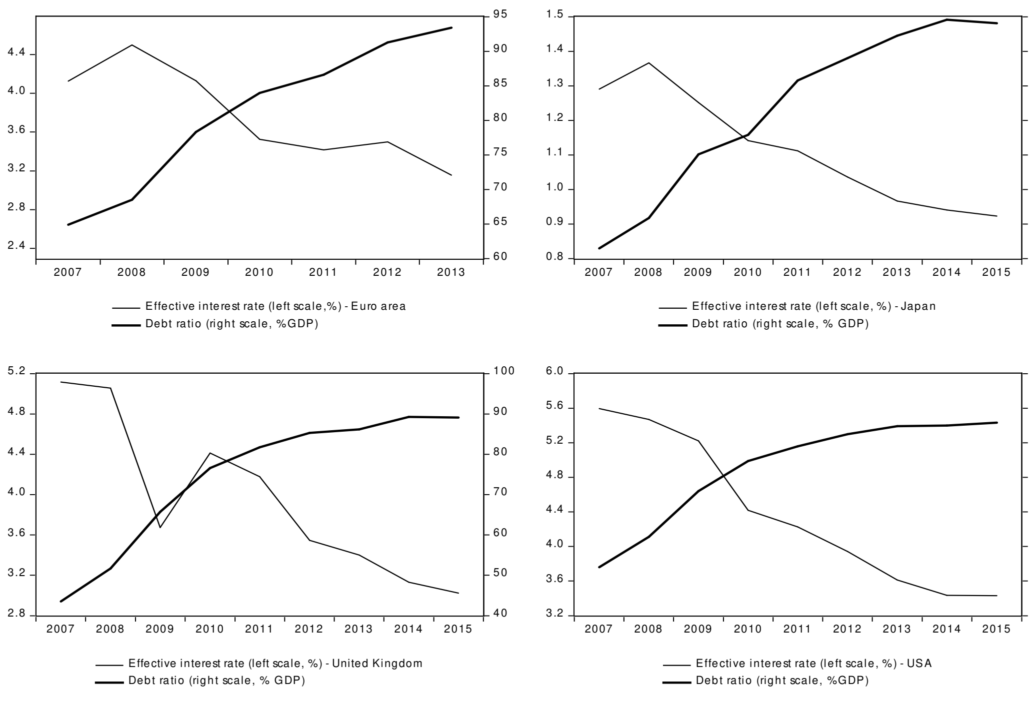
4.1. Were the conditions for successful fiscal dominance fulfilled during the seven years following the 2008 financial crisis?

We now examine whether the above conditions could apply to industrialized countries. For illustration purposes, we focus on the Euro area, Japan, the United Kingdom (UK) and the United States (USA) since 2008.

As a starting point, in Figure 1, we report the debt-to-GDP ratios. Table 1 presents the evolution of their determinants over time. We see that, despite fiscal consolidation efforts to reduce primary deficits, debt ratios have been on the rise since at least 2010. In Table 2, we report the *additional* primary balance surplus that would keep the debt-to-GDP ratios constant at their 2006 and 2007 level (e.g. before the financial crisis). This is obtained by computing the difference between the primary balance needed to achieve fiscal sustainability (constant debt ratio) and the current primary balance. We may note that, even with a great deal of discipline, the effort required is tremendously high, and sometimes inaccessible. Therefore, when examining how to end growing debt dynamics, the answer does not necessarily lie in fundamental changes to fiscal policy. Instead, more emphasis should be placed to the role of other debt determinants, e.g. the inflation rate, the interest rate and the real GDP growth rate.

In Figure 2, we draw the actual interest rate-growth differential and the differential which stabilizes debt ratios at their pre-crisis levels (2006 and 2007). The positive gaps suggest that either the inflation rate or output growth were too low to prevent the debt-to-GDP ratios from increasing. The latter have co-varied negatively with deflation in Japan and with low inflation rates below 2% in the Euro area and the United States. Moreover, in almost all countries, GDP growth rates have remained below their historic levels during non-crisis years.

Fig. 1.
Debt-to-GDP ratios and effective interest rates



Source: World Economic Outlook 2016 and authors' calculation

Given these observations, were the conditions fulfilled for a successful fiscal dominance strategy? Figure 1 suggests that high sovereign indebtedness occurred in the context of a huge decrease in the effective interest rate (defined as the ratio of interest payments over the debt of the previous year). This decline coincides with the adoption of unconventional monetary policies in industrialized countries. The scale of such policies has been unprecedented. For example, the Bank of England proposed the Funding for Lending Scheme (FLS) in July 2012 in order to encourage bankers to lend more money to non-financial companies and householders. At the same time, the European Central Bank also launched targeted longer-term refinancing operations (TLTRO). These unconventional measures consist of offering business banks a long-term loan while encouraging them to increase their lending activity to firms and householders in the Euro area. In particular, the ECB launched the first TLTRO series in 2014, while the TLTRO II was launched in March 2016. Similar policies were also adopted earlier in the United States and Japan, and were reinforced by the so-called "Abenomics" strategy.[6] Consequently, the size of the central banks' balance sheet increased, as shown in Figure 3.

Table 1. Debt ratio and its determinants in selected industrialized countries

Country / Year	2008	2010	2012	2015
	Debt-to-GDP ratio			
Euro area	68.5	84	91.3	93.2
Japan	191.2	215.8	238.0	248.0
United Kingdom	51.7	76.6	85.3	89.3
United States	72.8	94.7	102.5	195.8
	Primary balance (%GDP)			
Euro area	0.4	-3.7	-1.0	0.1
Japan	-3.8	-8.6	-7.9	-4.9
United Kingdom	-3.5	-7.2	-5.4	-2.8
United States	-4.6	-8.9	-5.7	-1.8
	Growth rate or real GDP (%)			
Euro area	0.4	2.1	-0.9	2.0
Japan	-1.0	4.7	1.7	0.5
United Kingdom	-0.6	1.9	1.3	2.2
United States	-0.3	2.5	2.2	2.6
	Inflation rate (%)			
Euro area	2.0	0.7	1.3	1.2
Japan	-1.3	-2.2	-0.9	2.0
United Kingdom	3.6	3.3	2.8	0.1
United States	2.0	1.2	1.8	1.1

Notes: Source IMF – World Economic Outlook database 2016

[6] See Collignon et al. (2012); D'Amico and King (2013); Aloy and Dufrénot (2016); Ueda (2012), and the special issue of the Journal of Japanese and International Economies (2015).

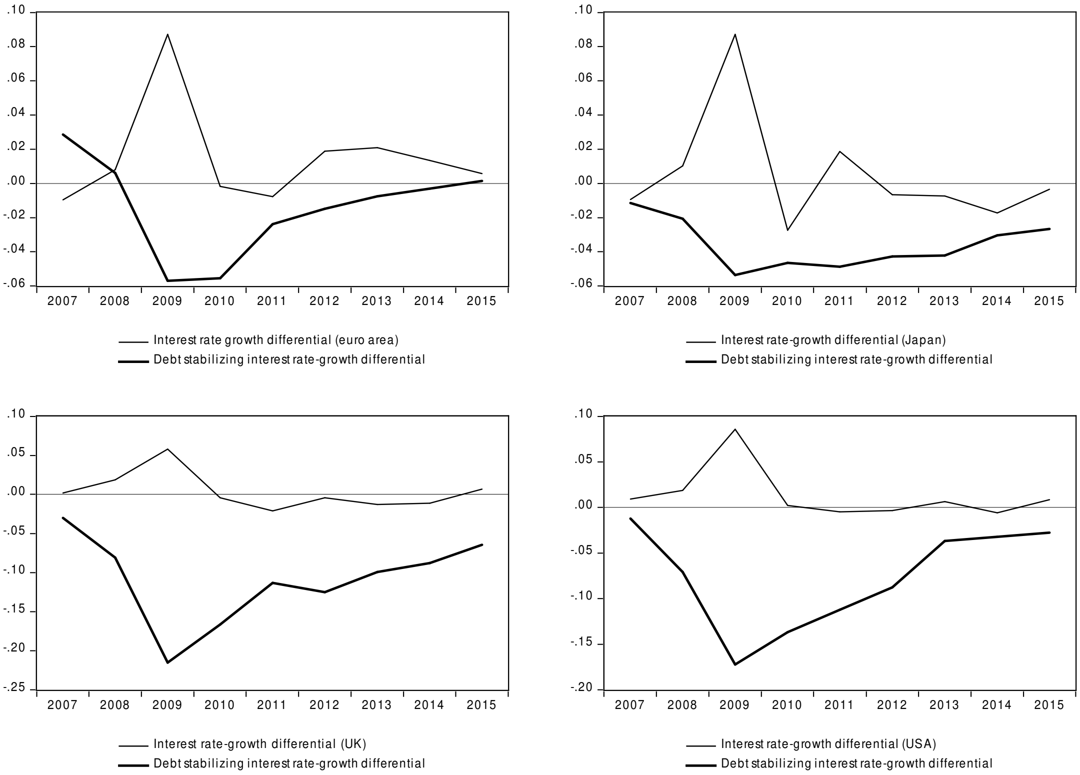
However, the decline in the cost of sovereign debt obscures differences between countries. As we showed in the preceding section, a condition for the convergence of the inflation rate towards its debt stabilizing target is that unconventional monetary policy impacts on output in a significant way. From the IS curve (Equation 17), we see that what matters is not the long-term rate per se, but the spread between this rate and the natural rate. While there are several definitions of the latter, we retain the most common interpretation which defines this rate as the long-term interest rate that would prevail if GDP was at its potential level. The idea was introduced by Wicksell and is viewed as a possible benchmark for a monetary policy stance.

Table 2. Primary balance adjustment needed to stabilize the debt ratio at the pre-crisis level (% GDP)

	2008	**2010**	**2012**	**2015**
Euro area	0.13	3.6	0.3	2.5
Japan	5.7	3.6	4.3	8.4
United Kingdom	4.3	7.0	3.1	5.3
United States	5.8	9.0	2.4	6.4

Source: World Economic Outlook 2016 and authors' calculation

Fig. 2.
Interest rate-growth differential in industrialized countries



Source: Fiscal monitor 2016 and authors' calculation

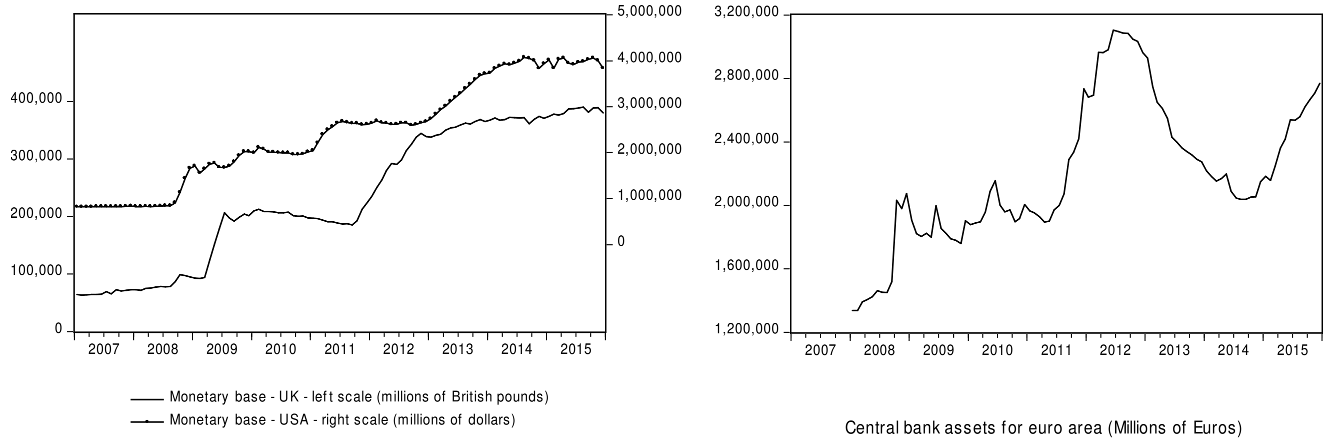
We estimate this rate using a state-space model, which is a variant of the semi-structural models proposed in recent papers by Laubach and William (2016), and Lubik and Matthes (2015). The latent variables are potential growth, potential GDP and the natural rate. The measurement equations define the aggregate supply and demand with the endogenous short-term interest rate, financial prices (real estate and shares) and the unemployment rate. The model is estimated using a Kalman filter and maximum likelihood with quarterly data from 1990 to 2015.[7]

In Figure 4, we report the computed natural rates, along with the inflation deflated 10-year government yields over the years 2007-2015. For illustration purposes, we consider two countries from the Euro area (France and Germany) in addition to Japan, the UK and the US.

The curves show different patterns. The natural rate reaches near zero level in Japan, the United States and France (since 2008). It becomes strongly negative in Germany after 2007 (reflecting the country's situation of over-saving compared to investment). While declining recurrently, the natural rate remains positive in the United Kingdom.

[7] To save place, and since this is not the focus of the paper, details about the estimates of the natural rate are not reported but can be obtained upon request.

Fig. 3. Monetary base (UK and USA) and ECB assets (Euro area)



Source: Federal Reserve of Saint-Louis, FRED database

The graphs highlight a difference between the stance of monetary policy in the Euro area compared to the other countries. Indeed, the gap between the actual real rate and the natural rate remains positive over the eight years in question. Monetary policy in the Euro area therefore seems to have been less expansionary and can be explained by the reluctance of the European Central Bank to refinance public deficit, even indirectly through the purchase of sovereign bonds in secondary markets. A strong QE policy was recently launched with the TLTRO programme in 2014.

This is in sharp contrast with the situation in the UK, the US and Japan. In the UK, the real long-term rate has remained below the natural rate since the beginning of the QE policy, suggesting an aggressive expansionary policy. The graph in the US shows that, following a period of rapid decline of the real rate towards its natural level (between 2008 and 2009), it passed through the zero line and below the natural rate in 2011 and 2012. After 2013, the gap turned positive as the economy rebounded. In Japan, the real rate closely followed the natural rate.

The implications of this result on the real effective interest rate of public debt can be seen in Figure 1. Euro area countries with higher long-term interest rate gaps either experienced less rapid decline in the cost of sovereign debt, or had to bear a higher cost than the others. In addition, differences in real GDP growth rate between the Euro area countries, the UK and the US could also reflect differences in their monetary policy stance (see Table 2).

In the light of these observations and our theoretical developments, we offer an illustration of what might have happened had fiscal dominance been adopted by the central banks in Japan, the UK, the US and the Euro area.

In Table 2, we observed that primary surpluses required strong adjustments to achieve debt sustainability. Given the numbers, such adjustments appear unfeasible, suggesting that the dynamics of $-b_t$ would not be bounded. Accordingly, Condition 1, which defines the asymptotic stability of Equation 31, would apply to Japan, the US, the UK and the Euro area. Under this condition, we could observe periods in which public deficits would not be bounded (or would not correspond to a stabilized debt-to-GDP ratio). The condition also suggests that, in this case, R_t^h must be negative everywhere $t > 0$.

Looking at the bold lines in Figure 2, we see that the interest rate-growth differentials, which would have led to a stabilization of the debt ratio (given the observed primary deficits), are indeed negative. Strong fiscal dominance could therefore have characterized the countries had such a strategy been retained by their central banks.

4.2. Were the inflation expectations anchored?

We have seen that the degree of inflation expectations anchoring influences the rate of convergence of both the inflation rate and the debt ratio to the debt-stabilizing level. To study the degree to which expectations were anchored from 2008 onwards, we propose the following empirical framework (for illustration purposes, we focus on the short-term inflation forecasts in the US, the Euro area and the UK).

We estimate the following nonlinear time-varying coefficient equation:

$$\pi_{t+1}^{he} = (1 - \varrho_t)\xi + \varrho_t \pi_{t-1}^h, \ \varrho_t = F(\pi_t^h; \delta; c) = \frac{1}{1+\exp[-\delta(\pi_t^h - c)]}, \quad (35)$$

where function F is represented in Figure 5. This functional form is flexible enough to embrace a wide range of possible adjustment dynamics of expectations between a fixed anchor and past inflation rates. ξ is a constant parameter. Function F delineates two regimes. A first regime corresponds to a high inflation environment (π_t^h above a threshold value). In this regime, the agents are likely to show low/high confidence in the central bank's forward guidance policy, and form their expectations of future inflation according to the inflation observed during the preceding periods. In this case ϱ_t is near 1. Using the estimate of ϱ_t, we gain an indication of the tightness with which the expectations are anchored to a given value: $\chi_t = 1 - \varrho_t$, where χ_t corresponds to the degree of anchoring of expectations in the theoretical model. Conversely, when inflation is low (below a given threshold), monetary policy becomes more credible and the values of ϱ_t are near 0.

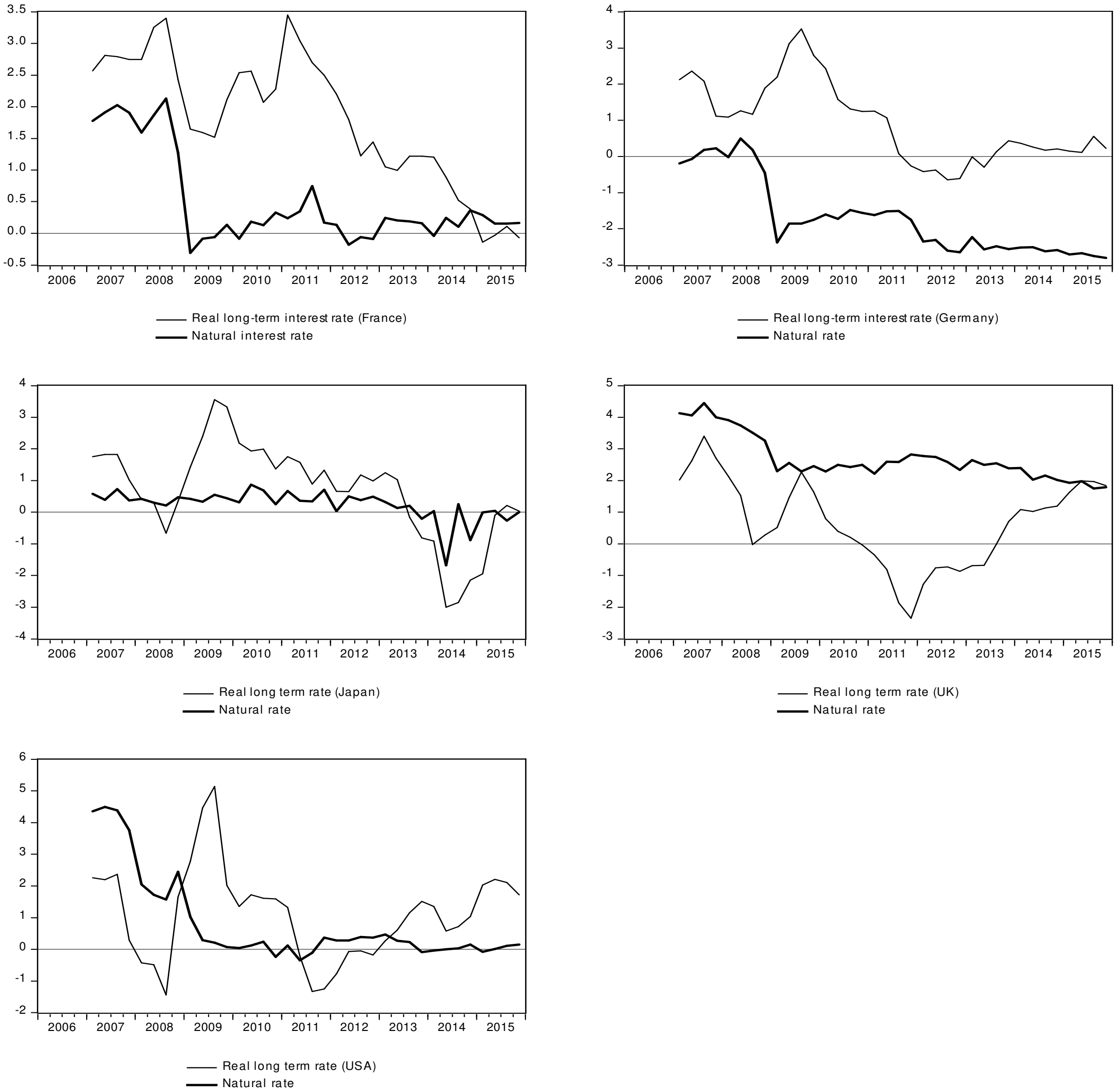
Our aim is not to identify the anchor to which the expectations converge, but rather to see whether we observe a disconnection between the forecasts and past inflation rates, and their convergence towards a 'focal' point captured by the constant parameter ξ.

The parameter δ is a transition parameter which describes a transition between high and low inflation regimes. This transition can be smooth (when δ is small) or rapid (when δ is large). For

π_t^h , we consider core inflation computed by applying a Hodrick Prescott filter to the headline inflation rate series. We estimate the parameters δ, c by nonlinear least squares using quarterly data.

Figure 6 show the estimated function *F* and the time-varying coefficient ϱ_t for the United States. Expectations of future inflation are taken from the Greenbook (one-year ahead forecasts since 1980). We find estimates of $\delta = 2.83$ and c = *3.34%*. High and low inflation environments are therefore identified as years of inflation rates respectively above and below 3.34%. Given the small value of δ, the transition between the regimes is seen to be smooth over time.

Fig. 4.
10-year Government bond yield (real) and the natural interest rate



Source: FRED database and authors' calculations

Fig. 5.
The function $\varrho_t = 1 - \chi_t = F(\pi_t^h; \delta; c)$, Abscissa: π_t^h; ordinate: ϱ_t

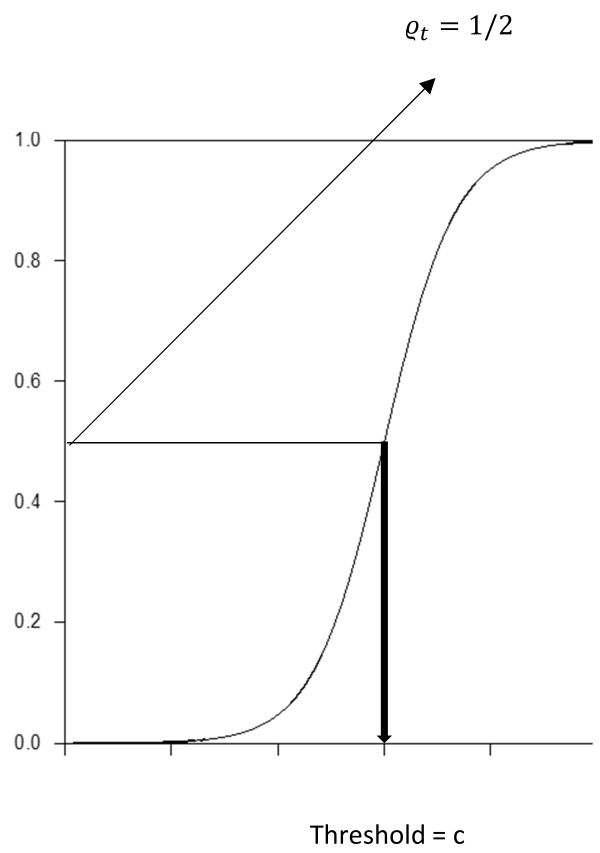
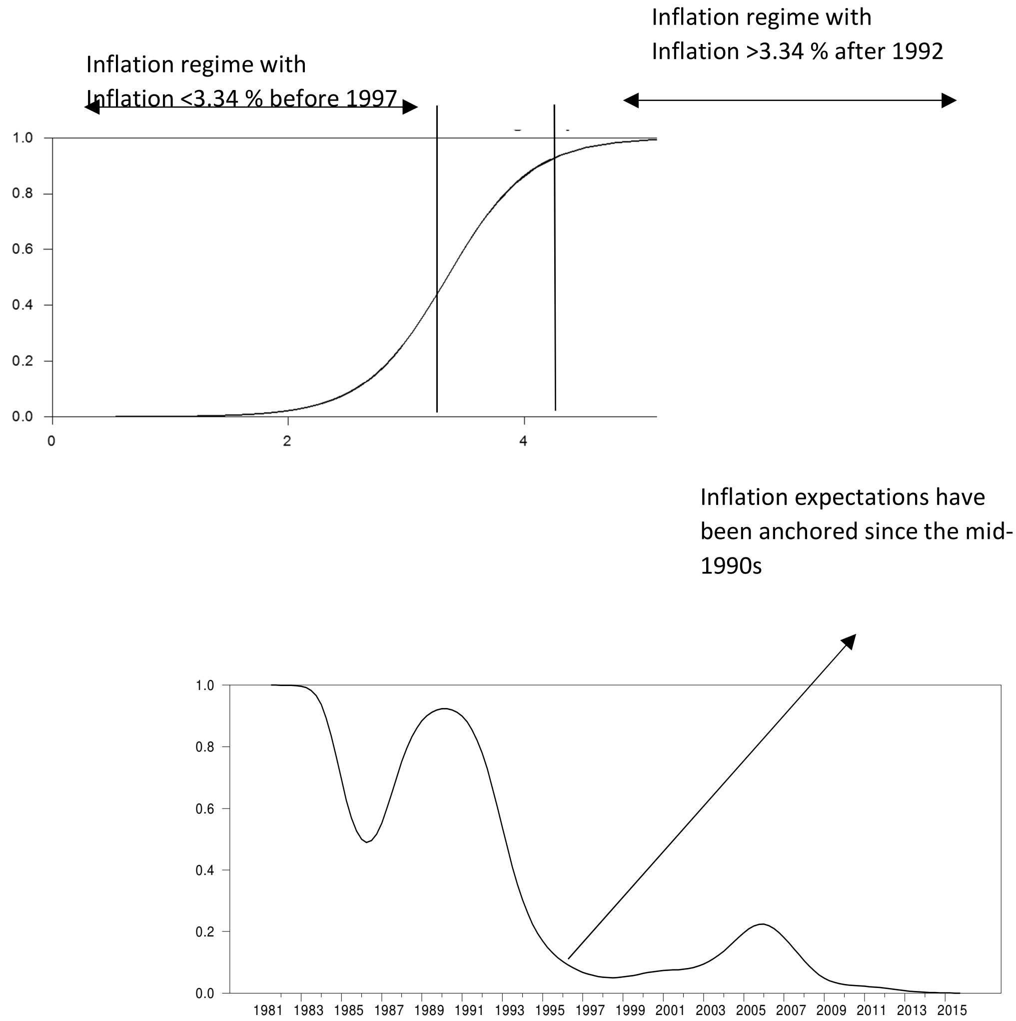


Figure 5 shows a clear shift in inflationary regime occurring during the 1990s (between 1992 and 1997). We see that the coefficient ϱ_t grew smaller from 1997, indicating an anchoring of expectations from that year onwards.

With regards to the inflation rates observed after 2008, we conclude that had the Fed's monetary policy been characterized by fiscal dominance, inflation expectations would have been anchored.

Fig. 6.

Estimation of function F (upper panel) and of ϱ_t (lower panel) – USA



We do a similar exercise for the Euro area. For π_{t+1}^{he}, we use the forecasts published by Eurostat since 1999 (one-year ahead forecasts). We find estimates of δ=20.93 and c=2.01%. Figure 7 shows the estimated weight ϱ_t and the inflation rates since 1999. The biggest change in the anchoring of expectations occurs after the disinflationary shock of 2008. Before the crisis, future inflation expectations were strongly influenced by past inflation rates, which fluctuated above 2%. The transition between high and low inflation regimes has been rapid (roughly 2 years from mid-2008 to the end 2010) and anchoring appears to have been strong since 2012 ($\varrho_t = 0$).

Figure 8 shows the estimated ϱ_t for the United Kingdom. The anchoring of expectations is assessed using survey data from the Bank of England between 2000 and 2015 (median expectations of the rate of inflation over the forthcoming year). We obtain the following estimates: $c = 2.52$ and $\delta = -13.06$. The results are in sharp contrast with those of the Euro area and the United States. For the latter, in the years of unconventional monetary policies, anchoring tightness increased and became stronger from 2012. In the United Kingdom, they weakened to a greater degree, deviating from their anchor to the level of past inflation as current inflation became broadly stable.

5. Conclusion

This paper proposed an open economy model, where fiscal dominance is used as a strategy to increase inflation and output in order to achieve debt sustainability. In a context of zero lower bound, monetary stimulus is implemented through an unconventional monetary policy. Unlike former fiscal dominance models, the central bank does not print new currency to buy government issued bonds. Rather, the cost of government debt is erased by making real long-term rates decrease towards their natural rate through a real depreciation of the domestic currency and by anchoring the private sector's expectations to a level of the central bank's targeted inflation for which the debt-to-GDP ratio is stabilized.

Formally, the inflation and debt dynamics are exemplified by different equations where the interest rate-growth and primary surplus coefficients are time-varying. We thus obtain the conditions for global stability and for convergence towards the medium-term debt-stabilizing inflation target and debt ratio. We provided an example showing that, even with a Ricardian government, fiscal policy may encounter some limits that prompt the monetary authorities' intervention.

One of the key issues for a successful fiscal dominance policy is the anchoring of expectations. Empirical evidence suggests that inflation expectations in the United States have been anchored since the mid-nineties. But anchoring occurred late in the Euro area (not before 2013) while inflation expectations in the United Kingdom seem to have been dependent on past inflation rates.

We also observed that although effective public debt rates have been decreasing everywhere, the stance of unconventional monetary policies has differed across countries. Specifically, the positive gap between the real long-term interest rate and the natural rate suggest that the policy has been more moderate in the Euro area compared to Japan, the United States and the United Kingdom. The condition that output reaction needs to be significantly reactive to unconventional monetary policy is therefore unlikely to have been fulfilled in the Euro area.

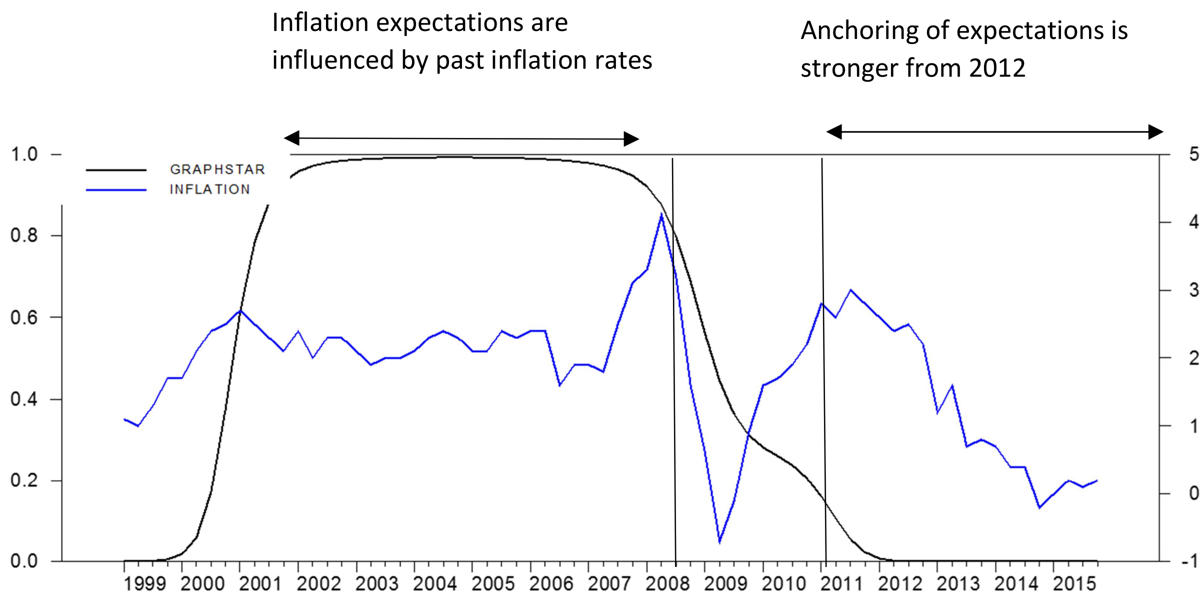


Fig. 7.

Estimation of parameter ϱ_t and inflation rate – Euro area

We are not claiming that fiscal dominance is the panacea for dealing with high debt levels. However, we modestly suggest it as potentially suited to a post-financial crisis situation. For instance, we do not assume that higher inflation will impact on nominal rates. Indeed, our context is that of secular stagnation with deflationary pressure. Nor do we introduce any cost for inflation in the central bank's loss function, largely because the issue today is that of deflation. We admit that fiscal dominance can only be a transitory policy until inflation and public debt ratios return to their pre-crisis level.

The analysis presented here is silent on several factors, suggesting avenues for future research. First, the long-run nominal interest rate may hit a zero lower bound (different from the short-term zero lower bound) for several reasons (the monetary authorities want to avoid bubbles and are confronted with commercial banks' responses to limit the decline in banking sector profitability). Second, above a given inflation rate, fiscal dominance is likely to induce some costs. Third, there is also the question of an exit from a fiscal dominance strategy involving timing and ways to avoid the risk of returning to deflationary traps.

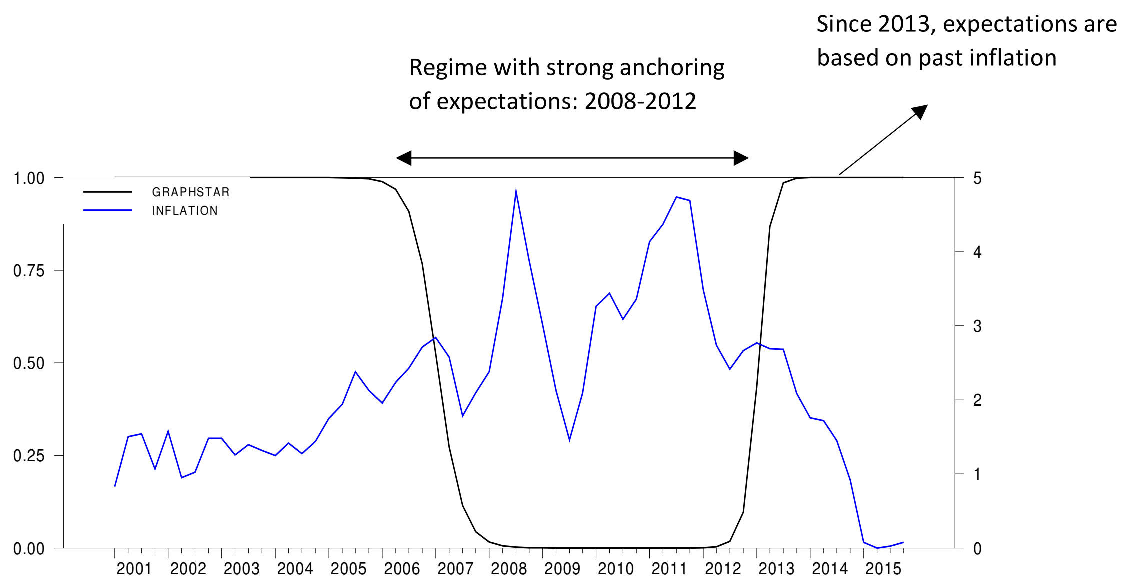


Fig. 8.

Estimation of parameter ϱ_t and inflation rate – United Kingdom

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