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Using time-varying transition probabilities in Markov switching processes to adjust US fiscal policy for asset prices

Luca Agnello [a], Gilles Dufrénot [b,c,d,e,f,*], Ricardo M. Sousa [g,h]

[a] University of Palermo, Department of Economics, Business and Finance, Italy
[b] Aix-Marseille University (Aix-Marseille School of Economics), Château La Farge — Route des Milles, 13290 Les Milles Aix-en-Provence, France
[c] CNRS, France
[d] EHESS, France
[e] Banque de France, France
[f] CEPII, France
[g] University of Minho, Department of Economics and Economic Policies Research Unit (NIPE), Portugal
[h] London School of Economics, Financial Markets Group (FMG), United Kingdom

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ABSTRACT

This paper tests for nonlinear effects of asset prices on the US fiscal policy. By modeling government spending and taxes as time-varying transition probability Markovian processes (TVPMS), we find that taxes significantly adjust in a nonlinear fashion to asset prices. In particular, taxes respond to housing and (to a smaller extent) to stock price changes during normal times. However, at periods characterized by high financial volatility, government taxation only counteracts stock market developments (and not the dynamics of the housing sector). As for government spending, it is neutral vis-a-vis the asset market cycles. We conclude that, correcting the fiscal balance and, notably, the revenue side for time-varying effects of asset prices provides a more accurate assessment of the fiscal stance and its sustainability.

1. Introduction

The deepening of the 2008–2009 financial crisis was mainly driven by the sharp collapse of asset prices (after several years of boom) and simultaneous destruction of financial and housing wealth. This has renewed the interest of academics and policymakers on the linkages between economic policy and asset markets (Agnello and Nerlich, 2012; Agnello and Schuknecht, 2011; Agnello and Sousa, 2011, in press; Castro, 2010; Sousa, 2010, in press).

While several papers have emphasized the existence of a nexus between the conduct of monetary policy and the developments in financial markets, the empirical evidence on the reaction of fiscal authorities to such dynamics is still at an early stage. This is somewhat surprising, in particular, if one takes into account the recent behavior of sovereign bond markets and the new challenges for public debt that have emerged in advanced economies (Bouthevillain et al., 2011).

Some authors have stressed that taxation should account not only for the business cycle, but also for the asset price cycle (Jaeger and Schuknecht, 2007; Tujula and Wolswijk, 2007).[1]

More recently, Afonso and Sousa (2011) use a fully simultaneous system of equations and quarterly data for Germany, Italy, UK and US, and find that fiscal policy shocks have a positive and persistent impact on housing prices and a negative effect on stock prices. Afonso and Sousa (2012) rely on a partial recursive identification of the fiscal policy shocks and data for the same set of countries, and uncover an important role for fiscal policy in explaining variation in both housing and stock prices. Agnello and Sousa (2011, in press)

* Corresponding author.
E-mail address: lopaduf@aol.com (G. Dufrénot).

[1] In fact, asset prices can affect the government budget via two major mechanisms: (i) the "direct" channel, through certain revenue categories; and (ii) the "indirect" channel, through the feedback effect on real economic activity. In the case of the "direct" channel, an increase in stock prices can have a positive impact on capital gains–losses related taxes, government revenue from households and corporations and turnover taxes (i.e. changes in government revenue via transactions in assets) and, consequently, can influence the fiscal stance. As for the "indirect" channel, higher stock prices can lead to a rise in consumer's confidence and household's wealth, boosting consumption and real economic activity and, thereby, increasing government revenue. In contrast, a sharp correction in stock prices and the design of fiscal stimulus packages can raise costs to governments and, therefore, deteriorate the public finances.

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show that fiscal policy is particularly effective during severe housing busts and the government's attempt to mitigate stock price developments may de-stabilize housing markets. In the same vein, Agnello et al. (2012) find that fiscal policy becomes expansionary in the context of a rise in financial stress, thereby, partially offsetting the decline in wealth.

As it stands, most of the existing empirical works have typically relied on the assumption that there is either: (i) a linear relationship between the fiscal policy instrument and the dynamics of asset prices (as in Afonso and Sousa, 2011, 2012; Agnello and Sousa, 2011, in press); or (ii) a nonlinear relationship that characterizes sudden changes in fiscal policy associated with events such as a financial crisis, but also imposes fixed (exogenous) transition probabilities across the different states of the economy (as in Agnello et al., 2012).

In the current work, we argue that the US fiscal policy developments that emerge in response to asset market changes may be better described within a time-varying transition probability Markov-switching (TVPMS) framework as originally proposed by Filardo (1994) and further extended by Kim et al. (2008). Indeed, the estimated state variable (such as asset wealth or asset prices) quite often displays a close link with the business cycle. Consequently, the state of the world might be endogenous. Moreover, the effects of fiscal policy over the business cycle might be different, depending on whether the economy is expanding or contracting moderately or facing a severe recession or a period of exuberant growth. As a result, the impact of fiscal policy should be non-monotonic. These features suggest that a model characterized by time-varying transition probabilities might be better suited for capturing the reaction of governments to the dynamics of the asset markets than frameworks with fixed transition probabilities such as the standard Markov-switching (MS) model. We show that changes in asset prices lead to significant adjustments of the revenue-side of fiscal policy, especially, during normal times, where taxes respond to both housing and stock prices. In contrast, during periods of high volatility in the financial markets, fiscal policy is used as a stabilizing tool, but only in response to the dynamics of the stock market. That is, at times of financial distress, the developments of the housing sector do not seem to be taken into account by governments.

In what concerns the government spending, we find that it is neutral with respect to asset markets, that is, the spending-side of fiscal policy is acyclical vis-a-vis the dynamics of housing and stock prices.

Finally, we show that one can assess more accurately the behavior of the fiscal stance and its long-term sustainability from the perspective of the path for government debt, by accounting for the asset market cycles.

The plan of the paper is as follows. Section 2 describes the econometric methodology. Section 3 presents the empirical results. Finally, Section 4 concludes.

2. The econometric model

2.1. The general framework

The basic idea behind Markov-switching modeling strategy is that many economic series might obey to different economic regimes associated with events such as financial crises (Jeanne and Masson, 2000) or abrupt changes in economic policy (Hamilton, 1988). This observation has given rise to the Markov switching model formulation (Goldfeld and Quandt, 1973; Hamilton, 1989).

A basic assumption behind such models consists of imposing fixed transition probabilities (FTP) governing the move between different states. Filardo (1994) relaxes this assumption and allows for time-varying transition probabilities (TVP) in a Markov switching autoregressive model. Such probabilities are modeled as functions of certain conditioning variables (i.e., the state variables), which are found to be relevant in explaining the regime switches (Filardo and Gordon, 1998; Kim et al., 2008).

From an economic perspective, several reasons make TVPMS models particularly attractive for exploring the linkages between fiscal policy and asset prices.

First, the conduct of fiscal policy changes over different cyclical phases (Agnello and Cimadomo, 2012) and asset prices usually proceed in tandem with business cycles (Dufrénot and Malik, 2012). Therefore, fiscal policy instruments are likely to respond in a nonlinear fashion to the asset markets developments.

Second, doubts about the effectiveness of policy interventions generally rely on the recognition that there is a stochastic shift of fiscal regimes that can be identified as active or passive, Keynesian or Ricardian, low or high debt-to-GDP ratio, and low or high financial distress. Moreover, the nature of the fiscal adjustment can also depend on features, such as adjustment costs, credit and liquidity constraints, informational limitations, leverage effects and market imperfections. Similarly, given that financial crises happen occasionally and suddenly, governments may find it hard to implement fixed-regime rules (Bouthevillain and Dufrénot, 2011).

Third, the selected state variable explaining the transition from one regime to another quite often exhibits a strong correlation with the business cycle. As a result, rather than mapping the evidence of a nonlinear behavior of fiscal policy into regimes that are defined ex-ante in accordance with a prior belief — as in the case of a Markov-switching model with *fixed* transition probabilities, it is more plausible to use an approach whereby economic agents make a probabilistic inference regarding the future policy rule and the state of the economy. In this context, reaction functions that can be associated with smoother (thereby, less frequent) regime switches are more prone to stabilize the economy and to provide a better understanding of how the fiscal authority responds to asset market developments.

Therefore, we model tax and spending rules as follows

$$\begin{aligned}\Delta\log(F_t) &= \rho_0(s)+\rho_1(s)\Delta\log\left(F_{t-j}\right)+\rho_2\Delta\log\left(Y_{t-j}\right)+\rho_3\Delta\log\left(B_{t-j}\right)\\ &\quad+\rho_4(s)\Delta\log\left(HP_{t-j}\right)+\rho_5(s)\Delta\log\left(SP_{t-j}\right)+\sigma_t(s)\vartheta_t,\end{aligned} \quad (1)$$

where the fiscal policy instrument (F_t) either taxes (T_t) or government expenditure (S_t), is explained by its lagged values, the lagged values of the GDP growth rate (ΔY_t) and the debt to GDP ratio (ΔB_t) as conventionally done in the standard fiscal policy rule. Then, we augment the model specification by accounting for the effects of housing prices (HP_t) and stock prices (SP_t). All variables are expressed in stationary terms.

The optimal lag is selected using the standard information criteria. We also allow the coefficients associated to asset prices (besides those linked to the constant and the lagged dependent variable) to switch between two different states, i.e. $s_t\in\{1,2\}$. In contrast, we assume that the relation between the fiscal policy indicators, output growth and public debt is always linear. This is in line with the idea that policymakers care both about demand stabilization and debt sustainability (Agnello et al., 2012). But the policy reaction can differ across different regimes depending upon whether stock and housing prices are increasing or decreasing. The observation of either regime 1 or 2 at time t depends upon the realizations of an unobservable Markov chain, that is, s_t is conditioned by $s_{t-1}, s_{t-2}, \cdots, s_{t-k}$. At any time $\tau<t$ the regime that will be observed at time t is unknown with certainty. Thus, we introduce a probability P of occurrence of s_t given the past regimes. Assuming, for purpose of simplicity, that s_t is a first-order Markov-switching process, we define $P\{s_t/s_{t-1}, s_{t-2}\cdots, s_{t-k}\}=P\{s_t/s_{t-1}\}$. We further assume that the transition from one regime to the other depends upon a transition variable observed at time $t-k, z_{t-k}$, so that $P\{s_t/s_{t-1}\}=P\{s_t/s_{t-1}, z_{t-k}\}$. The transition probabilities are defined as follows:

$$\begin{cases} p_{11}(z_{t-k})=\dfrac{\exp(a_1+b_1z_{t-k})}{1+\exp(a_1+b_1z_{t-k})}, \quad p_{22}(z_{t-k})=\dfrac{\exp(a_2+b_2z_{t-k})}{1+\exp(a_2+b_2z_{t-k})},\\ p_{12}(z_{t-k})=1-p_{11}(z_{t-k}), \quad p_{21}(z_{t-k})=1-p_2(z_{t-k}),\end{cases} \quad (2)$$