Shocking Policy Coefficients

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Abstract

This paper proposes an empirical framework to study the effects of a policy regime change defined as an unpredictable and permanent change in the policy parameters. As an application, we study the effects of changes in fiscal policy rules in the US. We find that discretionary fiscal policy has become more countercyclical over the last decades. In absence of such a change surplus would have been higher, debt lower and output gap more volatile but only until mid 80s. An increase in the degree of counter-cyclicality of fiscal policy has a positive effect on output gap in periods where the level of debt-to-GDP ratio is low and a zero or negative effect when the ratio is high. This explains why a more countercylical stance of the systematic fiscal policy taking place in 2008:II is predicted to be rather ineffective for recovering from the crisis.

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1 Introduction

What are the effects of policy regime changes? Answering this question is the centerpiece of policy analysis but has proven to be a difficult task. Typically in empirical macro-models a policy regime is associated to a parameter, or a set of parameters, of a function describing the behavior of the policy makers, i.e. the policy rule (Taylor, 1999). A regime change is represented by a shift in such parameters. The difficulty of assessing the consequences of regime shifts arises from the well-known observation (Lucas, 1976) that in empirical models the parameters of the remaining non-policy equations are not policy invariant. Neglecting such relations is likely to yield to misleading predictions about the effects of the policy shift.[1]

This paper proposes an empirical framework to study the effects of policy regime changes.[2] The empirical model is a reduced form vector autoregression. The reduced form parameters are functions of policy and potentially other non-policy structural time-varying parameters. The key ingredient of our procedure is the identification of the parameters representing the policy regime. Once identification is achieved, a policy regime shift is defined as an unpredictable and permanent change, i.e. a shock, in these parameters. Identification has a crucial implication: the correlations between policy parameters and the remaining reduced form parameters are also identified. Therefore variations in non-policy parameters following the regime shift are taken into account making our procedure not subject to criticism mentioned above.

We apply our methodology to fiscal policy rules. While a great deal of attention has been paid on changes in monetary policy (see e.g. the seminal paper Clarida Gali and Gertler, 2000, or Lubik and Schorfheide, 2004) there is little evidence documenting changes in fiscal policy rules (see Favero and Monacelli, 2005, and Taylor, 2000, Davig and Leeper, 2006, and Chung, Davig and Leeper, 2007). But most importantly there is even less devoted to document the macroeconomic consequences of such changes. Here we investigate the effects of fiscal policy regime changes with special attention to the systematic response of the cyclically adjusted surplus to output gap, the coefficient representing the degree of counter-cyclicality of discretionary fiscal policy.

We find that discretionary fiscal policy has become more countercyclical over the last decades. This change has substantially increased the level of debt to GDP ratio, the

[1]Benati (2010) shows that the bias in the results can be substantial.
[2]Leeper and Zha (2002).

deficit and, to a lesser extent and only in specific periods of time, stabilized economic activity. An increase in the degree of counter-cyclicality of fiscal policy has a positive effect on output gap in periods where the level of debt-to-GDP ratio is low and a zero or negative effect when the ratio is high. This seems to explain why we find that a more countercylical stance of the systematic fiscal policy taking place in 2008:II is predicted to be rather ineffective for recovering from the crisis.

The remainder of the paper is organized as follows. Section 2 describes the econometric framework; section 3 discuss an application to the US fiscal policy; section 4 concludes.

2 The econometric framework

2.1 The model

Here we discuss the assumptions underlying our econometric procedure.

A1) A n-dimensional vector of economic variables y_t satisfies

$$y_t = X_t \theta(\gamma_t) + \varepsilon_t \tag{1}$$

where $X_t = (I_n \otimes x_t)$, with $x_t = [y'_{t-1} \, ... y'_{t-p}]$, ε_t is a Gaussian white noise vector with covariance matrix R_t, γ_t is a q-dimensional vector including policy and possibly other structural non-policy coefficients, with $q \leq n^2 p + n$, and $\theta_t(\gamma_t)$ is a $n^2 p + n$-dimensional vector of reduced form coefficients which are functions of the structural ones.

A2) The structural coefficients evolve smoothly and in a unpredictable way, i.e.

$$\gamma_t = \gamma_{t-1} + u_t \tag{2}$$

where u_t is a q-dimensional Gaussian white noise vector with identity covariance matrix and uncorrelated with ε_t. We assume that there are $r < q$ policy coefficients collected in the subvector $\bar{\gamma}_t$ of γ_t and the corresponding policy shocks are collected in the subvector $\bar{u}_t$ of u_t. Conditional on the information available at time t the current regime is expected to be in place in the future. Policy regime changes in the economy occur unexpectedly, i.e. are shocks, and are permanent, i.e. the regime is not expected to revert back.

A3) The elements of θ_t are linear functions of γ_t,

$$\theta_t \equiv \theta(\gamma_t) = A\gamma_t$$

where A is a $n^2p+n \times q$ left invertible matrix, that is there exists a $q \times n^2p+n$ matrix $\tilde{A}$ such that $\tilde{A}A = I_q$. Notice that when policy changes all the reduced form coefficients can change. Linearity is a somewhat restrictive assumption but has the advantage that it dramatically simplifies the analysis.

Assumptions A2) and A3) imply the following law of motion for θ_t

$$\theta_t = \theta_{t-1} + e_t \tag{3}$$

where $e_t = Au_t$ with covariance matrix $AA' = Q$. Equations (1) and (3) form the Time-Varying Coefficients model proposed by Cogley and Sargent (2001, 2005) and recently used in many applications[3]. The only difference is that Q can be singular, that is the number of sources of variations in the economy can be smaller than the number of reduced-form coefficients. Using the estimation techniques in Cogley and Sargent (2005), Primiceri (2006) or deWind and Gambetti (2010) for the case $q < n^2p+n$, the posterior distribution of all the model parameters can be characterized.

Consider the following decomposition $Q = V\Lambda V'$ where Λ is the $q \times q$ diagonal matrix whose diagonal elements are the nonzero eigenvalues of Q and V the matrix formed by the corresponding eigenvalues. We can rewrite (3) as

$$\theta_t = \theta_t + V\Lambda^{1/2}v_t$$

where v_t is a Gaussian white noise vector with identity covariance matrix. Now, let H be any orthogonal $q \times q$ matrix. Therefore

$$\theta_t = \theta_t + V\Lambda^{1/2}Hu_t$$

where $u_t = H'v_t = \tilde{A}e_t$ with $\tilde{A} = H'\Lambda^{-1/2}V'$. To identify u_t $q(q-1)/2$ restrictions have to be placed on H. To identify the vector of policy shocks $\bar{u}_t$ only r columns of H have to be fixed. Call H_r the $n^2p+n \times r$ matrix formed by such columns. The vector of policy shocks and related parameters can be found as $\bar{u}_t = H_r'\Lambda^{-1/2}V'e_t$, $\bar{\gamma}_t = H_r'\Lambda^{-1/2}V'\theta_t$

Identifying policy changes is not an easy task. The idea is that information about the relations between structural and reduced form coefficients or the effects (see below) of some policy change on some variables should be used to fix the elements in H_r. A simple case is when the policy coefficient coincides with a reduced form coefficient. In

[3]See Gali and Gambnetti (2009) and Primiceri (2005) among many others.

this case the scalar $\bar{\gamma}_t$ coincides with the element θ_{jt} for some j and identification is achieved by imposing $A_{ji} = 0$ for $j \neq i$ and $A_{jj} = 1$.

2.2 Policy analysis

Our objective is to study, using the model illustrated above, the effects of a policy regime change. We define a particular policy change occurring at time t as $\bar{u}_t^*$. The resulting value of the policy parameter vector following the change will be

$$\bar{\gamma}_t^* = \bar{\gamma}_{t-1} + \bar{u}_t^*.$$

The probability distribution of u_t will provide information about how likely, given the history of data, is the policy change. Although in principle any change can be implemented, data will be more informative about policy changes that have occurred in the past or are not too unlikely to occurr.

We will discuss three types of analysis that can be conducted within our setup conditional on a policy change. Forecasting, impulse response functions and counterfactuals.

2.2.1 Conditional forecasting

Conditional forecasting analysis is designed to address the following question: given the knowledge of the economy at time $t-1$ what is the predicted path of future time series conditional on the policy regime change ($\bar{u}_t^*$)? Mathematically the answer to this question corresponds to the conditional expectation

$$y_{t+k|t-1} = E(y_{t+k}|\bar{u}_t^*, \mathcal{I}_{t-1}), \quad k = 0, 1, ... \tag{4}$$

where $\mathcal{I}_{t-1}$ is the information set available at time $t-1$. The information set can include y_{t-1}, so that 4 is the mean of the multivariatre conditional forecast density, or it can include also the coefficients (random variables) at that time. In this second case 4 is a random vector itself and the point estimate of the conditional forecast will be the mean of this vector.

2.2.2 Impulse response functions

Impulse response fcuntions analysis is designed to address the following question: what are the dynamic effects on future time series of a the policy regime change ($\bar{u}_t^*$)? The difference with conditional forecast is that in this case the behavior of y_{t+k} conditional on $\bar{u}_t^*$ is evaluated with respect to a baseline value. We define impulse response functions as the difference in two conditional expectations differing for the information set. The former includes the policy change the latter (the baseline case) does not. Formally

$$IR_{t+k} = E(y_{t+k}|\bar{u}_t^*, \mathcal{I}_{t-1}) - E(y_{t+k}|\mathcal{I}_{t-1}), \quad k = 0, 1, ... \tag{5}$$

Notice that the impulse response functions coincide with the generalized impulse response functions described in Koop, Pesaran and Potter (1996). Unlike the responses to additive VAR shocks the responses of shocks to policy coefficients are nonlinear: the shape of the impulse response depends on the size and the sign of the shock. Moreover it is easy to show that impulse response functions also depend on the level of economic variable at the time preceding the shock. For instance, for $k = 0$, $IR_t = X_t V \Lambda^{1/2} H_r$.

2.2.3 Counterfactuals

Policy counterfactual exercises investigate what would have been the path of economic variables under a policy scenario different from the actual one. The standard counterfactual exercises within structural VAR work as follows. The model is estimated, then the relevant policy parameters are changed and a new vector of time series is computed using the estimated residuals. The problem with this procedure, which is an illustration of the Lucas critique, is that typically the parameters of the other equations are not policy invariant. Neglecting these correlations is likely to yield completely misleading results.

On the contrary our setup allows us to run policy counterfactuals where dependencies between policy and other reduced form parameters are properly taken into account. Suppose the sequence of policy shock $\{\bar{u}_t\}_{t=1}^T$ for a sample of length T has been identified. Consider a particular sequence of policy changes $\{\bar{u}_t^*\}_{t=1}^T$. Define u_t^* the vector of structural shocks where $\bar{u}_t = \bar{u}_t^*$ and define γ_t^* the vector of structural parameters where $\bar{\gamma}_t = \bar{\gamma}_t^*$ and $\theta_t^* = A\gamma_t^*$. The counterfactual path for y_t is represented by the sequence $\{y_t^*\}_{t=1}^T$ computed using $\{\theta_t^*\}_{t=1}^T$. Notice that in this case, unlike in standard counterfactuals, all the reduced form coefficients will change in a way consistent with the policy change.

Notice that counterfactual exercises can be performed for any function of the coefficients, $f(\theta_t)$ like variances, persistence and so on simply using $f(\theta_t^*)$.

2.3 Computations

Here we describe how to compute the quantities of interests described above. We assume that the posterior distribution of the coefficients is available and that the shocks have been identified. Clarifying the notation, for any parameters a we define a^j a draw from the joint posterior distribution.

Conditional forecasts in (4) can be computed as follows.

1. Draw θ_{t-1}^j, Q^j and compute V^j and Λ^j. Draw H_r according the the identification scheme adopted and arbitrarily fix the other column of H, say H_{-r} in such a way that matrix orthogonality is satisfied.

2. Draw a $(q-r)$-dimensional Gaussian white noise vector ν_t^m and compute
$$\theta_t^{j,m} = \theta_{t-1}^j + V^j(\Lambda^j)^{1/2}H_r^j\bar{u}_t^* + V^j(\Lambda^j)^{1/2}H_r\nu_t^m$$

3. Compute $y_{t|t-1}^{j,m} = X_t\theta_t^{j,m}$.[4]

4. Draw e_{t+1}^m from a Normal with zero mean and covariance Q^j and compute
$$\theta_{t+1}^{j,m} = \theta_t^{j,m} + e_{t+1}^m$$

5. Form $X_{t+1}^{j,m}$ using $y_t^{j,m}$ and compute $y_{t+1|t-1}^{j,m} = X_{t+1}^{j,m}\theta_{t+1}^{j,m}$.

6. Repeat steps 4-5 for all the forecasting horizons K obtaining at each step $y_{t+k|t-1}^{j,m}$ for $k = 1, ..., K$.

7. Repeat steps 3-6 M times and compute the averages for every forecasting horizon $k = 0, ..., K$
$$y_{t+k|t-1}^j = 1/M\sum_{m=1}^{M} y_{t+k}^{j,m}.$$
This is a realization of the random variable (4).

8. Repeating steps 1-7 J times the percentiles of interest of the distribution of the counterfactuals can be obtained.

To obtain the impulse response functions we need to compute the second expectation in (5). To do that the algorithm is the same as the one above but with step 2 replaced by the following step

[4] The ε's can be disregarded since they are independent from the shock in the coefficients.

$2'$ Draw ϵ_t^m from a Normal with zero mean and covariance Q^j and compute

$$\theta_t^{j,m} = \theta_{t-1}^j + e_t^m$$

The draw obtained in such a way is a realization of the random variable $E(y_{t+k}|\mathcal{I}_{t-1})$. The difference between the realizations obtained in the two algorithms is a realization of the impulse response functions.

To compute the counterfactuals let us proceed as follows.

i. Draw θ_1^j, Q^j and compute V^j and Λ^j; draw H_r according the the identification scheme adopted and arbitrarily fix the other column of H, say H_{-r} in such a way that matrix orthogonality is satisfied; compute $\nu_t = (H_{-r}^j)'(\Lambda^{1/2,j})^{-1}(V^j)'e_t$.

ii. Set $\theta_1^* = \theta_1$, and iterate on

$$\theta_t^{j*} = \theta_{t-1}^{j*} + V^j\Lambda^{1/2,j}H_r^j\bar{u}_t^* + V^j\Lambda^{1/2,j}H_r^j\nu_t$$

for $t = 2, ..., T$.

iii. Compute the residuals $\varepsilon_t^j = y_t - X_t\theta_t^j$ for $t = 1, ..., T$.

iv. Compute $y_t^{j*} = X_t^*\theta_t^{j*} + \varepsilon_t^j$ for $t = 1, ..., T$ where $X_1^* = X_1$ while for $t = 2, ..., T$ X_t^* includes the lags of y_t^{j*} .

v. The sequence $\{y_t^*\}_{t=2}^T$ is a realization of the vector of counterfactual series.

vi. Repeating steps 1-v J times the percentiles of interest of the distribution of the counterfactuals can be obtained.

3 An application to fiscal policy

We apply the econometric procedure described above to fiscal policy rules.

Let $y_t = [s_t \; g_t \; b_t]'$ where s_t is the cyclically adjusted surplus-to-GDP ratio, g_t is the ouput gap and b_t is the debt-to-GDP ratio. Data are U.S. quarterly data spanning from 1959:I-2008:IV. We set $p = 1$, $q = n^2p + n$ and estimate model (1) (3) using the MCMC method described in Primiceri (2005). The outcome of the estimation procedure is a collection of 700 draws for all the model coefficients.

3.1 A preliminary assessment

Consider the first equation of the model

$$s_t = \theta_1(\bar{\gamma}_t) + \theta_2(\bar{\gamma}_t)s_{t-1} + \theta_3(\bar{\gamma}_t)g_{t-1} + \theta_1(\bar{\gamma}_t)b_{t-1} + \varepsilon_{1t}$$

Such an equation is a time-varying paramaters version of the fiscal policy rule considered in Gali and Perotti,(2003)[5] and describes how discretionary systematic fiscal policy is conducted. ε_{1t} represents the non-systematic component while $d_t - \varepsilon_{1t}$ the systematic component of the rule, that is how fiscal authorities set deficit in response to changes in output gap $\theta_3(\bar{\gamma}_t)$ and debt $\theta_4(\bar{\gamma}_t)$ and the degree of inertia $\theta_2(\bar{\gamma}_t)$. We assume that the fiscal rule parameters depend only on structural policy parameters $\bar{\gamma}_t$.

Figure 1 plots the evolution of the coefficients $\theta_3(\bar{\gamma}_t)$, $\theta_4(\bar{\gamma}_t)$ and $\theta_3(\bar{\gamma}_t)/(1-\theta_1(\bar{\gamma}_t))$ $\theta_4(\bar{\gamma}_t)/(1-\theta_1(\bar{\gamma}_t))$ where the last two represent the long run response of surplus to oputput gap and debt respectively. Two results are worth noting. First, fiscal policy has become more countercyclical, $\theta_3(\bar{\gamma}_t)$ has increased, , consistently with the evidence reported in Auerbach (2002) and Taylor (2000). Second, it has become less reactive to the level of debt, $\theta_4(\bar{\gamma}_t)$ has fallen.

To evaluate the implications of these policy changes we perform the following exercise. We generate a new artifical economy under the constraint that the parameters of the fiscal rule remain at the level observed at the beginning of the sample. That is we assume that $\bar{\gamma}_t = 0$ for all $t = 2, 3, ...$ In practice $\bar{\gamma}_t$ is assumed to be a 4-dimensional vector containig the first four element of $\gamma_t = S^{-1}\theta_t$ where S is the Cholesky factor of Ω. Notice that for this specific exercise the results are invariant to the particular ordering of the elements of $\bar{\gamma}_t$.

For sake of comparison, first of all we perform the exercise in the classsical way where correlations among the parameters are neglected. In practice the fiscal rule parameters are kept constant at the initial value and the estimated values of the remaining coefficients are used to generate the new series. Figure 1 shows the three original variables and the counterfactual series obtained. The counterfactual predicts higher surplus, lower output gap and lower debt over the whole sample. From a quantitative point of view differences are large for all the variables. Quite striking is the result for debt. Had fiscal policy rule remained as in 1965, debt nowadays would be around 20% instead of

[5] Such a rule is aopted also in Andres and Domenech, and Taylor, . Debt is included following Bohn (1998).

60%. Based on these results we would conclude in favor of a very important role played by change in the coefficients.

Second, we perform the same type of counterfactual using the procedure described in section 2.2.3. Figure 2 shows the original data and the series obtained by running the counterfactual. In this case we draw the non-policy coefficients conditional on the policy parameters being constant over the whole sample. In other words conditioning on a realization equal to zero of $\bar{u}_t^*$ for $t = 2, 3, ...$ Differences with the previous case are striking. Deviations from the actual series are much smaller than in the previous case. Depending on the specific year, counterfactual surplus and output gap are higher or lower than actual ones and conterfactual debt is around 40%-50%, smaller than the actual one but much higher than that predicted in the previous counterfactual. Changes in the fiscal policy rule turn out to be less relevant than those estimated in the previous counterfactual.

Table 1 which shows reduced form parameters correlations. Correlations are non-zero both within equation and across equations. Disregarding these correlations affects the results. This explains the difference with the previous conuterfactual

3.2 The effects of countercyclical systematic fiscal policy

Here we focus on the macroeconomic effects of changes in the extent to which the systematic fiscal policy responds to output gap. That is what happens when fiscal policy becomes more (less) countercyclical?

Policy parameter identification is reached by assuming that the parameter on output gap in the surplus equation is a structural parameter that represents the fiscal authority preferences about stabilization goals. Formally $\theta_3(\gamma_t) = \bar{\gamma}_{1,t}$ (the first element of $\bar{\gamma}_t$) where $\bar{\gamma}_{1,t}$ is the structural parameter representing the fiscal authorities stabilization preferences. An increase (fall) in the parameter means that the discretionary policy becomes more (less) countercyclical. This assumption identifies the policy parameter whose effects we want to investigate. In fact the restrictions implies that $\bar{u}_{1,t} = e_{3,t}$. We do not make any assumption about the other parameters.

We perform the three types of analysis described above.

3.2.1 Counterfactuals

We run three counterfactual experiments.

The first aims at assessing the historical effects of changes in the systematic response of fiscal policy to output gap. Specifically we generate three series assuming no change in $\theta_3(\bar{\gamma}_{1,t})$, that is we set $\bar{u}^*_{1,t} = 0$ or equivalently $\bar{\gamma}_{1,t} = \bar{\gamma}_{1,1}$ for all $t = 2, 3, ...$. Figure 4 shows the three original series (solid lines), the three counterfactual (dotted lines) series. We also report for sake of comparison the counterfactual series (dashed-dotted lines) obtained ignoring correlations. Counterfactual surplus is higher during the 80s and the 90s, while slightly lower at the beginning of the new millenium. Counterfactual gap is slightly lower during the 80s and after mid 90s although the differences are quantitatevely small. The biggest difference is observed for debt. Having the response of fiscal policy to output gap remained constant at the 1965 value, the debt would have been about 20% of GDP less than the actual one after mid 80s. Overall changes towards a more countercyclical policy seem to have substantially increased deficit and public debt with limited gains in terms of output gap.

In the second countefactual we generate an economy where fiscal policy is perfectly acyclical, that is $\bar{u}^*_{1,2} = -\bar{\gamma}_{1,1}$ and $\bar{u}^*_{1,t} = 0$ for $t = 3, 4, ...$ such that $\bar{\gamma}_{1,t} = 0$ for $t = 2, ..., T$. Figure 5 shows the results. Results are almost identical to the previous case. Had an acyclical policy been implemented over all the sample, public surplus would have been substantially higher and debt substantially lower and output gap slightly lower.

In the last exercise we simulate an economy where $\bar{\gamma}_{1,t}$ reaches the maximal level observed over the sample in period two and it remains at that level until the end of the sample. That is $\bar{u}^*_{1,2} = \bar{\gamma}_{1,60} - \bar{\gamma}_{1,1}$ and $\bar{u}^*_{1,t} = 0$ for $t = 3, 4, ...$ such that $\bar{\gamma}_{1,t} = \bar{\gamma}_{1,60}$ for $t = 2, ..., T$. The idea here is to generate an economy under a more countercyclical policy. Results are shown in Figure 6. The counterfactual series overlap the original ones except for few years around the 70s. A more countercyclical policy would have had no very little effects on the three variables.

Figure 7 shows the true and onuterfactual pattern of the parameter $\bar{\gamma}_{1t}$

Figure 7 plots the actual (solid line) and the counterfactual variances of the output gap.[6] Before mid 90 the more countercyclical the response of fiscal authorities to output gap the smaller the variance. In absence of the observed policy the output gap

[6] The variance is computed using the companion form of the VAR. In one case it is computed using the actual coefficients $\{\theta_t\}_{t=1}^T$, while in the counterfactual cases is computed using the counterfactual coefficients $\{\theta^*_t\}_{t=1}^T$.

variance would have been about 15% higher. Over such a period of time systematic discretionary fiscal policy is stabilizing. After early 90 results are more difficult to interpret in part because of several missing points[7] but seem to suggest the opposite. Less countercyclical policies seem to be stabilizing.

3.2.2 Impulse response functions

Figure 7 plots the impulse response functions of the three variables to an unexpected increase in the degree of counter-cyclicality of systematic fiscal policy, a positive shock $\bar{u}_t^*$, of dimension two standard deviations for every period of the sample. The dotted lines refers to the effects at an horizon of one year, the solid lines to an horizon of two years.

Changes in the responses of the three variables are evident. Until early 80s the shock, at an horizon of two years, tends to reduce the surplus increasing output gap with little effects of public debt. After mid 80s there are two big changes. First, the sign of the response of output gap changes sign becoming negative; second the shock increases public debt substantially.

Why the responses have changed? Figure 8 plots the response of output gap (solid lines left scale) and the level of debt-to-GDP ratio (dotted lines right scale). The two series are negatively correlated and the switch in the sign of the response of output gap occurs in the first half of the 80s precisely when the debt takes off. After that date, in a regime of high debt, a shift towards a more countercyclical policy yields a reduction of the output gap. The results in this subsection, along with those in the previous section seem to point to the level of debt as very relevent in terms of transmission mechanisms of fiscal policy actions a finding which has been already documented in literature (see Bertola and Drazen, 1993, Perotti 1999, Sutherland 1997, and Gordon and Leeper, 2005). The point is that agents expectations about future taxes are likely to depend on the level of debt and this can generate very different dynamics for fiscal shocks.

3.2.3 Forecast

Finally we produce forecast for the three variables conditional on a one-standard deviation positive shock in u_{pt} occurring in 2008:II. Figure 8 plots the results. The solid lines

[7] Missing point refer to periods of time were the roots of the VAR polynomial are larger or equal to one so that the formula cannot be used to compute the variance

are the three series. The dashed lines are the unconditional forecasts while the dotted lines are the conditional forecasts made using (4). The two forecast are very similar. If any, the difference is that a more countercyclical policy would induce the perverse effect of a worsening of both surplus and debt and at the same time a reduction of the output gap. This is consistent with the evidence presented in the previous subsection.

4 Conclusions

This paper proposes an econometric framework to evaluate the effects of policy regimes change which is not subject to the Lucas critique. The methodology models the correlation structure between policy and non-policy coefficients in such a way that after a policy regime change non-policy coefficients are allowed to change accordingly.

We apply the procedure to fiscal policy rules. The main findings are: (i) discretionary fiscal policy has become more countercyclical; (ii) the change has substantially increased the level of debt to GDP ratio, the deficit and to a lesser extent and in specific periods of time stabilized the output gap; (iii) the effects on output gap of the increase in the degree of countercyclicality of fiscal policy depend on the level of debt-to-GDP ratio: positive in periods where the ratio is low and zero or negative when the ratio is high; (iv) a more countercylical stance of the systematic fiscal policy in 2008:II turns out to be ineffective to recover from the last crisis.

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Tables

Table 1: Correlations u_j, u_i

Eq.		d_t				g_t				b_t			
	u_i	c	d_{t-1}	g_{t-1}	b_{t-1}	c	d_{t-1}	g_{t-1}	b_{t-1}	c	d_{t-1}	g_{t-1}	b_{t-1}
d_t	c	1											
	d_{t-1}	0.36	1										
	g_{t-1}	-0.05	0.54	1									
	b_{t-1}	-0.99	-0.42	0.03	1								
g_t	c	0.01	0.23	0.15	-0.03	1							
	d_{t-1}	0.20	0.13	0.10	-0.21	0.42	1						
	g_{t-1}	0.16	-0.02	-0.11	-0.16	-0.07	0.47	1					
	b_{t-1}	-0.02	-0.24	-0.15	0.04	-0.99	-0.49	0.05	1				
b_t	c	-0.04	-0.13	-0.08	0.04	-0.78	-0.34	0.07	0.78	1			
	d_{t-1}	-0.22	-0.16	-0.11	0.23	-0.37	-0.87	-0.40	0.43	0.44	1		
	g_{t-1}	-0.23	-0.09	-0.02	0.22	-0.01	-0.47	-0.81	0.03	0.00	0.55	1	
	b_{t-1}	0.05	0.14	0.08	-0.06	0.78	0.40	-0.06	-0.78	-0.99	-0.51	-0.02	1

Figures

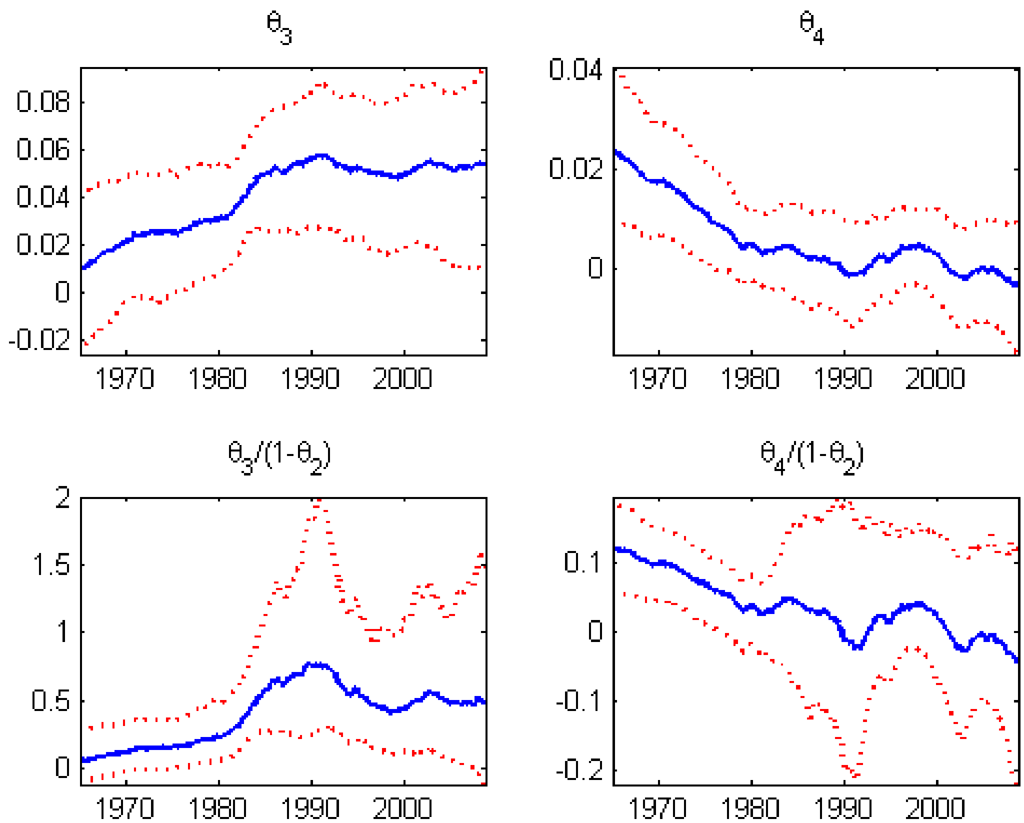

Figure1: Estimated parameters of the policy rule. Solid line are median dortted line are 68% confidence bands.

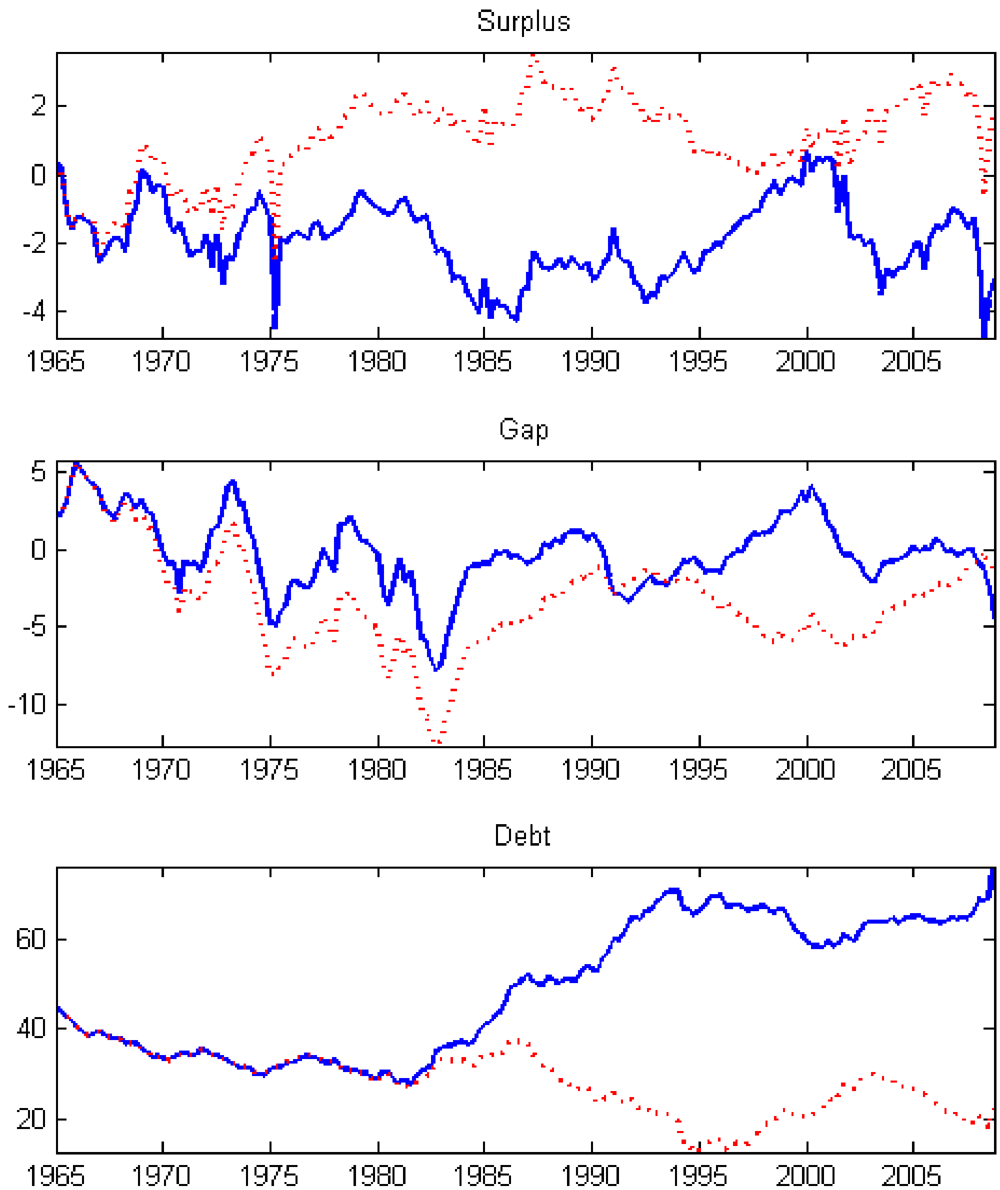

Figure2: Standard counterfactual neglecting correlations. Solid lines are original series, dotted lines are couinterfactual series.

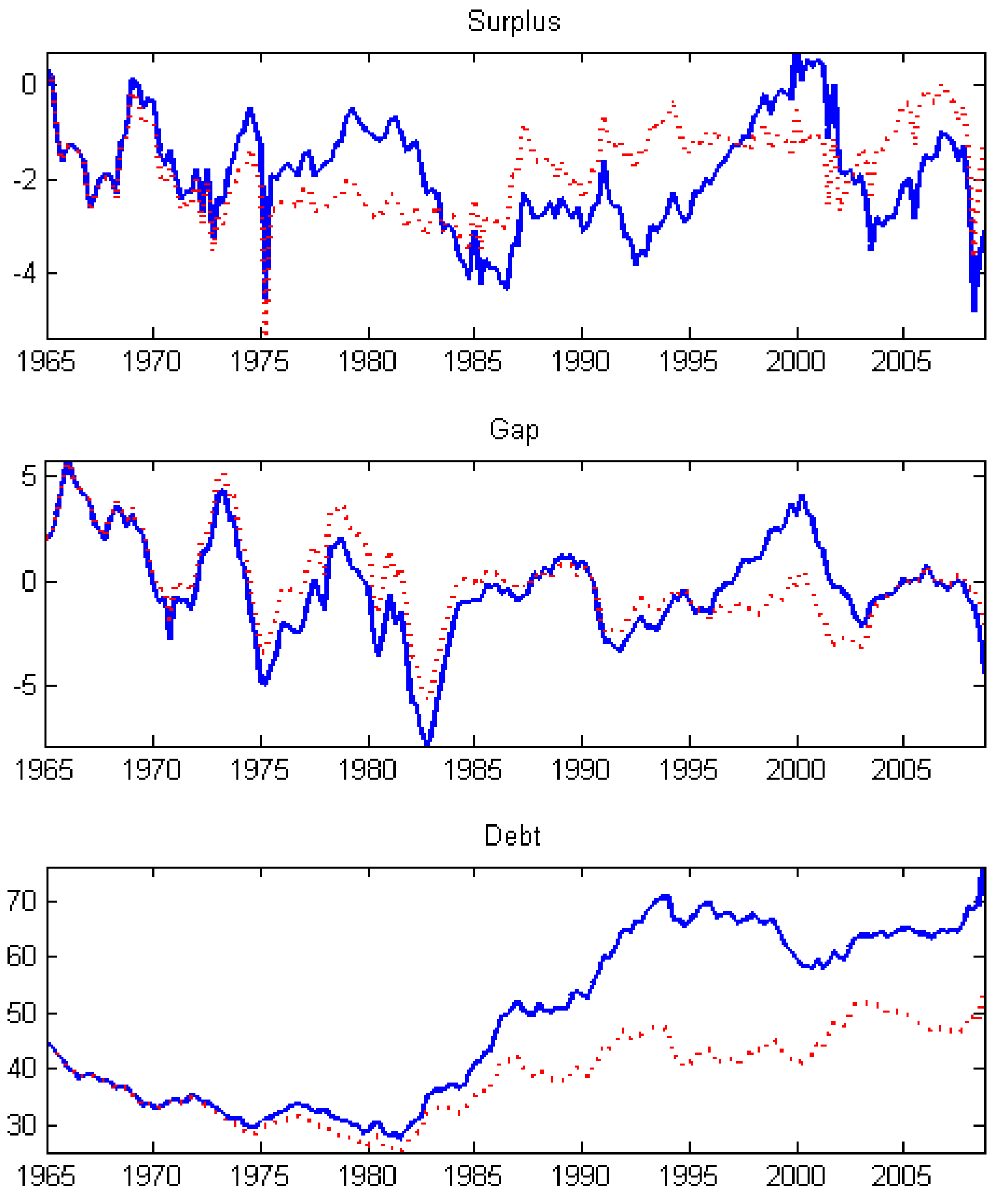

Figure3: Counterfactual using our method. Solid lines are original series, dotted lines are couinterfactual series.

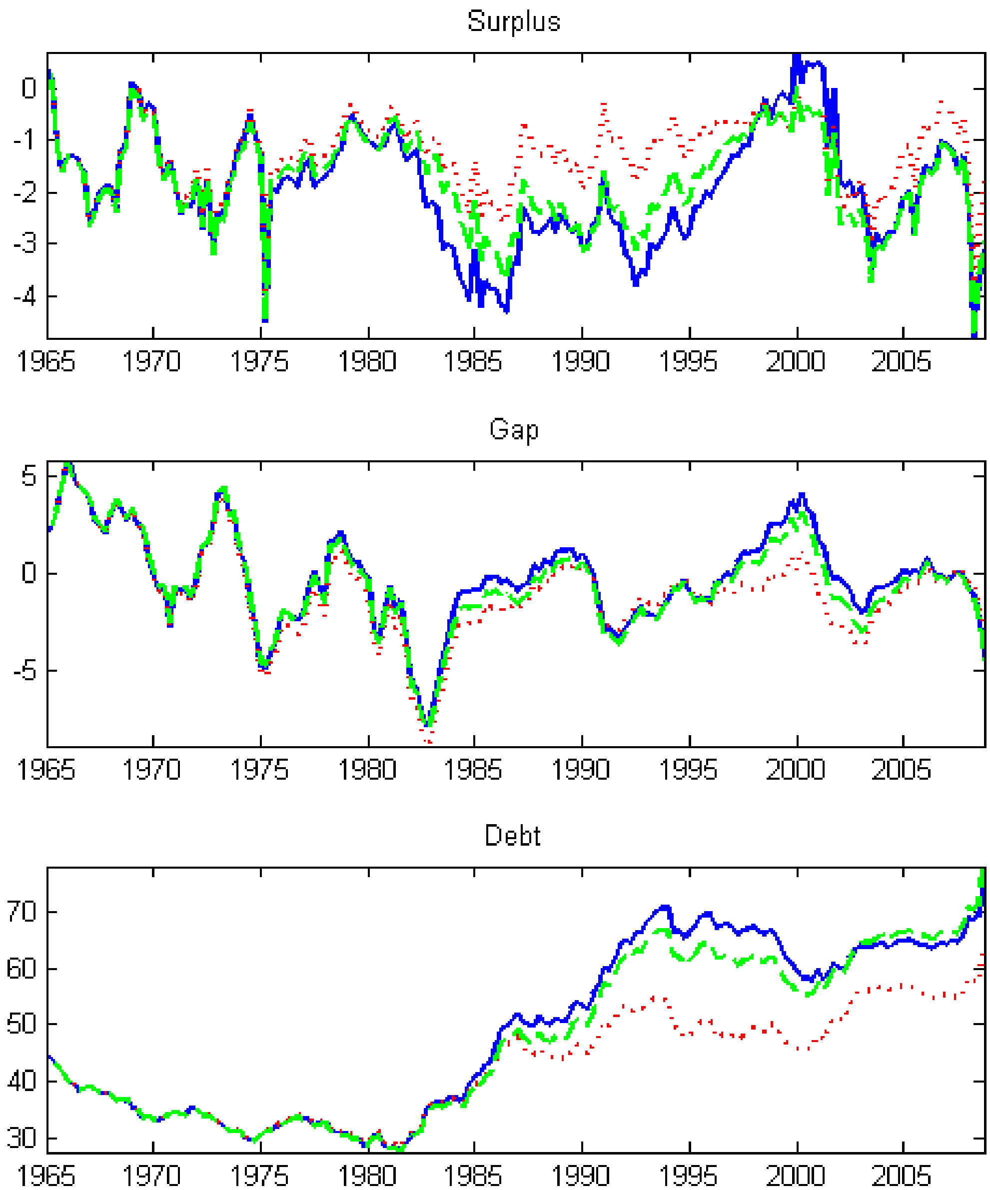

Figure 4: Counterfactual 1. Solid lines are original series; dotted lines are counterfactual series; dashed-dotted lines are counterfactual series obtained with the standard method that neglect correlations.

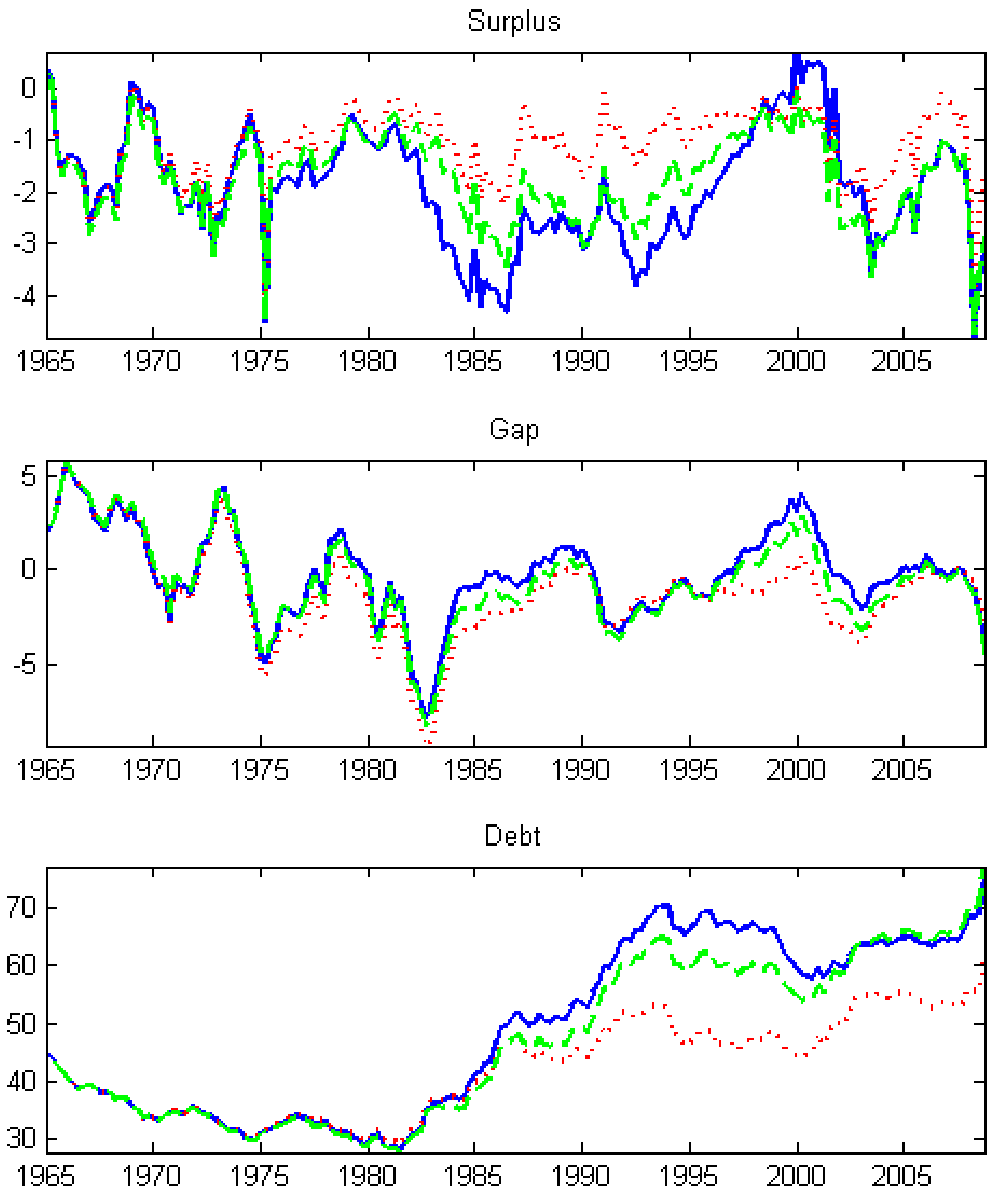

Figure 5: Counterfactual 2. Solid lines are original series; dotted lines are counterfactual series; dashed-dotted lines are counterfactual series obtained with the standard method that neglect correlations.

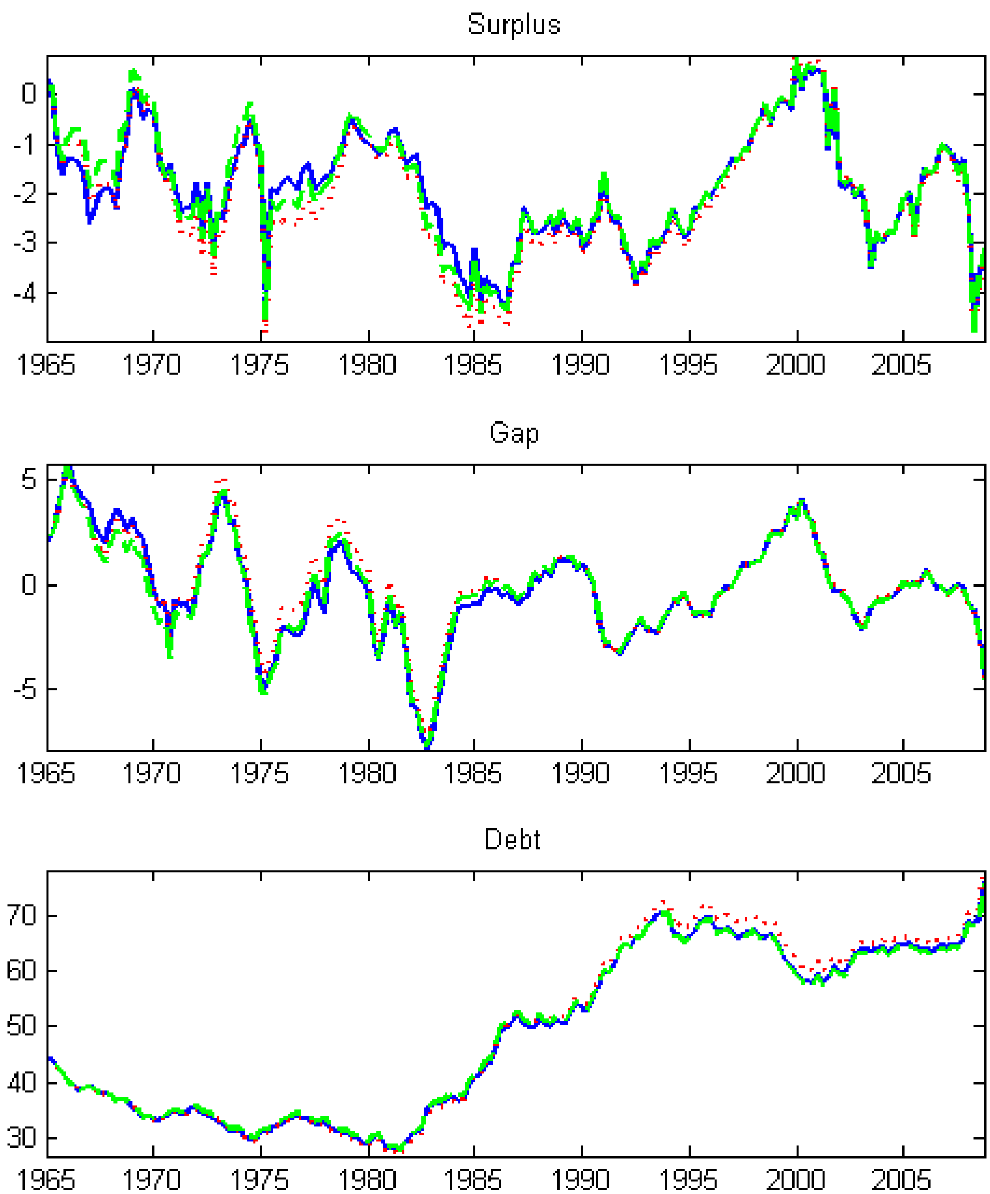

Figure 6: Counterfactual 3. Solid lines are original series; dotted lines are counterfactual series; dashed-dotted lines are counterfactual series obtained with the standard method that neglect correlations.

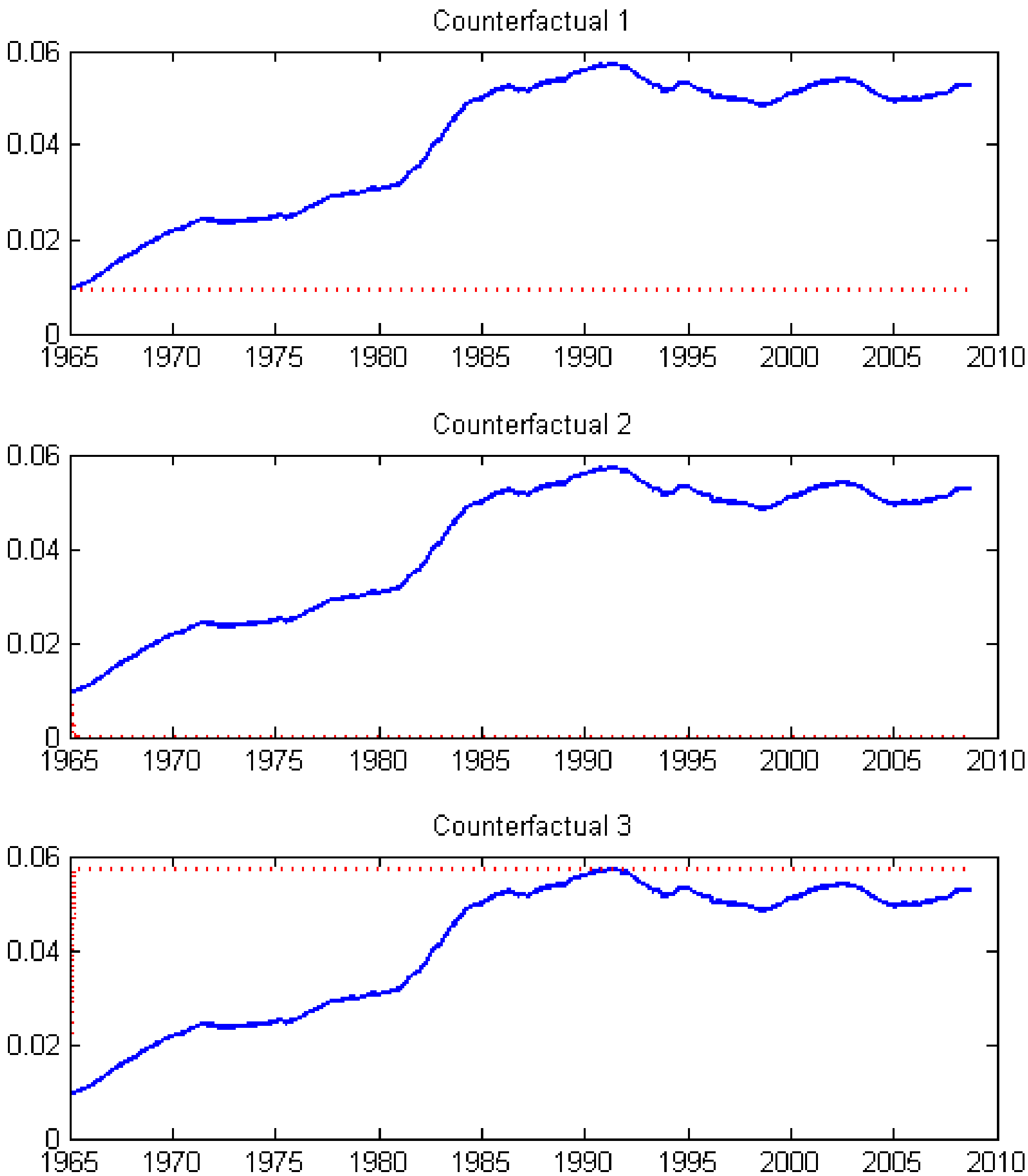

Figure 7: path for the coefficient $\bar{\gamma}_{1t}$. Solid line is the estyimated coefficient; doted line is counterfactual path for the coefficient.

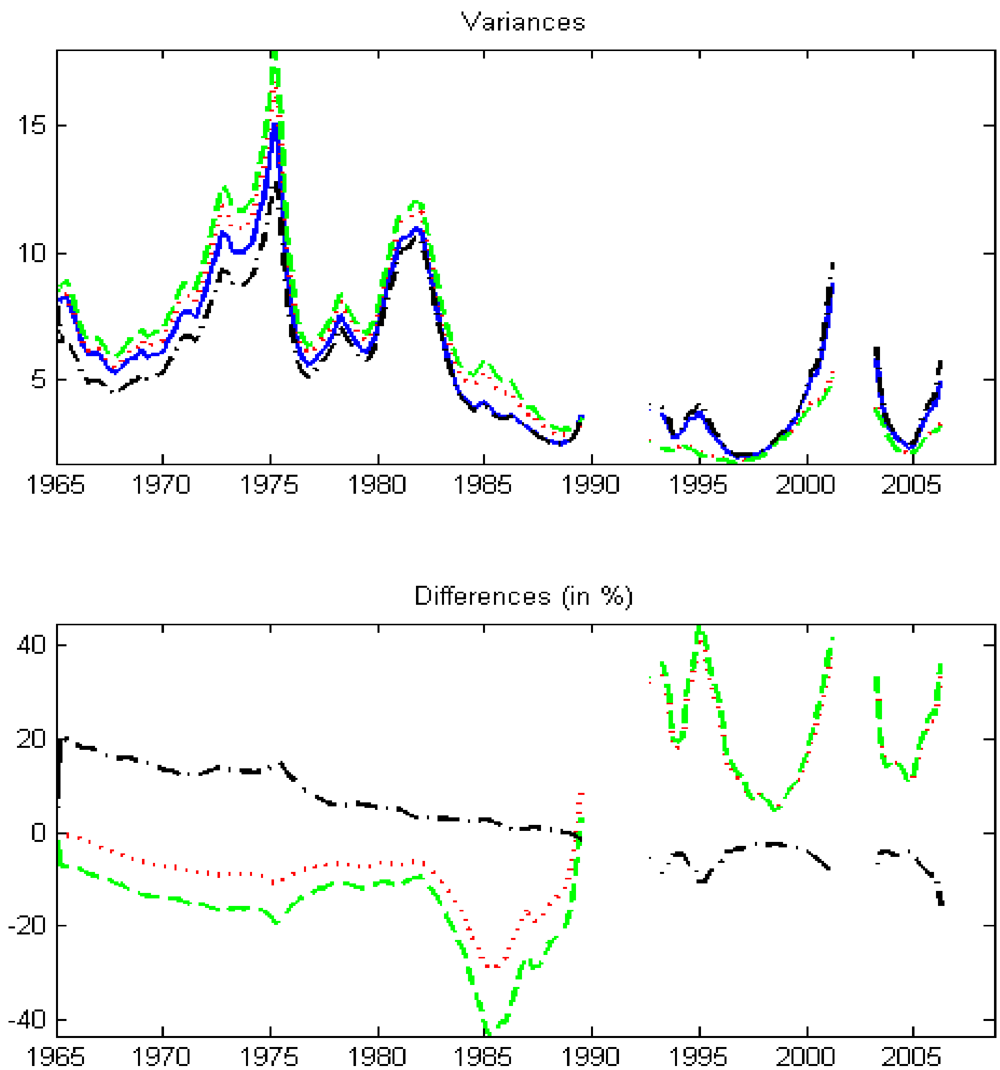

Figure 8: variances. Top panel plots the estimated variance (solid line) and the variance obtained in Counterfactual 1 (dotted line), Counterfactual 2 (dashed line) and Counterfactual 3 (dashed-dotted line). In the bottom panel we plot the percentage gain (positive numbers) or loss (negative number) in terms of variance respect to real case in the three counterfactuals.

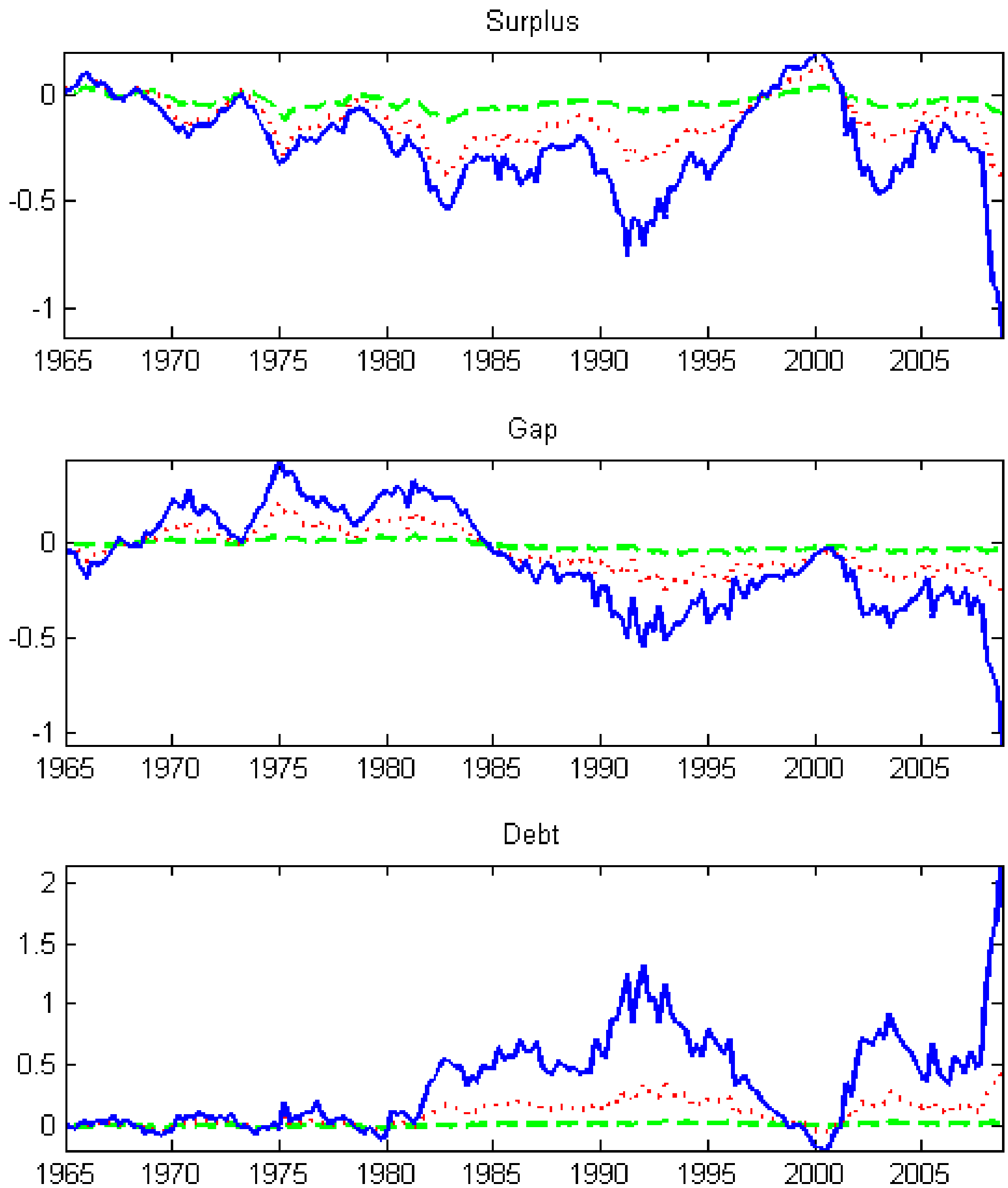

Figure 9: Impulse response functions on impact (dotted), 4 quarters (dshed line) and 8 quarters (solid line).

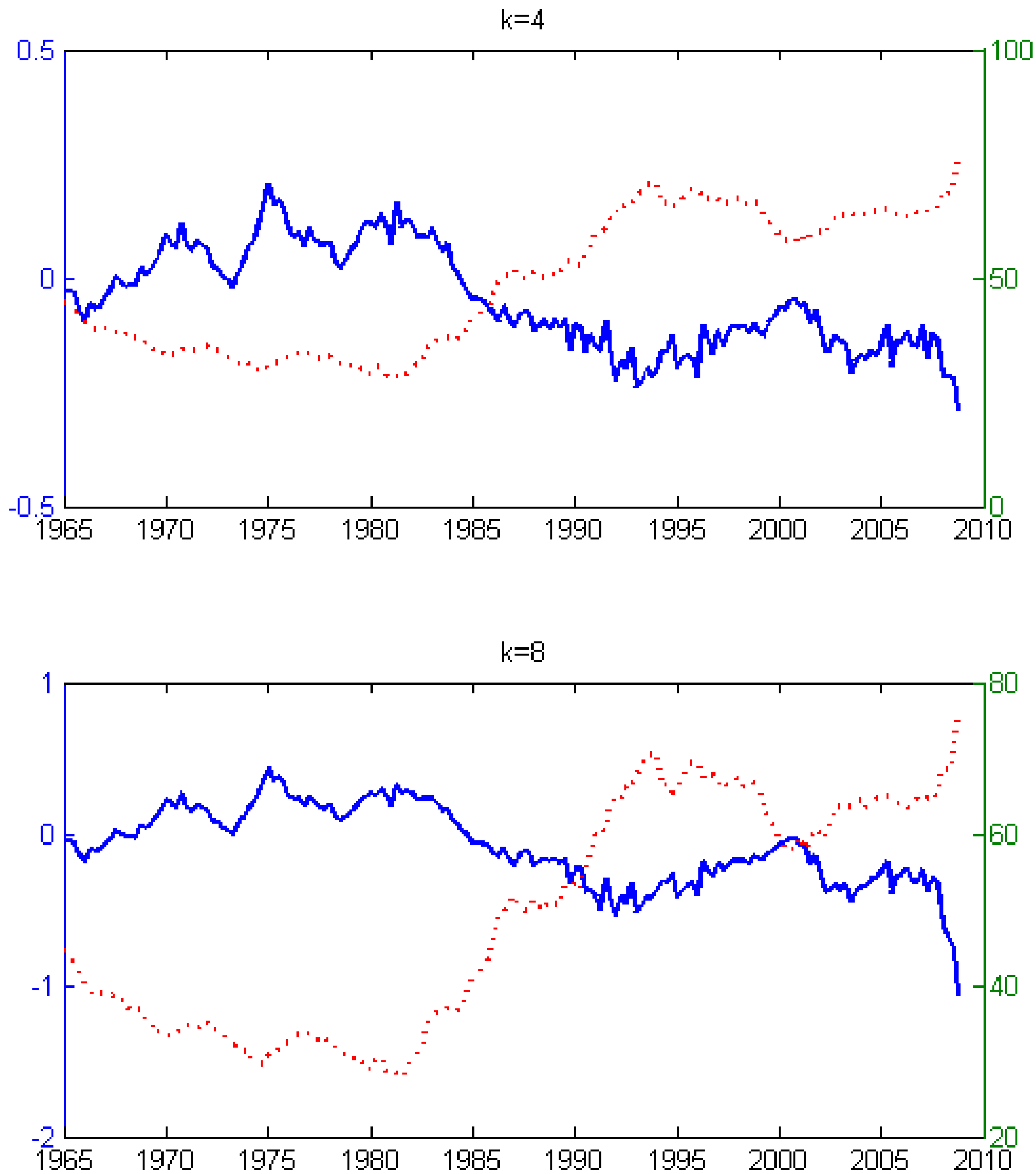

Figure 10: Impulse response functions for output gap (solid left scale) and the level of debt-to-GDP ratio (right scale).

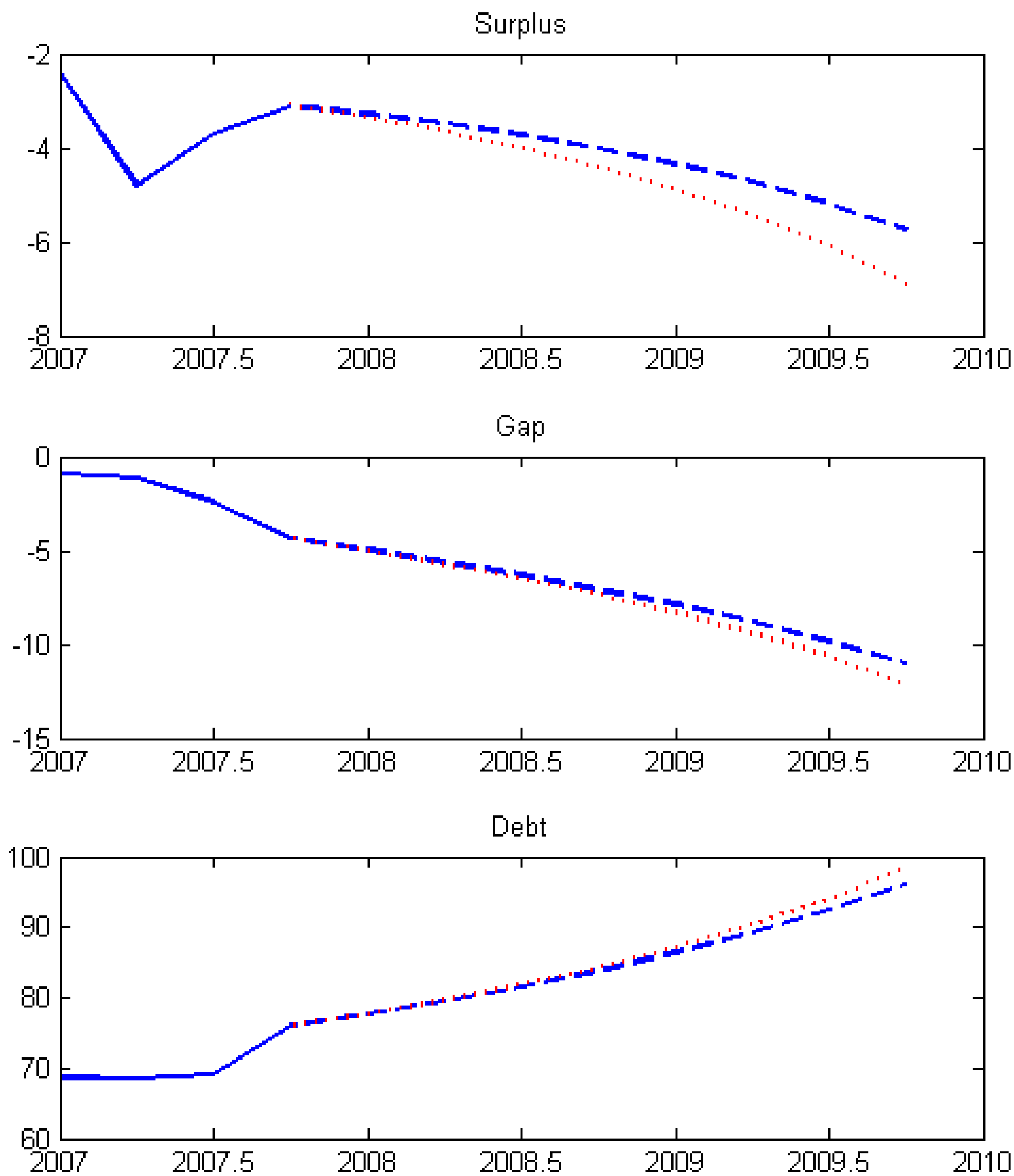

Figure 10: Forecast. Undonditional (solid line) and conditional (dotted line).