Non-linear Effects of Fiscal Policy in Germany: A Markov-Switching Approach

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Abstract: Keynesian theory suggests that a reduction in government expenditure has a negative effect on private demand and therefore on output. Contrary, neoclassical theory argues that a fiscal contractions makes room for an expansion of the private sector and thus has a stimulating effect on the economy. The recent literature discusses that both theories might be right at different times. In this paper, we test for non-linear effects of fiscal policy on consumption in Germany in a Markov-switching approach. We find two different regimes, with a non-Keynesian regime prevailing around 1972-74, 1979-82 and 1992-93. Furthermore, using time-varying transition probabilities (TVTP) for the Markov process, we test if the non-Keynesian reaction of private consumption to fiscal variables depends on variables reflecting the sustainability of the debt path, as theory suggests. Though our results are more consistent with theories that focus on the discretionary change in fiscal policy than with those stressing initial conditions in the economy as trigger for non-Keynesian effects, we are unable to obtain strong results in support of either hypothesis.

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1 Introduction

The effect of fiscal policy on private demand has for long been an intensely debated issue in theoretical macroeconomics. Keynesian theory suggests that a reduction in government expenditure has – by the working of the multiplier – a negative effect on private demand and therefore on output. Contrary, neoclassical theory argues that reduced public expenditure makes room for an expansion of the private sector and thus has a stimulating effect on the economy. It is hence an empirical question which theory adequately describes the reality. Yet empirical research on the effects of fiscal policy is only at the beginning of clarifying this issue. Although there are studies that find support for either theoretical view, reality may be more complex. Recently, the theoretical literature has proposed the hypothesis of expansionary fiscal consolidations as an explanation for non-linearities in the effects of fiscal policy. This view is based on Giavazzi and Pagano (1990) who argue that during "normal" times the economy may behave as standard Keynesian theory would predict, yet there seem to be periods during which the economy reacts in a neoclassical way. This happens mainly – at a first thought paradoxically – during times of tight fiscal contractions from high levels of debt; the reasoning hence is that reducing public activity by fiscal consolidation can be stimulating to the economy. During the course of time, therefore, the effect of fiscal policy on private demand may change in magnitude and even may switch sign.

This paper looks at potential non-linearities in the effect of fiscal policy on private consumption in Germany. We do so in an a-theoretical way by trying to identify possible non-linearities within the statistical framework of Markov-switching models. Starting with the seminal contributions by Hamilton (1989 and 1990), the Markov-switching approach has become popular mainly in business-cycle research, as it is a convenient analytical tool for the analysis of repeated and endogenous switching between regimes that exhibit some sort of persistence. Applying this framework to the analysis of fiscal policy we are able to identify episodes of non-conventional fiscal effects endogenously from the data. This procedure in our view constitutes a considerable advantage over much of the empirical literature on non-linear effects of fiscal policy, as in existing studies periods of non-Keynesian effects are typically determined exogenously, before in a second step the coefficients for the Keynesian and the non-Keynesian regime are estimated.[1] In contrast, we simultaneously estimate the effects of fiscal policy on consumption and identify endogenously the switching points.

[1] See for example Giavazzi and Pagano (1996) or Giavazzi, Jappelli and Pagano (2000).

In the second part of the analysis we investigate possible explanations of these non-linearities by introducing time-varying transition probabilities into the Markov-switching model. This enables us to test the influence of specific economic variables on the probability of a switch into a non-Keynesian regime. Although a direct mapping of the structural hypothesis of expansionary consolidations into our empirical framework is difficult, this procedure may help to assess the validity of certain aspects of the hypothesis.

Our results support the existence of switches between a Keynesian and a non-Keynesian regime in the German case. However, there remain some doubts whether these non-linearities can indeed be solely attributed to the phenomenon of expansionary fiscal consolidations. The analysis is structured as follows. In Section 2, a brief overview over previous theoretical and empirical work on non-linear fiscal effects is presented. Section 3 discusses our methodology and the data used, and Section 4 presents the results. Section 5 provides a summary and some concluding remarks.

2 Previous Work on Non-linear Effects of Fiscal Policy

2.1 Theoretical Considerations

One of the central explanations of non-linearities in the effects of fiscal policy on private demand is the hypothesis of expansionary fiscal consolidations, suggesting that there might be a "switch" to non-Keynesian policy effects before or during consolidation efforts to reduce the public deficit and the accumulated level of debt. This hypothesis goes back to an argument by Hellwig and Neumann (1987) and has regained considerable interest with an influential paper by Giavazzi and Pagano (1990). They demonstrate that the fiscal stabilisations in Ireland from 1987 to 1989 and in Denmark from 1983 to 1986 may be regarded as expansionary fiscal adjustments and illustrate their argument with some evidence that challenges the predictions from conventional Keynesian theory. Following Giavazzi and Pagano (1990) the literature in this area has grown considerably and in several directions; the following therefore only gives a brief sketch of the main ideas that might serve as a background to the later discussion of non-linearities in this paper.

A first channel for a fiscal consolidation to generate non-Keynesian policy effects is the standard macroeconomic wealth channel. Private wealth is affected by changes in interest rates

that can be brought about directly by reducing the deficit (crowding-in effects) as well as by a reduction in the risk premium on government debt. Both effects lower interest rates and thus raise private wealth, stimulating household consumption. In addition, two other channels for the emergence of non-Keynesian effects may be effective: a fall in expected inflation and the substitution of private for previously public consumption.[2] Considering the anecdotic and econometric evidence presented in Giavazzi and Pagano (1990), however, it has been shown that these channels may not be sufficient to explain the drastic changes in private consumption observed during several consolidations in the past. Consequently, other models have been put forward in the literature that complement the standard wealth channel by proposing changes in agents expectations as a possible cause for the switch to non-Keynesian effects.

The expectations channel presumes that a sufficiently large temporary fiscal adjustment may lead agents to expect permanently lower taxes in the future, see e.g. Feldstein (1982). This increases households' permanent income and thus raises current and planned consumption. It is central to the expectations channel that private agents observe signals in the economic environment leading them to revise their expectations; in other words, current policy actions trigger expectations about future policy actions that in turn affect current behaviour of the agents.

Blanchard (1990) models the effect of a fiscal consolidation on private consumption – brought about by increasing current taxation – through two channels: on the one hand the above mentioned direct negative wealth effect of increased taxation on consumption[3], and on the other hand a positive expectation effect on output, as a timely consolidation before reaching a certain threshold tax rate prevents more drastic and costly consolidation measures later. For an expansionary consolidation hence the expectations channel has to dominate the wealth channel. The likelihood of this occurring rises the more Ricardian consumption behaviour is and the closer the economy is to the threshold tax rate. Another aspect of the role of the economy's initial conditions in triggering switches in the policy effect is captured by the neoclassical model of Bertola and Drazen (1993). Here, the effects of government expenditure depend on its own initial value, triggering non-Keynesian effects when public expenditure hits some threshold level but an expected consolidation does not occur, so that changes in current government spending generate expectations of future changes in fiscal policy in the opposite direction. Central to both models is the change in expectations occurring once a consolidation is initiated, which depends on the initial conditions of the economy.

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[2] Giavazzi and Pagano (1990) derive all effects theoretically in a version of the finite horizon model by Blanchard (1985).

[3] This channel only works if consumers are non-Ricardian, as the present value of taxation is not changed by the consolidation measures.

The model by Perotti (1999) generates switches in the effects of fiscal policy depending on the initial conditions of the economy without resorting to the expectations channel. He builds a three period model, where distortions caused by taxes are convex and a fraction of consumers is liquidity constrained. In his model, the effect of public-expenditure shocks on private consumption depends negatively on accumulated government debt and positively on the probability that the current government will be in power in the next period.[4] Perotti shows that increased taxation may have an expansionary effect on private consumption, depending on the same variables as in the case of expenditure. Sutherland (1997) makes a similar point in a different framework.

The foregoing discussion has shown that the potential expansionary effects of a consolidation have at least two important dimensions: the characteristics of the consolidation itself and the circumstances or the initial conditions of a consolidation.

2.2 Empirical Evidence

Few attempts have been made in the empirical literature to test for non-linearities in the effects of fiscal policy. A fundamental question for empirical studies thereby is the way potential periods of non-linear fiscal policy effects are identified. The method proposed by Giavazzi and Pagano (1996), namely to exogenously identify potential periods of non-linearities, has by now become standard and several aspects of the expansionary fiscal adjustments hypothesis have been looked at using this method. After having classified periods that may qualify for non-standard effects based on some criterion function, a dummy variable with a unit entry at the specified dates is constructed and is used to test if fiscal policy has a significantly different effect during these episodes compared to "normal" periods. Significant non-linearities are then interpreted as evidence in favour of the underlying hypothesis that motivated the definition of the exogenous criteria.

Though, at a first glance, the criteria for the definition of fiscal adjustment periods in the literature seem to be similar in different studies, they lead to substantially different results regarding the periods that are classified as non-Keynesian. Table 1 summarises the classification from different studies for Germany. Motivated by the argument that fiscal adjustments may be expansionary during a substantial and sustainable stabilisation or expansionary period, most studies define a sufficiently large change in the cyclically adjusted deficit as the basis for their empirical characterisation of discretionary policy adjustments. Perotti (1999), in-

[4] This probability is a proxy for the degree the government is able to perform intertemporal tax smoothing.

stead, defines a threshold level for accumulated debt as criterion for fiscal stress, focussing on the role of initial conditions in triggering non-linearities. Along this lines, Giavazzi and Pagano (1996) and Perotti (1999) analyse the effect of fiscal policy on private consumption, whereas Giavazzi, Jappelli and Pagano (2000) look at the effect on national savings.[5] The empirical evidence of these papers supports the existence of significant non-linear effects during stabilisation periods.

Other studies, however, question the empirical relevance of the hypothesis. Kamps (2001) uses a panel of 14 EU countries and finds that the result of significant non-linearities is highly sensitive to the underlying definition of the consolidation criteria. Neumann (2000) estimates a time-varying coefficient VAR model on a German dataset and finds almost no evidence for non-linearities in the effects of fiscal policy. Overall, due to considerable methodological problems involved and the small amount of available evidence, no clear picture emerges. Moreover, almost all studies analyse potential non-linearities based on the *exogenous* definition of a dummy variable. Yet we believe that for a concise analysis of non-linear fiscal-policy effects one has to use an empirical model that is able to identify non-linearities *endogenously*.[6] In the present paper, we use the Markov-switching approach, which is able to identify distinct states reflecting different fiscal-policy effects endogenously from the data. Our approach does not restrict the fiscal-policy regimes to be connected to a somehow defined fiscal consolidation period, but the estimation procedure assigns the empirical observations to that regime, which is the most likely one in a statistical sense. Additionally, using time-varying transition probabilities (TVTP) for the Markov process we analyse the potentially underlying sources of the switches between the two identified states. This constitutes an advantage over the existing literature in that we can try to test the empirical relevance of potential "driving" variables.

[5] Another strand of empirical literature analyses explicitly the role of the budgetary composition of the fiscal adjustment, see e.g. McDermott and Wescott (1996) and Alesina and Perotti (1995, 1997) among others.

[6] To the best of our knowledge, Neumann (2000), estimating a non-linear VAR with Kalman filter techniques, is the only attempt in this direction so far.

3 Methodology and Data

3.1 The Consumption Function

Since our aim is to analyse the effect of government activity on private consumption, we adopt for our empirical analysis the distributed lag model proposed by Blinder and Deaton (1985), a modification of which has also been used by Giavazzi and Pagano (1996). This specification includes first differences and lagged levels of the explanatory variables, thus reflecting both the short-run and the long-run properties of the consumption-income relation, and has proved sufficiently flexible to capture the time-series aspects of the data as well as the main determinants from the theory. The specification is able to accommodate "Euler-type" consumption functions, derived from the optimisation problem of a representative consumer, as well as error-correction specifications (see Blinder and Deaton 1985). Moreover, it nests the Keynesian and the neoclassical view to model the behaviour of aggregate consumption in that it includes disposable income, taxes and government expenditure as separate regressors (see Giavazzi and Pagano 1996). A drawback of this flexible specification, however, is that the number of parameters to be estimated is rather high so that we have to impose further restrictions, which we discuss in more detail below.

We set up the following specification: the change in consumption is regressed on the changes in disposable income, taxes, government expenditure and an error-correction term, which is computed as the difference in the levels of consumption and disposable income.[7] Equation (1) presents the specification of the consumption function:

$$\Delta c_t = \alpha_1(S_t) + \alpha_2(S_t)\Delta r_t + \alpha_3(S_t)\Delta e_t + \alpha_4 \Delta y_t + \alpha_5 ec_{t-1} + \varepsilon_t(S_t) \qquad (1)$$

where c_t is private consumption, r_t tax revenues, e_t stands for government expenditure, y_t for personal disposable income and ec_{t-1} is the lagged error correction term, with Δ denoting first differences. All variables are in logarithms and in real terms, deflated by the consumer price index. The regime S_t can switch between two different states, $S_t \in \{0, 1\}$. The residuals in each regime are a white noise process, with $e_t \sim N(0, s_1)$ if the process is in regime 1, and $e_t \sim N(0, s_0)$ if regime 0 prevails.

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[7] Unit root tests using the Phillips-Perron test confirmed that consumption, disposable income, tax revenues and government expenditure are I(1), i.e., they are non-stationary in levels but stationary in first differences. The error-correction term is stationary so that equation (1) constitutes a valid regression model.

As our aim is to analyse the non-linear effects of fiscal policy, we incorporate Markov switching only into the coefficients on taxes and expenditure (and the constant) but we do not allow the coefficients on disposable income and the error-correction term to switch. This assumes that the short-run income elasticity of consumption as well as the adjustment towards equilibrium are independent from being in a Keynesian or non-Keynesian regime. As we want to identify time periods where fiscal policy has different effects, these assumptions ensure that switching is not driven by other than the fiscal variables.

To keep the model tractable, we do not include lagged levels of taxes and government expenditure into the model. This has two reasons. First, to account for the non-linearity of fiscal policy one would also like to have the long-run coefficients on expenditure and tax revenues depending on the regime the economy is in. However, this would increase the already large number of parameters to be estimated by another four. Second, switching in the long-run relation would bring time-varying cointegration into the model, which would open up a number of difficulties (see Granger and Lee 1991) we prefer to avoid. Therefore, we decided to focus only on the short-run effects of fiscal policy, implicitly assuming that changes in government expenditure and taxes do not alter the long-run relation between consumption and disposable income. Moreover, given a limited number of degrees of freedom, we aim at keeping the specification of a consumption function in a Markov-switching framework as parsimonious as possible. Therefore, we restrict the coefficients of the lagged levels on income and consumption to be of the same size with different sign.[8] In effect this restricts long-run income elasticity of consumption being unity, implying a proportional long-run reaction of consumption to increases in income.

3.2. Markov-Switching

The introduction of Markov switching allows the coefficients α_1, α_2, and α_3 in equation (1) to switch between the two different states $S_t = 0$ and $S_t = 1$.[9] If our conjecture that fiscal policy at times has non-Keynesian effects is correct, one state should correspond to a regime with Keynesian effects, denoted by a superscript *K*, and the other state to an alternative regime

[8] This restriction could not be rejected in explorative estimations of the consumption function.

[9] Alternatively, non-linearities in the effects of fiscal policy could be estimated in a time-varying coefficients (TVC) model with Kalman filtering, see Neumann (2000). This method though assumes that changes in the economic structure or in institutions occur continuously over the sample period. If, instead, changes in the underlying regime are assumed to happen only occasionally and take the form of clearly identifiable, discrete events, Markov-switching seems more adequate to model these regime shifts.

with non-Keynesian effects, denoted by a superscript *NK*:

$$\alpha_i \in \alpha_i^K, \alpha_i^{NK},\ i = 1, 2, 3$$

Nevertheless, we do not impose neither different signs on the coefficients a priori nor force the process to switch into the other regime at a certain time. We only assume that there are two different regimes, while everything else is determined from the data in the estimation.

The series S_t, $t = 1, 2, \ldots, T$ provides information about the regime the economy is in at date t. If S_t were known before estimating the model, we could apply a dummy variable approach as, e.g., Giavazzi and Pagano (1996) do, meaning that α_i and σ would be defined as

$$\alpha_i(S_t) = \alpha_i^K S_t + \alpha_i^{NK}(1 - S_t),\ i = 1, 2, 3$$
$$\sigma^2(S_t) = \sigma^K S_t + \sigma^{NK}(1 - S_t)$$

with $S_t = 0$ or $S_t = 1$. In the Markov-switching approach, however, we assume S_t to be not observed, and we estimate the evolution of the regimes endogenously from the data. Therefore, we have to consider the joint distribution of y_t and S_t

$$f(y_t, S_t | y_{t-1}) = f(y_t | S_t, y_{t-1}) f(S_t | y_{t-1})$$

with

$$f(y_t | S_t, y_{t-1}) = \frac{1}{\sqrt{2\pi}\,\sigma(S_i)} \exp\left\{\frac{-e^2(S_i)}{2\sigma^2(S_i)}\right\} \tag{2}$$

being the conditional normal density function for the regime $S_t = i$ and ψ_{t-1} denoting information at time $t - 1$ (see Kim and Nelson 1999). The likelihood function thus becomes

$$\ln L = \sum_{t=1}^{T} \ln\left\{\sum_{i=0}^{1} f(y_t | S_t, y_{t-1}) \Pr[S_t = i | y_{t-1}]\right\}$$

and can be estimated using an iterative Maximum Likelihood procedure. $\Pr[S_t = i | \psi_{t-1}]$ denotes the probability of being in state 0 or 1 in period t. The likelihood function is thus a weighted average of the density functions for the two regimes, the weights being the probability of being in regime 1 or 0.

To make estimation feasible, one has to assume a stochastic process that determines the probability $\Pr[S_t = i | \psi_{t-1}]$. Here we assume a first order Markov process, i.e., the probability of being in a particular state in period t only depends on the state prevailing in period t - 1. The transition probabilities are defined as follows:

$$
\begin{aligned}
p &= \Pr\left[S_t = 1 \middle| S_{t-1} = 1\right], \\
1-p &= \Pr\left[S_t = 0 \middle| S_{t-1} = 1\right], \\
q &= \Pr\left[S_t = 0 \middle| S_{t-1} = 0\right], \\
1-q &= \Pr\left[S_t = 1 \middle| S_{t-1} = 0\right].
\end{aligned} \tag{3}
$$

At the beginning of time *t* the probabilities are calculated as

$$
\Pr\left[S_t = i \middle| \psi_{t-1}\right] = \sum_{j=0}^{1} \Pr\left[S_t = i \middle| S_{t-1} = j\right] \Pr\left[S_{t-1} = j \middle| \psi_{t-1}\right],
$$

where $\Pr\left[S_t = i \middle| S_{t-1} = j\right]$ are defined in equation (3). At the end of each period, the probabilities are updated using the following iterative filter (see Kim and Nelson 1999),

$$
\Pr\left[S_t = i \middle| \psi_t\right] = \Pr\left[S_t = i \middle| \psi_{t-1}, y_t\right] = \frac{f\left(y_t \middle| S_t = i, \psi_{t-1}\right) \Pr\left[S_{t-1} = i \middle| \psi_{t-1}\right]}{\sum_{i=0}^{1} f\left(y_t \middle| S_t = i, \psi_{t-1}\right) \Pr\left[S_{t-1} = i \middle| \psi_{t-1}\right]},
$$

with $f\left(y_t \middle| S_t = i, \psi_{t-1}\right)$ as defined in equation (2).

3.3 Constant versus Time-Varying Transition Probabilities

Constant transition probabilities mean that the probability of switching from one regime to the other does not depend on time nor on other variables indicating the state of the economy. This implies that the expected duration of a regime at a given point in time is constant and given by $1/(1-p)$ for regime 1 and $1/(1-q)$ for regime 0.

To force *p* and *q* to lie between 0 and 1, and to keep the model set-up for the constant transition probabilities similar to the case of the time-varying transition probabilities, we employ the following specification for *p* and *q* in the estimation:

$$
p = \frac{\exp(p_1)}{1+\exp(p_1)} \quad \text{and} \quad q = \frac{\exp(q_1)}{1+\exp(q_1)}.
$$

The TVTP approach was first developed by Filardo (1994) in the context of business-cycle research. He shows that indicator variables for the business cycle significantly determine the time-varying probabilities of the Markov process and thereby help to predict the switching points between booms and recessions. In a TVTP framework thus we can test if some "indicator" variable, like the path of accumulated debt or the budget deficit, influences the transition probabilities, as theory suggests. As has been discussed in Section 2, it seems apparent from

theoretical as well as econometric evidence that non-linear fiscal-policy effects are likely to be observed in times of fiscal stress or during a prolonged and substantial fiscal consolidation. If we find a significant impact of high budget deficits on the probability to switch into a non-Keynesian regime, this would give support to the expectations channel of fiscal-policy effects, as evidence would be consistent with economic agents that regard the debt path as unsustainable and expect higher taxes in the future.[10]

The concept of TVTP can be formalised as follows. Let Z_t be a vector of economic variables that affect the possibility of a regime switch. The time-varying transition probabilities then have the following form:

$$p_t = \Pr[S_t = 1 | S_{t-1} = 1, Z_{t-1}] = \frac{\exp(p_1 + Z_{t-1}' p_2)}{1 + \exp(p_1 + Z_{t-1}' p_2)}$$

$$q_t = \Pr[S_t = 0 | S_{t-1} = 0, Z_{t-1}] = \frac{\exp(q_1 + Z_{t-1}' q_2)}{1 + \exp(q_1 + Z_{t-1}' q_2)}$$

The maximisation of the likelihood function is executed in the same way as before. Instead of constant probabilities, p and q, the process now gives estimates of the coefficients p_1, q_1 and p_2, q_2. From the assumed functional form of the TVTP given above, one can then infer the series p_t and q_t. Once the model is estimated and $\Pr[S_t = j | y_t]$ is generated, one can use a algorithm developed by Kim (1994) to estimate the smoothed probability for regime S_t using all information in the sample, i.e. $\Pr[S_t = j | y_T]$, where $t = 1, 2, \ldots, T$.

The Markov-switching model is estimated using a recursive, non-linear optimisation routine.[11] Starting values for the optimisation routine are obtained with the EM algorithm (Hamilton 1990). Hamilton showed that this algorithm exhibits stable convergence towards the maximum of the likelihood function even if initial starting values are far away from the maximum but becomes less efficient once convergence has proceeded into the neighbourhood of the maximum.[12]

It is well known that for parameter estimates to be consistent the error term in the estimation equation has to be uncorrelated with the explanatory variables, or, in other words, the explanatory variables have to be exogenous with respect to the endogenous variable. In our

[10] We are aware that this is a rather indirect method of testing the expectations channel as we do not attempt to model expectations in any way.

[11] All estimations are performed with RATS 5.0.

[12] Also for the model with TVTP we obtain starting values from the EM algorithm, which is adapted to allow for TVTP based on Diebold, Lee, and Weinbach (1994).

situation, however, this is possibly not the case, as disposable income, taxes and government expenditure presumably are endogenous. Therefore, we also use instrumental variable (IV) estimation. We employ an approach that is analogous to the two-stage least squares (2SLS) estimator. To obtain the exogenous part of the endogenous variables, the one-step ahead forecasts from a vector autoregression (VAR) are used.[13] We do not distinguish between different regimes in this first-stage estimation. In the second step the consumption function is estimated using maximum likelihood estimation as described above.[14]

3.4 Data on Fiscal Policy

Unfortunately, as for most countries, the availability of data on fiscal policy in Germany is limited. Though readily available, annual data would not give enough degrees of freedom for a Markov-switching estimation. On the other hand, data at a higher frequency like quarterly data have the problem that the budget is planned on an annual basis and the assignment of revenues and expenditures to a specific quarter in some respect is arbitrary. In using quarterly data on fiscal variables, one has to choose between two different sources. The national accounts statistic tries to book revenue and expenditure on an accrual basis, whereas the receipt-expenditure accounting statistic is on a cash basis. Both concepts have their advantages and draw-backs. While the national accounts use statistical methods to assign expenditure and revenues to a certain period, data in the accounting statistic represent actual receipts and payments and thus are of a higher quality. On the other hand, actual payments and receipts can be affected by various occurrences such as wage agreements for the public service, holidays and the like, with the consequence that the statistic can contain outliers. Despite of this problem, we decided to use fiscal data from the receipt-expenditure accounting statistic that is published by the Bundesbank in its monthly reports. The data covers all government units, including the central government budget, the 'Länder' and 'Gemeinden' budgets, excluding social security funds. Expenditure is defined as total government expenditure, including government consumption and investment, interest payments and transfers. Revenues are total tax revenues, excluding extraordinary revenues, e.g. from privatisations. The E-Views X-11 filter is

[13] The VAR is specified in levels with income, expenditure and taxes as endogenous variables and 4 lags. As exogenous variables 4 lags of the change in the debt-to-GDP ratio and a constant are included.

[14] As the second stage is linear in the variables, a two-stage approach is applicable. See Davidson and MacKinnon (1996, pp. 224) for issues arising with non-linear IV estimation. Pagan (1984) shows that for a test of the null hypothesis that the coefficients equals 0 asymptotic t-values from a 2SLS estimation coincide with those from OLS. Though this result is not exactly applicable in our case, we did not correct t-values, as the switching variance poses problems in this respect.

used to seasonally adjust the originally unadjusted fiscal data. The data start 1968, first quarter, and end in the last quarter of 2000. The data on the outstanding debt are also from the Deutsche Bundesbank; data on consumption, GDP, and disposable income are seasonally adjusted at the source and are from the DIW. All variables are deflated with the consumer price index.[15]

Because of the effects of German unification on consumption, disposable income, taxes, and government expenditure, we first regress the time series in differences on a dummy that is one in the first quarter of 1991 and then subtract the effect of German unification. Altogether, the adjustment is certainly subject to severe identification problems as one does not know what portion of the change in variables should be attributed to the enlargement of the area and what part should be counted as a change in policy. As the choice of an adjustment method is somewhat arbitrary, we estimate our model for a sample period up to the end of 1989 as well as for the full sample period until the last quarter of 2000.

4 Results

4.1 Fiscal Policy in Germany

As a background to the discussion of our results, this section aims to provide a quick tour through some baselines of fiscal policy in Germany over the sample period. The reader who wants to proceed directly to the results of the empirical analysis may skip this section.

Fiscal policy is usually considered as consisting of two components: the working of automatic stabilisers and discretionary policy actions. In contrast to the automatic stabilisers that are directly tied to the economy's general tax and welfare system and thereby are a stable and predictable component of fiscal policy, the role and direction of discretionary policy – being closely connected to the prevailing political paradigm – has changed considerably over time. In Germany it took until the first significant post-war recession 1966/67 that Keynesian anti-cyclical fiscal policy became a tool of active economic policy. As a consequence, the expenditure ratio as well as overall debt increased considerably. Furthermore, in the beginning of

[15] We use the consumer price index for West Germany as after German Unification the East German price index showed a number of jumps due to the successive liberalisation of prices in East Germany. After this transition period, the West German and the German price index are almost identical.

the seventies, the state was ascribed an increasingly important role in raising overall welfare through debt financed expenditure programs, in addition to its role in active business-cycle stabilisation. The escalating problems with the underlying fiscal position of the federal state finally became apparent during the recession of 1974/75 following the first oil price shock, when excessive stabilisation programs remained unsuccessful but dramatically increased public debt. This situation called for consolidation measures to regain the sustainability of public finances. Though the economy moved out of recession during 1976, the ruling coalition of Social and Free Democrats was nevertheless unable to reverse the tendency of deteriorating public finances in the following years. The situation became even worse after the second oil price shock 1979, leading finally to the end of the coalition in 1982. By then, compared to the level in the sixties, public debt had almost doubled to around 40 percent of GDP. The new coalition between Christian and Free Democrats started with the clearly formulated aim of consolidating the excessively high debt that had accumulated over the years. This was part of an overall policy change in the direction of supply-side economics that resulted in a condemnation of active stabilisation policy. Although a cyclical upswing in the first half of the eighties helped economic policy, the following period also demonstrated the difficulty to significantly lower the amount of debt once it has reached high levels. Though the new administration was successful in stopping the debt growth during the eighties, it failed to significantly reduce it so that public debt stabilised at around 40 percent. Germany's move towards unification in 1990 again constituted a substantial structural break in the course of economic policy. After some initially overoptimistic forecasts claiming that unification only needed an initial "knock-on financing", which would be financed by increased tax revenues of the then following unification boom, it soon became clear that massive public transfers from West to East Germany were necessary. From 1990 until 1995 net transfers to the East amounted to 4 to 5 percent of West German GDP per annum. In the beginning around 66 percent of the transfers were financed through increased borrowing, where parts of this debt was raised through an off-budget fund ("Fonds Deutsche Einheit"). The ratio of debt financing, however, decreased to 25 percent in 1995. When finally a basic concept for a sustainable financing of the ongoing transfer needs was decided on in 1993 ("Solidarpakt"), public debt had reached the level of 60 percent and the mounting problems were tackled largely by means of increased taxes, instead of an adjustment of expenditures. Above and beyond German unification, another development that had a lasting influence on public finances in the nineties was the Maastricht convergence process that required the future member states of EMU to have a debt level below 60 percent and a deficit below 3 percent. Ultimately this process forced public finances in Ger-

many back on a consolidation course, a tendency that has regained strength since the implementation of a far-reaching fiscal consolidation program by the new coalition between the Social Democrats and the Green party after a rethinking of their economic policy in 1999.

4.2 Are There Non-Linearities in the Effects of Fiscal Policy? – Results for Constant Transition Probabilities

Table 2 presents the results of the estimation of the Markov-switching model with constant transition probabilities. As the choice of appropriate instruments is always a difficult question, we show the results for the estimation without instrumental variables in columns (i) and (iii) and with instrumental variables (IV) in columns (ii) and (iv) of table 2. For both sample periods as well as for both estimation approaches – i.e., without and with instrumental variables – two distinct regimes for expenditure and for taxes can be identified. In the first regime ($S_t = 1$), expenditures and taxes have the typical Keynesian effects, i.e., government expenditure is expansive whereas taxes reduce consumption, although only in the case with instrumental variables. In the second regime ($S_t = 0$), both signs reverse; the second regime thus follows neoclassical predictions. On the whole, the coefficients on taxes in the Keynesian regime shows the expected sign only if instrumental variables are used, which may indicate that endogeneity is a problem in the case of estimation without instruments. The size of the coefficients on the fiscal variables corresponds roughly to the results of Giavazzi and Pagano (1996) who, e.g., find a short-run effect of public expenditure of 10 % in the Keynesian and of – 10 % in the non-Keynesian regime. With instrumental variables, the coefficients on the fiscal variables in general become larger in absolute value, making the difference between the Keynesian and the non-Keynesian regime even more pronounced. The coefficient on disposable income is around 0.6 and thus is also in line with the results in the literature.[16] While the coefficients on government expenditure, except for the sample period up to 2000 without instrumental variables (column (iii) of table 2), are significant at least at the 10 % level, for taxes in general only one regime is significant. In the case of the estimation with instrumental variables for the long sample period even both coefficients remain insignificant. This corresponds to the results by Perotti (1999), who also finds that the evidence of non-Keynesian effects for taxation is slightly weaker than for expenditure.

The error-correction term varies between –0.18 for the post-unification period and –0.45 for the pre-unification sample, implying a slower adjustment to equilibrium in the 1990s. In all

cases, the transition probability p is estimated to lie around 0.95 and q around 0.90. This means that both regimes exhibit high persistence, with the mean duration of the Keynesian regime being approximately 20 quarters and a mean duration of the neoclassical regime of 10 quarters. The last row of table 2 gives a test of a non-linear versus a linear model (Garcia 1998). While without instrumental variables for the period before German unification a linear model cannot be rejected, for all other models the non-linear specification fits the data better than a linear one at least on the 5 % significance level.[17]

The smoothed probabilities $\Pr[S_t = 1|y_T]$ of the Markov process corresponding to the results in table 2 are shown in figure 2. A probability close to unity means that the economy is in the standard Keynesian regime (S_t = 1), while a probability close to zero signifies the non-Keynesian regime (S_t = 0). For the sample period before German unification (left column) two periods of non-Keynesian effects around 1972-74 and 1979-82 emerge in the graphs, where the first period is shorter and the second longer in the case with instrumental variables. The smoothed probability for the complete sample (figure 2, right column) again shows non-Keynesian regimes occurring at around 1973-74 and 1979-82 with another non-Keynesian regime occurring around 1992-93.

The results presented confirm the existence of significant non-linearities in the effects of fiscal policy in Germany. This is undoubtedly an important result as we can confirm the findings in the empirical literature using a completely different approach where the switching dates are determined endogenously. Next, we want to investigate the sources of these non-linearities. In particular, in section 2 we discussed the hypothesis of expansionary fiscal consolidations as the leading theory in the literature to motivate changing effects of fiscal policy over time. In the remainder of the paper we want to analyse if the non-linearities we find can be explained by this hypothesis or if other effects may be at work.

4.3 The Hypothesis of Expansionary Consolidations Considered – Further Results using Time Varying Transition Probabilities

In this section we try to shed some light on the potential of the hypothesis of expansionary adjustments to explain our results. To map this hypothesis into the Markov-switching framework, we extend the model to include time-varying transition probabilities, see section 3.3. Using accumulated debt or the debt-to-GDP ratio as the explanatory variable Z for the time-

[16] See e.g. the cross country study by Giavazzi and Pagano (1996) or the evidence presented in Deaton (1992).

varying transition probability is not feasible in our empirical model due to the non-stationarity of the variable. We therefore use the change in the debt level[18], which is included as a 4 quarter moving average to reflect the idea of the persistence of a fiscal stimulus (see also Giavazzi, Jappelli, and Pagano 2000). It enters the specification with a one-period lag and thus captures developments occurring before the regime shift takes place.

Estimation results for the TVTP model are presented in table 3. Again we estimate the model using both sample periods, without and with instrumental variables. Coefficient estimates and their significance remain basically unchanged compared to the estimation with constant transition probabilities (upper part of table 3). The bottom part of table 3 shows the coefficients from the equations for the time-varying transition probability. The slope coefficient p_2, which indicates the reaction of the transition probability to the change in the debt level, is insignificant in all cases. The point estimate nevertheless indicates a positive relationship, with the exception of the shorter sample period using IV.[19]

To visualise the relation between the time-varying transition probabilities and the relevant explanatory variable, we present scatter plots of the change in the debt level against the probability p_t of remaining in the first (Keynesian) regime. As the positive coefficient for p_2 already indicates, the scatter plots in figure 3 (right column) show a positive relation, meaning that slower growth or a reduction in the level of debt makes a transition into the non-Keynesian state more likely.[20] For the estimation with instrumental variables, the points cluster narrowly around values of 0.95 for p_t, meaning that even a sizable change in the debt level has almost no effect on the probability of remaining in the Keynesian regime. We therefore do not place much weight on the negative relationship in figure 3ii-b.

In the following we discuss how the positive relation between p_t and the change in the debt level can be interpreted in the light of the 'expansionary fiscal adjustments' hypothesis advanced in the literature. Two main versions of the hypothesis of non-linear fiscal-policy effects can be distinguished. Giavazzi and Pagano (1996) propose that fiscal-policy effects may switch sign when a sizeable and lasting consolidation signals lower taxes in the future. Thus they focus on a sizeable and lasting change in the deficit as criterion for an potential expan-

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[17] Garcia (1998) derives the critical values of the test statistic for a model including no explanatory variables apart from a constant so that results should be regarded with caution.

[18] Using the budget deficit yields similar results with opposite signs. We therefore do not present the results.

[19] While the theoretical models give us an idea which variables should influence the transition from the Keynesian into the non-Keynesian regime, e.g. budget deficit or debt ratio, the factors influencing the transition from the non-Keynesian to the Keynesian regime are less clear. This may explain why we were unable to get sensible estimates for the slope coefficient for the transition probability from second to the first regime, q_2. As this coefficient caused problems with convergence, we restricted q_2 to zero.

sionary adjustment.[21] On the other hand, Perotti (1999) regards a sizeable accumulation of public debt as the main condition for a switch into a non-Keynesian fiscal-policy regime. Note the difference in the underlying theoretical reasoning: Perotti tries to capture the considerable *worsening* of public finances, whereas Giavazzi and Pagano do not differentiate among a sizeable improvement and a deterioration of fiscal conditions, but explicitly look at discretionary fiscal-policy changes.

Our results for the TVTP model are inconsistent with the hypothesis put forward by Perotti (1999) that the probability of a switch into the non-Keynesian regime increases with the level of debt. The results, on the other hand, can be interpreted in line with the consolidation hypothesis, in that a low or a negative growth of debt increases the likelihood of a regime switch. Note that – especially in the case of figure 3 (iii-b) – only a few observations are driving the probability of a switch to the non-Keynesian regime while the mass of observations clusters around high values of *p*.

We also tried the change in the deficit as an explanatory variable in the TVTP equation. Depending on how agents form their expectations on the prospects of solid or instable public finances in the future, this could be a relevant variable to indicate the course of stabilisation. Using the change in the deficit, however, did not yield sensible results. Overall, considering the low significance of the TVTP results and the clustering of the debt changes at high probabilities *p* to stay in the first regime, the evidence in support of the 'expansionary fiscal consolidations' hypothesis is weak.

Another piece of evidence concerning the hypothesis of expansionary fiscal adjustments can be obtained by looking at the regime-switching dates we find in our study, i.e., the years 1973-75, 1979-82 and 1992-93. The years 1973-75 are marked by a sizeable increase in the deficit, although directly before this time the budget even showed a surplus, see figure 1. The period 1979-81 is again characterised by a significant increase in the deficit, while in 1993 the deficit had already risen to a high level due to the transfer payments connected to German unification. Though these dates fall around marked increases in the deficit, they do not exactly correspond to those derived by an exogenous criterion in other studies. Table 1 collects the different criteria that have been applied to fiscal policy in Germany and the corresponding dates. Although the results are to some extent sensitive to the criterion used, it appears that

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[20] Note that the evolution of debt *before* the switch is important, not the development while the second regime prevails.

[21] Note that in Giavazzi and Pagano (1996) also considerable fiscal expansions may lead to a switch in the sign of the fiscal policy effects. The analysis of Giavazzi, Jappelli and Pagano (2000) as well as Alesina and Perotti (1995), Alesina and Ardagna (1998) and McDermott and Wescott (1996) go into the same direction.

periods of fiscal contractions are 1976/77, 1983/84 and 1995/96, whereas fiscal policy had an expansionary stance in 1974/75 and 1989-91.

Thus the questions remains open what developments are responsible for the observed non-linearities in the effects of fiscal policy. Looking at our regime-switching dates, apparently all of them fall into periods of business-cycle downturns.[22] Although the hypothesis of expansionary fiscal consolidation has received by far the most attention in the theoretical literature, one may think of a connection between the effects of fiscal policy and the position of the economy in the business cycle. One possible line of reasoning is that agents during recessions increase their amount of precautionary savings and thus reduce consumption. Once this effect dominates the usual fiscal-policy effect, one would observe a switch in the coefficient.

We therefore thought about additional variables Z_t that might reflect the foregoing reasoning in the TVTP application. For example, we tried to include variables that reflect business-cycle expectations, as for example the IFO business-climate index, a consumer-confidence index and other leading indicators. All attempts unfortunately did not yield sensible results.

Our finding of non-Keynesian effects during recessions cannot simply be explained by the fact that fiscal policy in Germany possibly has been procyclical in the past (see e.g. IMF, 2000). Even if the government tends to reduce expenditure and increase taxation during business cycle downturns, this does not explain why the effects of fiscal policy on aggregate consumption should switch sign.[23] Hughes Hallet and Adams (1998) suggest that most expansionary fiscal contractions occurred because a monetary relaxation took place shortly after the fiscal contraction started. To test this conjecture, however, is impossible in the framework of our empirical model.

The difficulty to obtain strong results with the TVTP model undoubtedly to some extent may reflect the problems in mapping the underlying structural hypothesis into the empirical framework. Furthermore, considering the problems involved in using quarterly fiscal data and the limited amount of observations available, the TVTP model possibly makes too high demands on the data.

[22] See the Annual Reports of the Sachverständigenrat for a dating of the German business cycle.

[23] Note that the regime switches do not simply pertain to phases of high and low aggregate consumption, as the inclusion of the fiscal variables in addition to a switching constant are indeed necessary to generate the regime switches.

5. Conclusion

The search for non-linear effects of fiscal policy in recent time has become an interesting field for macro-econometricians. Previous empirical studies have shown significant evidence for the existence of these non-linearities in the effects of fiscal policy on aggregate private consumption. One limitation in the literature so far is that the dates of regime switches are determined by relying on exogenous and somewhat arbitrary criteria and are not derived endogenously from the empirical model. Therefore we propose in this paper to investigate potential non-linear fiscal policy effects using the Markov-switching framework, which delivers coefficient estimates for different regimes while endogenously determining the regime-switching dates.

We find two different regimes, one that can be interpreted as Keynesian and one that matches with the neoclassical predictions. Concerning the dates of regime shifts, the periods 1973-75 and 1980-82, and – for the sample including the post-unification period – also 1992-93 reveal non-Keynesian effects of fiscal policy on private consumption expenditure in Germany. The dates in which the non-Keynesian regime prevails, however, do not correspond closely to the stabilisation periods identified in the literature on 'expansionary fiscal adjustment' for Germany.

To obtain evidence on possible explanations for the observed non-linearities, we extend the Markov-switching model to include time-varying transition probabilities. Our study thus presents an advantage over the existing literature in that we can try to find the cause for the switch into a non-Keynesian regime, though our approach to map the hypothesis of expansionary fiscal adjustments into the empirical framework of a Markov-switching model with time-varying transition probabilities is certainly an indirect empirical test of the implications of the theory. In our application we find no strong evidence in favour of the expansionary fiscal consolidation hypothesis. As this hypothesis places very demanding assumptions on the consumer's optimisation behaviour this result might have been expected. Though our switching dates indicate a link to the business cycle, we were not able to shed light on the causes for these effects; may they be related to precautionary savings, changing consumer confidence or some other mechanisms. Nevertheless, this is an avenue of research that should certainly be explored further.

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Tables and Figures

Table 1. Definition of Non-Keynesian Periods for Germany

Autor	Criterion	Periods
Alesina and Perotti (1995)	absolute change in cyclically adjusted deficit is more than 1.5 percentage points	Contraction: 1969, 1973, 1976, 1989 Expansion: 1974, 1975, 1990
Giavazzi and Pagano (1996)	cumulative change in structural deficit exceeds 5 (4, 3, 3) percentage points in 4 (3, 2, 1) successive years	1981, 1982, 1983, 1990, 1991
McDermott and Wescott (1996)	structural deficit improves by at least 1.5 percentage points over 2 years and does not decrease in either year	last year of two-year consolidation period: 1977, 1982, 1983, 1993, 1994
Alesina and Ardangna (1998)	cyclically adjusted deficit improves by at least 2 percentage points in a year or by at least 1.5 percentage points in each of 2 consecutive years	./.
Giavazzi, Jappelli and Pagano (2000)	full employment surplus changes by at least 2 percentage points over a 2 year period	Contraction: 1971, 1972, 1976, 1977, 1983, 1984, 1995, 1996 Expansion: 1974, 1975, 1989, 1990, 1991
Perotti (1999)	a) adjusted government debt greater than 90^{th} percentile of sample b) cyclically adjusted deficit exceeds 3 % in the 2 preceding years	a) ./. b) 1977

Table 2. Markov Switching Model with Constant Transition Probabilities

	(i) 1968-1989	(ii) 1968-1989 IV	(iii) 1968-2000	(iv) 1968-2000 IV
constant ($S_t = 1$)	0.003 (1.83)	0.006 (4.13)	0.003 (3.39)	0.005 (3.26)
constant ($S_t = 0$)	-0.002 (-1.30)	-0.005 (-1.97)	0.001 (0.16)	-0.003 (-1.06)
expenditure ($S_t = 1$)	0.110 (1.77)	0.230 (2.52)	0.058 (1.83)	0.152 (1.95)
expenditure ($S_t = 0$)	-0.153 (-2.35)	-0.249 (-1.74)	-0.050 (-0.94)	-0.309 (-2.05)
taxes ($S_t = 1$)	0.024 (0.48)	-0.128 (-2.07)	0.047 (1.91)	-0.052 (-0.88)
taxes ($S_t = 0$)	0.172 (3.63)	0.097 (0.73)	0.114 (2.53)	0.081 (0.67)
income	0.783 (7.70)	0.602 (3.35)	0.634 (10.28)	0.598 (3.74)
EC_{-1}	-0.398 (-4.75)	-0.435 (-4.74)	-0.179 (-2.75)	-0.330 (-3.10)
p	0.952 (3.47)	0.958 (4.29)	0.949 (3.52)	0.952 (4.32)
q	0.926 (2.93)	0.909 (2.96)	0.905 (2.39)	0.888 (2.91)
σ_1 (x 10^{-4})	0.351 (4.21)	0.509 (4.79)	0.214 (3.58)	0.591 (5.74)
σ_0 (x 10^{-4})	0.483 (3.40)	0.866 (3.25)	0.744 (3.47)	0.910 (3.54)
Linear vs. Non-linear	11.808	20.947	15.470	14.080

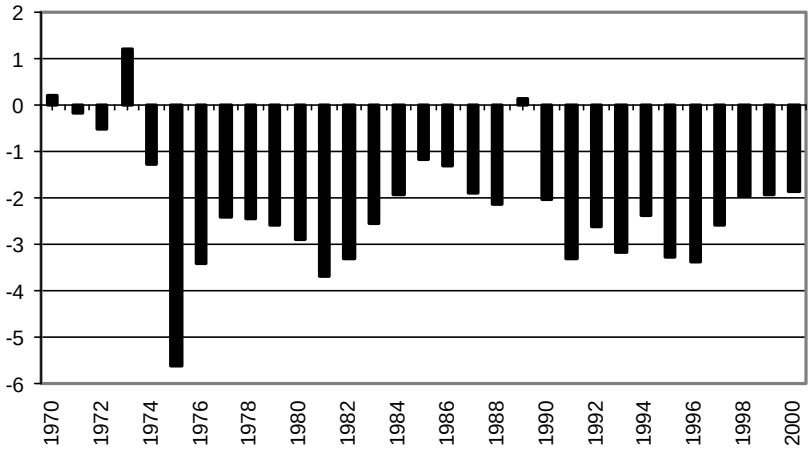
Notes: T-values in parenthesis. Columns (ii) and (iv) present results for the instrumental-variable estimation. The last row shows a test of the null hypothesis of a linear versus a non-linear model (Garcia 1998). Critical values are 14.11 for the 5 % and 12.23 for the 10 % significance level.

Table 3. Markov Switching Model with Time-varying Transition Probabilities

	(i) 1968-1989	(ii) 1968-1989 IV	(iii) 1968-2000	(iv) 1968-2000 IV
constant ($S_t = 1$)	0.003 (2.10)	0.006 (4.51)	0.003 (2.83)	0.005 (3.40)
constant ($S_t = 0$)	-0.002 (-1.48)	-0.005 (-2.01)	0.001 (0.08)	-0.003 (-0.05)
expenditure ($S_t = 1$)	0.117 (2.03)	0.230 (2.55)	0.066 (1.77)	0.151 (2.03)
expenditure ($S_t = 0$)	-0.165 (-2.72)	-0.250 (-1.87)	-0.046 (-0.86)	-0.303 (-1.96)
taxes ($S_t = 1$)	0.026 (0.54)	-0.128 (-2.12)	0.045 (1.70)	-0.053 (-0.97)
taxes ($S_t = 0$)	0.181 (4.61)	0.096 (0.84)	0.111 (3.12)	0.081 (0.72)
income	0.814 (10.22)	0.601 (3.57)	0.652 (11.08)	0.602 (3.88)
EC_{-1}	-0.393 (-5.38)	-0.436 (-4.94)	-0.190 (-2.17)	-0.339 (-3.29)
Transition probability equations				
p_1	2.169 (1.75)	3.204 (3.85)	2.657 (2.40)	2.843 (4.05)
p_2 (change in debt)	5.563 (1.40)	-0.342 (-0.18)	2.889 (1.28)	0.986 (0.67)
q_1	2.149 (2.37)	2.297 (2.89)	2.440 (2.97)	2.132 (3.05)
σ_1 (x 10^{-4})	0.360 (4.54)	0.509 (5.75)	0.209 (3.27)	0.581 (5.81)
σ_2 (x 10^{-4})	0.452 (3.72)	0.863 (3.43)	0.688 (3.76)	0.919 (3.68)

Notes: T-values in parenthesis. Columns (ii) and (iv) present results for the instrumental-variable estimation.

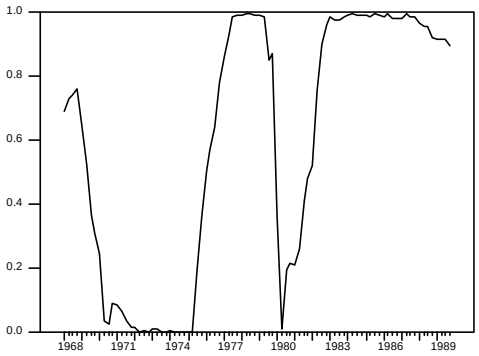
Figure 1: Budget Deficit in Germany



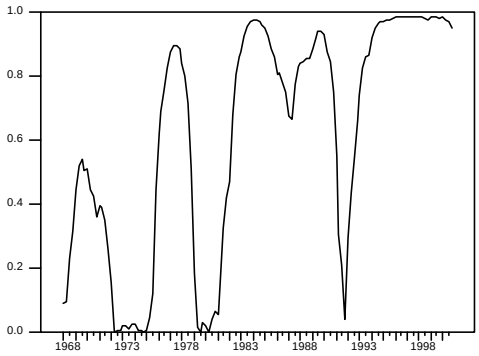
Note: Annual data in percent of GDP. Source: OECD Fiscal Positions and Business Cycles (FPBC) Database

Figure 2: Markov Switching Model with Constant Transition Probabilities

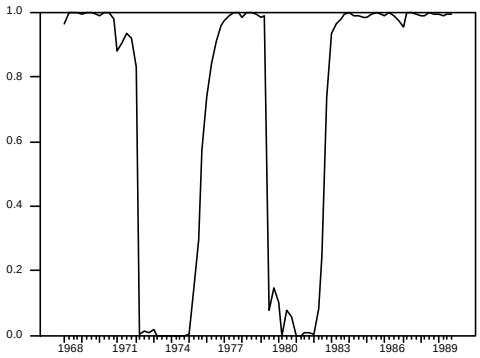
(i) 1968-1989



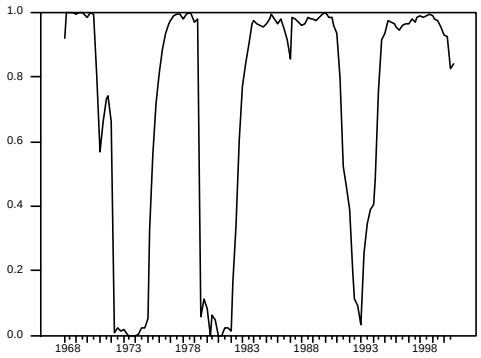
(iii) 1968-2000



(ii) IV, 1968-1989



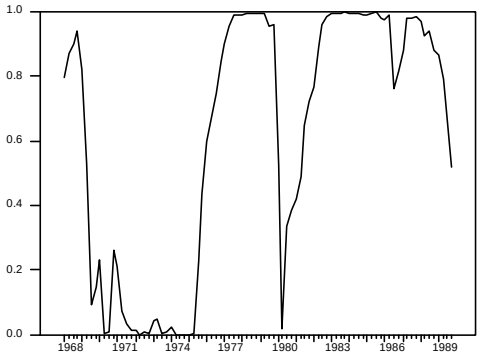
(iv) IV, 1968-2000



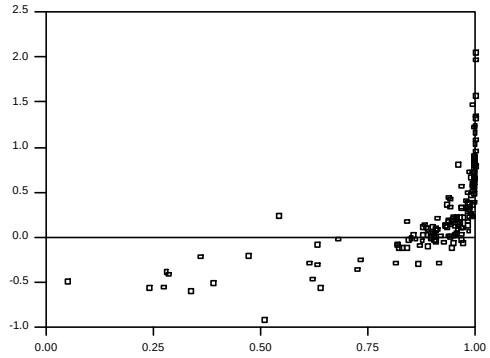
Notes: Smoothed transition probability of being in regime 1.

Figure 3: Markov Switching Model with Time-varying Transition Probabilities

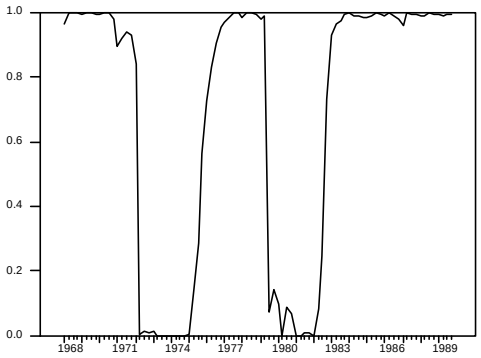
(i-a) 1968-1989



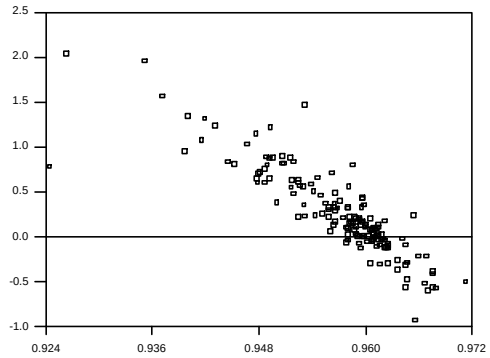
(i-b) 1968-1989



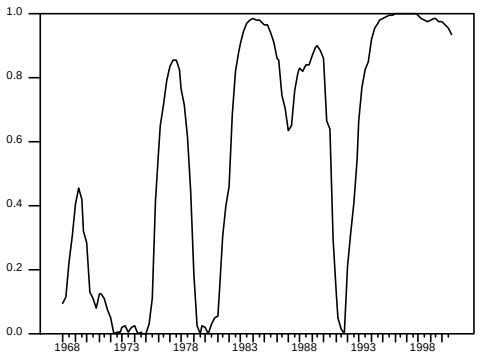
(ii-a) IV, 1968-1989



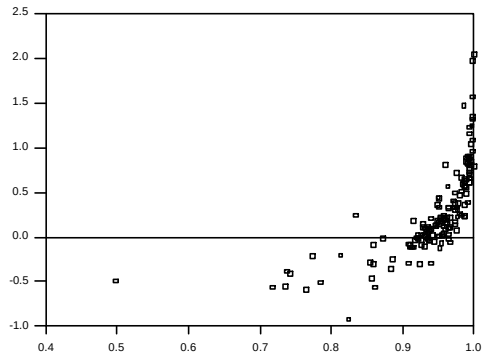
(ii-b) IV, 1968-1989



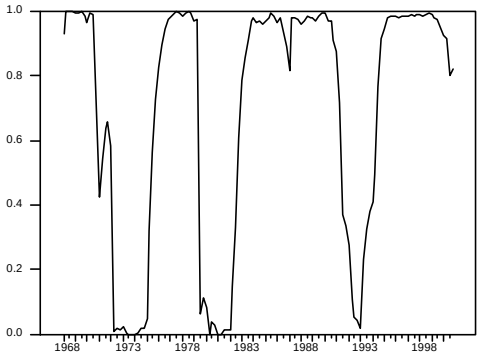
(iii-a) 1968-2000



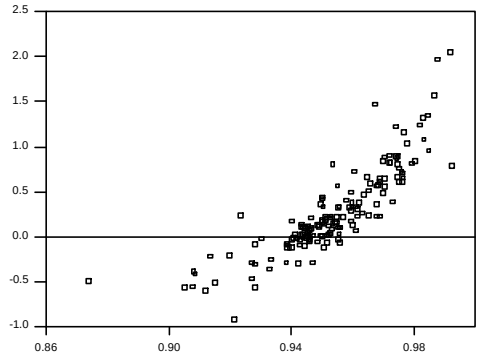
(iii-b) 1968-2000



(iv-a) IV, 1968-2000



(iv-b) IV, 1968-2000



Notes: The left column gives the smoothed transition probability of being in regime 1, the right column shows a scatter plot of the time-varying transition probability against the change in the debt level.