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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 reduced public expenditure makes room for an expansion of the private sector and thus has a stimulating effect on the economy. Additionally, expectations of a lower tax burden in the future should stimulate consumption. The recent literature discusses that both theories might be right at different times. Especially, during times of fiscal contractions from high levels of debt the economy might react in a neoclassical way. In this paper, we test for non-linear effects of fiscal policy in a Markov-switching approach. We find two different regimes, with a neoclassical regime prevailing around 1972-74, 1979-82 and 1991-93. Furthermore, using time-varying transition probabilities (TVTP) for the Markov process, we test if the neoclassical reaction of private consumption to fiscal variables depends on some variable reflecting the sustainability of the debt path, as theory suggests. We find that the deficit influences the transition to the neoclassical regime, though results are significant only for the sample including the post-unification period.

JEL classification: E62, E21, C22

Keywords: fiscal policy, private consumption, Markov-switching, time-varying transition probabilities.

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. Giavazzi and Pagano (1990) introduced a third dimension to the argument by presenting anecdotic evidence that both may at times be right: 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 rather neoclassical way. This happens mainly – at a first thought paradoxically – during times of tight fiscal contractions from high levels of debt. The empirical evidence on fiscal contractions gave rise to the notion of the so-called "expansionary fiscal adjustment": the idea that reducing public activity by fiscal consolidation can be stimulating to the economy. However, this idea implies that fiscal policy has a non-linear effect over time, depending on the initial fiscal environment.

Empirical analyses of non-Keynesian effects of fiscal policy in the literature generally first identify periods of drastic and sizeable budget cuts or expansions, and then test whether during these episodes fiscal policy has different – possibly non-Keynesian – effects.[1] In our paper, we pursue a slightly different approach. More specifically, we assume that there are two different fiscal policy regimes following a first-order Markov process over time. In the framework of a Markov-switching model we are able to identify episodes of non-conventional fiscal effects endogenously. Periods of non-Keynesian effects are not determined exogenously in a first step but are estimated simultaneously with the coefficients of the model. Starting with the seminal contribution 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.

Using Markov-switching models for the analysis of non-linear fiscal policy effects is an application that suggests itself. Furthermore, by investigating the possibility of time-varying

[1] See, e.g. Giavazzi and Pagano (1996) or Giavazzi, Japelli and Pagano (2000).

transition probabilities (TVTP) for the Markov process, we are able to test the influence of specific economic variables like the deficit on the probability of a switch into non-Keynesian regime. Thus, our approach in some sense reverses the methodological procedure by Giavazzi and Pagano (1996), in that we simultaneously identify the endogenous switching points and are able to test on what economic preconditions the switching probability depends. We believe this more flexible approach to the analysis of non-linearities in the effects of fiscal policy to be an interesting alternative to the approaches in the literature.

In this paper, therefore we analyse a quarterly data set on German fiscal policy using a TVTP Markov-switching model. The results strongly support the existence of switches between a Keynesian and a non-Keynesian regime in the German case. The paper 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 concludes.

2 Previous Work on Non-linear Effects of Fiscal Policy

In their influential paper, Giavazzi and Pagano (1990) demonstrated that the fiscal stabilisations in Ireland from 1987 to 1989 and in Denmark from 1983 to 1986 constitute expansionary fiscal adjustments, in that they challenge the predictions from conventional Keynesian theory about the working of the multiplier.

Two main channels can theoretically be identified to generate these non-Keynesian policy effects: a standard macroeconomic wealth channel and an expectations channel. Private wealth is affected by changes in interest rates that can be brought about directly by a reduced deficit (crowding-in effects) as well as by a reduction in the risk premium on government debt. Both effects lead to lower interest rates and thus to higher private wealth, which stimulates household consumption. For the expectations channel to work, the temporary fiscal adjustment has to be large and sustainable enough for agents to expect permanently lower taxes in the future. This would increase households' permanent income and thus raise current and planned consumption.[2] Giavazzi and Pagano (1990) demonstrated that it is indeed

[2] Giavazzi and Pagano (1990) identify two other possible channels for the working of non-Keynesian effects of fiscal policy: a fall in expected inflation and the substitution of private for previously public consumption. They derive all effects theoretically in a version of the finite horizon model by Blanchard (1985). Another potential channel that has been identified is the exchange rate channel (see Giavazzi and Pagano 1990).

necessary to resort to these channels to explain the expansionary fiscal adjustments in Ireland and Denmark.

It is central to the expectations channel that private agents observe signals in the economic environment that lead them to revise their expectations. Different types of signal effects have been proposed in the literature. In the model by Bertola and Drazen (1993), the effects of government expenditure depend on its own initial value, triggering non-Keynesian effects when public expenditure hits some threshold level. In a recent paper, Perotti (1999) builds a three period model in which a fraction of consumers is liquidity constrained. In his model, the effect of public expenditure shocks on private consumption depends negatively on the accumulated government debt and positively on the probability that the current government will be in power in the next period. Correspondingly, he shows, in the same line as Sutherland (1997) and Blanchard (1990) that, depending on the same variables as in the case of expenditure, increased taxation may have an expansionary effect on private consumption.

Especially in the context of highly stability-oriented European countries, there might be political or other events that trigger a consolidation and that are not adequately captured by the 'trigger point' models introduced before.[3] Therefore, another strand of the literature takes a consolidation as an exogenously given event and then analyses the effects of the structural composition of the budget cut.[4] While it would certainly be interesting to apply a Markov-switching model to different expenditure categories, we do not pursue this approach here because of the lack of reliable and sufficiently detailed time-series data.

The fundamental question for empirical studies is to identify potential periods of non-linear fiscal policy effects. The method by Giavazzi and Pagano (1996) or Giavazzi, Japelli, and Pagano (2000) has by now become standard and is used in many empirical studies on expansionary fiscal adjustments. The underlying assumption of this approach is that non-linear fiscal policy effects are closely connected to prolonged and substantial fiscal stabilisations. In these studies, conditions for the adjustment path of the budget deficit during a stabilisation are defined, under which a stabilisation is classified as prolonged and substantial. In Giavazzi and Pagano (1996) e.g., the four conditions are that the cumulative change in the structural deficit in i successive years including t exceeds $i + 1$ percent of potential GDP for $i = 2, 3, 4$ as well as that the deficit in year t exceeds 3 percent. Based on his theoretical framework, Perotti (1999) uses accumulated debt as criterion for fiscal stress,

[3] Take for instance the European wide consolidation triggered by the Maastricht convergence criteria.

[4] See Alesina and Perotti (1995 and 1997), McDermott and Wescott (1996) or Alesina and Ardagna (1998) among others.

instead of the change in the deficit as Giavazzi and Pagano (1996). A dummy variable with a unit entry at the specified dates is then constructed that can be used to test if fiscal policy has a significantly different effect during these episodes. Along this line, Giavazzi and Pagano (1996) and Perotti (1999) analyse the effect on private consumption whereas Giavazzi, Japelli and Pagano (2000) look at the effect on national savings. Overall, this literature suggests the existence of significant non-linear effects of fiscal policy during stabilisation periods.

Anyway, it may be the case that non-linear effects of fiscal policy are not always exclusively related to consolidation periods. It might be also possible that expectations of agents are primarily affected by political or for instance, business-cycle events that only in the second place then have an effect on budget variables. With our approach, we do not restrict the fiscal policy regimes to be connected to a fiscal consolidation period, but the estimation procedure assigns the empirical observations to that regime, which is the most likely one in a statistical sense. Our paper thus proposes an alternative method for an endogenous identification of non-linear policy effects.

3 Methodology and Data

3.1 The Consumption Function

Since our aim is to analyse the effect of government activity on private consumption, we have to specify a consumption function that includes variables on government activity. Although there is by now a large literature on the derivation and specification of aggregate consumption functions[5], only a few studies focus on the effects of government activity on consumption. In a classical paper, Feldstein (1982) analyses the effects of taxes and government purchases on private consumption. Aschauer (1985) and more recently Karras (1994) derive a consumption function with government expenditure, utilising restrictions implied by the intertemporal Euler equation.

Two main strands of modelling consumption have evolved in the literature. One was initiated by the influential study by Hall (1978) who showed that under rational expectations consumption should follow a random walk. Empirically, however, it turned out that

[5] For a general introduction see Deaton (1992) or Muellbauer and Lattimore (1995).

disposable income nevertheless has a significant impact on consumption[6], as Keynesian theory would predict. The second approach is the statistical modelling of aggregate consumption in an error-correction framework, a literature started by the seminal work of Davidson et al. (1978).

As we do not want to go into the details of the discussion on the theoretical foundations of the consumption function, 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 and has proved sufficiently flexible to capture the time-series aspects of the data as well as the main determinants from the theory. Moreover, it nests both general approaches to model the behaviour of aggregate consumption. A drawback of this flexible specification, however, is that the number of parameters to be estimated is rather high so that we opted for imposing some restrictions, which are discussed 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:

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

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. All variables are 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 $\varepsilon_t \sim N(0, \Sigma_1)$ if the process is in regime 1 and $\varepsilon_t \sim N(0, \Sigma_0)$ if regime 0 prevails. 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.

We stress that we do not aim to add to the voluminous literature on modelling consumption but to find a reasonably adequate specification of the consumption function that allows us to investigate the regime dependent effects of fiscal policy. Moreover, we have to consider that –

6 See, e.g., Blinder and Deaton (1985) and the references cited therein.

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.

given a limited number of degrees of freedom – the specification of a consumption function in a Markov-switching framework has to be as parsimonious as possible. Therefore, we restrict the coefficients of the lagged levels of income and consumption to be of the same size with different sign. This restriction could not be rejected in explorative estimations of the consumption function. In effect this restricts long-run income elasticity of consumption being to unity, implying a proportional long-run reaction of consumption to increases in income. To keep the model tractable, we do not include lagged levels of taxes and government expenditure into the model. This has two reasons. Firstly, 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 high number of parameters to be estimated by another four. Secondly, it is not clear how switching in the long-run relation would affect the stationarity of the error-correction term. 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.

3.2. Markov-Switching with Constant Transition Probabilities

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 $St = 1$.[8] 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 with non-Keynesian effects, denoted by a superscript *NK*:

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

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. The only restriction we impose is that there are two different regimes, while everything else is determined from the data in the estimation.

[8] Alternatively, non-linearities in the effects of fiscal policy could be estimated in a time-varying coefficients (TVC) model with Kalman filtering. 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 seem more adequate to model these regime shifts.

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. 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. It is assumed that the transition between the two states is governed by a first order Markov process with the transition probabilities p and q, which can be summarised in form of a transition matrix P:

$$P = \begin{matrix} p & 1-q \\ 1-p & q \end{matrix} .$$

The transition probabilities are defined as follows:

$$\begin{aligned} p &= \Pr\left[S_t = 1 \middle| S_{t-1} = 1\right], \\ 1-p &= \Pr\left[S_t = 0 \middle| S_{t-1} = 1\right], \\ q &= \Pr\left[S_t = 0 \middle| S_{t-1} = 0\right], \\ 1-q &= \Pr\left[S_t = 1 \middle| S_{t-1} = 0\right]. \end{aligned} \qquad (2)$$

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 in period t - 1. 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 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 model can be estimated using an iterative Maximum Likelihood procedure maximising the following likelihood function:

$$\ln L = \sum_{t=1}^{T} \ln \sum_{i=0}^{1} \Pr\left[S_t = i \middle| y_{t-1}\right] \frac{1}{\sqrt{2p}\, s(S_i)} \exp \frac{-e^2(S_i)}{2s^2(S_i)} ,$$

with $\Pr\left[S_t = i \middle| \psi_{t-1}\right]$ denoting the probability of being in state 0 or 1 in period t and $\psi_{t\text{-}1}$ denoting all available information up to period $t-1$. 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 the transition probabilities as defined in equation (2). 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 $f\left(y_t \middle| S_t = i, \psi_{t-1}\right)$ being the conditional density for regime 0 and 1. Once the model is estimated and $\Pr[S_t = j | \Psi_t]$ is generated, one can use a smoothing algorithm developed by Kim (1994) to estimate the probability for regime S_t using all information in the sample, i.e. $\Pr[S_t = j | \Psi_T]$, where $t = 1, 2, \ldots, T$. In Section 4, we present the smoothed probabilities based on this algorithm.

The model is estimated using a recursive, non-linear optimisation routine. Starting values for this 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. The algorithm, however, becomes less efficient once convergence has proceeded into the neighbourhood of the maximum.

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 situation, however, this is likely not to be the case, as disposable income, taxes and government expenditure presumably are endogenous. Therefore, we use instrumental variable (IV) estimation. We employ an approach that is analogous to the two-stage least squares (2SLS) estimator. First, the endogenous variables are regressed on the instruments and the exogenous variables. We do not distinguish between different regimes in this first-stage estimation. In the next step the consumption function is estimated using maximum likelihood estimation as described above.[9]

[9] 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.

3.3 Introducing Time Varying Transition Probabilities

The standard Markov-switching model set up in the preceding section has constant transition probabilities, i.e., 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 as well. In the second part of our analysis, we relax this assumption and introduce time-varying transition probabilities (TVTP).

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. This idea can be applied to our context. As has been discussed in Section 2, it seems apparent from theoretical as well as econometric evidence that non-linear effects of fiscal policy are likely to be observed in times of fiscal stress or when the consolidation path of the government budget is prolonged and substantial.

In a TVTP framework, we therefore can test if some "indicator" variable, like the path of accumulated debt or the budget deficit, possibly influences the transition probabilities, as theory suggests. If we can 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 economic agents may 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 described in the previous section. 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. Thus the transition matrix P, which was a matrix of four scalars before, now becomes a matrix of four time series of probabilities. Again, we obtain starting values for the non-linear optimisation from implementing the EM algorithm, which is adapted to allow for TVTP based on Diebold, Lee, and Weinbach (1994). In Section 4, we present scatter plots of the TVTP against the variable Z_t. This is an easy and intuitive way of visualising the relationship of the variable Z_t and a changing transition probability.

3.4 Data on Fiscal Policy

Unfortunately, the availability of data on the German fiscal sector is very limited. Annual data on government revenues and expenditure based on the official national-accounts statistic is available, but annual data would not give enough degrees of freedom for a Markov-switching estimation. Therefore, one needs data at a higher frequency. The national statistical office publishes half-yearly data based on the official national accounts statistics delimitation, but these series are available only from 1971. Quarterly data covering all budget items necessary for the estimations is available from 1968 but these quarterly series are based on the official financial statistics, which is on a cash basis. We decided to use the latter series as it gives us the most degrees of freedom possible. The data covers the consolidated central government expenditures and revenues including the central government budget, the 'Länder' and 'Gemeinden' budgets, excluding social security funds. Expenditure is defined as government consumption and investment, excluding interest payments and current transfers. Taxes are total income tax revenues. The E-Views X-11 filter is used to seasonally adjust the originally unadjusted fiscal data.

Because of the effects of German unification on consumption, disposable income, 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. Taxes were not adjusted, as no significant break in this series could be detected. 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

[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.

arbitrary, we concentrate on a sample period up to the end of 1989 and results for the full sample period until the last quarter of 1998 should be regarded as tentative.

4 Results

4.1 Results for Constant Transition Probabilities

Table 1 presents the results of the estimation of the consumption function with constant transition probabilities.[11] Column (i) and (ii) show the results without and with instrumental variables[12] for the sample period from 1970:1 to 1989:4, i.e., before German unification. For this period, an overall stable pattern with two distinct regimes for expenditure as well as for taxes can be identified. In the first regime (S_t = 1), both variables have the typical Keynesian effects, i.e., government expenditure is expansive whereas taxes reduce consumption. In the second regime (S_t = 0), both signs reverse. The result for the second regime thus follows neoclassical prediction, in that government expenditure leads to higher expected taxes in the future and thus reduces consumption. Except for the tax elasticity in regime 2, all coefficients are significant. The size of the coefficients on the fiscal variables correspond 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. The coefficient on disposable income is around 0.5 and thus corresponds closely to the results in the literature.[13] When instrumental variables are used, the significance of the coefficients in general is reduced.

The smoothed probability $\Pr[S_t = 1|\Psi_T]$ of the Markov process for the pre-unification period, indicating the probability of being in regime 1, is shown in Fig. 1, left column. A probability close to unity means that the economy is in the standard regime S_t = 1, while a probability close to zero signifies the non-Keynesian regime S_t = 0. Two periods of non-Keynesian effects around 1973/74 and 1981/82 can be seen in the graphs. There is a tendency for the second period to be shorter when the estimation is performed with instrumental variables, but the overall pattern is stable.

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[11] All estimations are performed with RATS 4.3.
[12] As instruments we use levels of the variables lagged once and up to four lagged differences.
[13] See e.g. the cross country study by Giavazzi and Pagano (1996) or the evidence presented in Deaton (1992).

Extending the sample to include the post unification period leads to a worsening of the results. Column (iii) shows the coefficients for the estimation without IV. While the coefficient for government expenditure in the first regime remains significant, the coefficients for the second regime lose their significance and the tax coefficients even have the wrong sign. Results improve when using IV for the whole sample, but the coefficients for the second regime remain insignificant, see column (iv).

The last row of the table gives the R^2 computed from the residuals for both states, weighted with the smoothed probability of being in either state. Compared with the pre-unification period, the R^2 deteriorates markedly if the sample period up to 1998:4 is used. However, this result is hardly surprising, as the effects of German unification can be assumed to have changed the pattern of expenditure as well as consumption in a more or less unpredictable manner. The error-correction term varies between 0.2 for the post-unification period and 0.6 for the pre-unification sample with IV estimation. While it seems plausible that adjustment to equilibrium was slower in the 1990s, the difference in the error-correction terms without and with IV is more difficult to explain. In all cases, the transition probabilities *p* and *q* are estimated to lie around 0.95 and 0.9, respectively. 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 smoothed probability for regime 1 (Fig. 1, right column) again shows non-Keynesian regimes occurring around 1973/74 and 1981/82 as before. With the whole sample another non-Keynesian regime around 1991 emerges. Without IV estimation, the non-Keynesian regime at the beginning of the sample period lasts much longer, contradicting the evidence of the other graphs in Fig. 1. As also the coefficient estimates are less satisfactory, we prefer to concentrate on the results with IV.

Interestingly, the periods in which the non-Keynesian regime prevails closely correspond to the dating in the literature which is derived by defining cut-off values for the budget deficit.[14] Though at this point of our analysis we have proceeded on purely empirical grounds, and – so to say – have only "let the data speak", the results suggest an interpretation along the lines of the theory of expansionary fiscal adjustments. Though we started from a completely different set-up without specifying neither the sign for the coefficients in each regime nor the dates of the regime switches, we obtain similar results as Giavazzi and Pagano (1996), for the

[14] Giavazzi and Pagano (1996) classify (with annual data) the years 1981-83 and 1990/91 as stabilization periods, Giavazzi, Pagano and Japelli (2000) count the years 1971/72, 1976/77, 1981-83 and 1992-94 as fiscal contractions.

coefficients as well as – maybe even more surprising – for the timing of the regime changes. Thus we are convinced that our estimated coefficients indeed represent a reaction to some shift in the expectation of the fiscal stance, as the theory suggests. The next question now becomes if we can find a variable that drives the shifts between the Keynesian and the non-Keynesian regimes.

4.2 Results for Time Varying Transition Probabilities

Next, we estimate the model with time-varying transition probabilities. In a first exploration we considered different variables that may influence the probability to switch between the two regimes: the budget deficit, the change in the debt ratio (corresponding roughly, but not exactly, to the deficit) and the change in the budget deficit. Using accumulated debt or the debt-to-GDP ratio is not feasible in our empirical model due to the non-stationarity of the variable. We also tried the change in the deficit as 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 also be a relevant variable to indicate the course of stabilisation. Using the change in the debt ratio or the change in the deficit, however, did not improve the results, so that we only present results for the level of the deficit.

Estimation results are presented in Table 2. The deficit is included as a 8 quarter moving average to capture the idea of the persistence of a fiscal stimulus (see also Giavazzi, Japelli, and Pagano 2000). Again we estimate the model using both sample periods, without (columns i, iii) and with (columns ii, iv) instrumental variables. Coefficient estimates for expenditure, taxes and disposable income remain roughly unchanged compared to the estimation without time-varying transition probabilities. While the Keynesian regime is almost always significant, the non-Keynesian regime is significant only in the shorter sample period for expenditure using no instruments and for taxes with instrumental variables (see column (i) and (ii) of Table 2),. The slope coefficient for the transition probability, which indicates the reaction of the transition probability to the budget deficit, is insignificant for the short sample period, but significantly negative for the whole sample.

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 much less clear. This may explain why we do not get significant estimates for the slope coefficient for the transition probability from second to the first regime, q_2. In the estimations for the pre-unification period, we had to restrict q_2 to zero as this coefficient caused problems with convergence.

To visualise the relation between the time-varying transition probabilities and the relevant indicator variable, we present scatter plots of the budget deficit against the probability p_t of remaining in the first (Keynesian) regime. As the negative coefficient on the budget deficit in Table 2 already indicates, the scatter plots in Fig. 2 (right column) show a negative relation, meaning that a reduction in the budget deficit makes a transition into the non-Keynesian state more likely. One can see, however, that for the sample period up to 1989:4 the probability clusters in a narrow interval between 0.87 and 0.98. This means that a fall in the budget deficit does not alter the probability of a shift into the non-Keynesian state, i.e. $(1 - p_t)$, to a meaningful extent. In contrast, when using the whole sample the scatter plot shows that a balanced budget is associated with probabilities in the range of 0.4. The reason for this result could be that in the first part of the sample we may lack large shifts in the deficit, or that shifts in the regime occur not often enough to estimate a significant relation between the transition probability and the budget deficit. Nevertheless, as German unification represented a major shock to the whole economy, the result should be regarded with caution.

In accordance with Giavazzi, Jappelli and Pagano (2000) who find that a large and persistent change in the budget deficit can best explain the circumstance in which non-linear responses to fiscal policy arise, we find that the deficit has some power to explain regime shifts in Germany if the complete sample period is taken into account.

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 switching are determined by relying on exogenous and somewhat arbitrary criteria and are not derived endogenously in the model. We believe that it is interesting to investigate non-linear fiscal policy effects in a different and more flexible framework. In this paper, we therefore present an empirical analysis based on Markov-switching – a framework, which allows to estimate regime shifts endogenously from the data.

In general, our results corroborate the theory of expansionary fiscal adjustments. 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, a clear pattern emerges from our analysis. The periods 1973/74 and 1982/83, and – for the sample including the post-unification period – also 1991/92 reveal non-Keynesian effects of fiscal policy on private demand in Germany. Moreover, the dates in which the non-Keynesian regime prevails, corresponds closely to the stabilisation periods identified in the literature for Germany. Thus our results give evidence in favour of a Keynesian and a non-Keynesian regime of fiscal policy.

To obtain evidence on possible explanations for these shifts, we extend the Markov-switching model to include time-varying transition probabilities. While an improvement in the budget deficit significantly increases the probability of a non-Keynesian reaction to fiscal policy for the whole sample period, this relation cannot be found for the pre-unification period.

Our approach to test the theory of expansionary fiscal adjustments is an indirect and admittedly not very rigorous empirical test of some implications of the theory presented in Section 2. Nevertheless, the use of some indicator of fiscal stress to explain the time variation in the transition probability permits to relate agents' expectation to a fiscal variable, as testing expectations directly is not feasible. Further, it would be interesting to extend our framework, as there may also be non-linearities in the relation between the fiscal indicator and the time-varying transition probabilities. We did not consider the idea of a trigger point, e.g. in the debt level, which signals an unsustainable debt position, nor did we investigate the effect of the composition of budget items in a fiscal contraction. For these variables, theory would also predict an influence on the likelihood of entering a non-Keynesian regime but testing for these effects is beyond the scope of this paper.

References

Alesina, A. and S. Ardagna (1998): Tales of Fiscal Adjustment, *Economic Policy*, pp. 489-545.

Alesina, A. and R. Perotti (1995): Fiscal Expansions and Adjustments in OECD Countries, *Economic Policy* 21, pp. 207-248.

Alesina, A. and R. Perotti (1997): Fiscal Adjustments in OECD Countries: Composition and Macroeconomic Effects, *IMF Staff Papers* 44 (2), pp. 210-248.

Aschauer, D. A. (1985): Fiscal Policy and Aggregate Demand, *American Economic Review* 75 (1), pp. 117-127.

Bertola, G. and A. Drazen (1993): Trigger Points and Budget Cuts: Explaining the Effects of Fiscal Austerity, *American Economic Review* 83 (1), pp. 1170-1180.

Blanchard, O. J. (1985): Debt, Deficits, and Finite Horizons, *Journal of Political Economy* 93 (2), pp. 223-247.

Blanchard, O. J. (1990): Comment on “Can Severe Fiscal Contractions Be Expansionary?” by Giavazzi and Pagano, in: *Blanchard, O. J. and S. Fischer* (eds.): NBER Macroeconomics Annual, pp. 111-116.

Blinder, A. S. and A. Deaton (1985): The Time Series Consumption Function Revisited, *Brookings Papers on Economic Activity* (2), pp. 465-522.

Davidson, J. E. H., D. F. Hendry, F. Srba and S. Yeo (1978): Econometric Modelling of the Aggregate Time-Series Relationship between Consumers’ Expenditure and Income in the United Kingdom, *Economic Journal* 88, pp. 661-692.

Davidson, R. and J. G. MacKinnon (1996): Estimation and Inference in Econometrics, 2nd edition, Oxford University Press, New York.

Deaton, A. (1992): Understanding Consumption, Oxford University Press, Oxford.

Diebold, F. X., J.-H. Lee, and G. C. Weinbach (1994): Regime Switching with Time-Varying Transitions Probabilities, in: *Hargreaves, C. P.* (ed.): Nonstationary Time Series Analysis and Cointegration, pp. 283-302.

Feldstein, M. (1982): Government Deficits and Aggregate Demand, *Journal of Monetary Economics* 9 (1), pp. 1-20.

Filardo, A. J. (1994): Business-Cycle Phases and Their Transitional Dynamics, *Journal of Business and Economic Statistics* 12 (3), pp. 299-308.

Giavazzi, F., T. Jappelli, and M. Pagano (2000): Searching for Non-Linear Effects of Fiscal Policy: Evidence from Industrial and Developing Countries, *European Economic Review* 44 (7), pp. 1259-1290.

Giavazzi, F. and M. Pagano (1990): Can Severe Fiscal Contractions be Expansionary?, in: *Blanchard, O. J. and S. Fischer* (eds.) NBER Macroeconomics Annual, pp. 75-122.

Giavazzi, F. and M. Pagano (1996): Non-Keynesian Effects of Fiscal Policy Changes: International Evidence and the Swedish Experience, *Swedish Economic Policy Review* 3, pp. 67-103.

Hall, R. E. (1978): Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence, *Journal of Political Economy* 86, pp. 971-987.

Hamilton, J. D. (1989): A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle, *Econometrica* 57 (2), pp. 357-384.

Hamilton, J. D. (1990): Analysis of Time Series Subject to Changes in Regime, *Journal of Econometrics* 45, pp. 39-70.

Hamilton, J. D. (1994): State-Space Models, in: *Engle, R. F. and D. L. McFadden* (eds.) Handbook of Econometrics, IV, pp. 3041-3091.

Harvey, A. C. (1993): Time Series Models, 2nd edition, Prentice Hall/Harvester Wheatsheaf, Hempstead.

Karras, G. (1994): Government Spending and Private Consumption: Some International Evidence, *Journal of Money, Credit, and Banking* 26 (1), pp. 9-22.

Kim, C.-J. (1994): Dynamic Linear Models with Markov-Switching, *Journal of Econometrics* 60, pp. 1-22.

Kim, C.-J. and C. R. Nelson (1999): State-Space Models with Regime Switching: Classical and Gibbs-Sampling Approaches with Applications.

McDermott, C. J. and R. F. Wescott (1996): An Empirical Analysis of Fiscal Adjustments, *IMF Staff Papers* 43 (4), pp. 725-753.

Muellbauer, J. and R. Lattimore (1995): The Consumption Function: A Theoretical and Empirical Overview, in: *Pesaran, M. H. and M. R. Wickens* (eds.): Handbook of Applied Econometrics, Vol. I: Macroeconomics, pp. 221-311.

Perotti, R. (1999): Fiscal Policy in Good Times and Bad, *Quarterly Journal of Economics* 114 (4), pp. 1399-1436.

Sutherland, A. (1997): Fiscal Crises and Aggregate Demand: Can High Public Debt Reverse the Effects of Fiscal Policy?, *Journal of Public Economics* 65, pp. 147-162.

Tables and Figures

Table 1. Markov Switching Model with Constant Transition Probabilities

	(i) 1970-1989	(ii) 1970-1989 IV	(iii) 1970-1998	(iv) 1970-1998 IV
constant (S_t = 1)	0.008 (5.66)	0.011 (5.00)	0.002 (2.90)	0.006 (3.97)
constant (S_t = 0)	-0.001 (-0.31)	-0.005 (-1.54)	0.001 (1.41)	-0.001 (-0.12)
expenditure (S_t = 1)	0.206 (3.79)	0.096 (0.89)	0.126 (3.24)	0.219 (3.35)
expenditure (S_t = 0)	-0.152 (-2.19)	-0.201 (-1.40)	0.029 (0.50)	-0.088 (-0.51)
taxes (S_t = 1)	-0.108 (-2.82)	-0.160 (-1.76)	0.074 (2.63)	-0.167 (-2.19)
taxes (S_t = 0)	0.069 (1.44)	0.228 (1.95)	-0.040 (-0.87)	0.103 (0.66)
income	0.582 (7.36)	0.502 (2.83)	0.647 (11.24)	0.480 (3.57)
EC_{-1}	-0.377 (-5.14)	-0.585 (-4.90)	-0.195 (-4.20)	-0.230 (-2.69)
p	0.949 (4.26)	0.953 (4.02)	0.935 (3.34)	0.927 (3.43)
q	0.910 (3.11)	0.892 (2.68)	0.923 (3.52)	0.902 (3.39)
σ_1 (x 10^{-4})	0.416 (4.50)	0.920 (4.71)	0.240 (3.49)	0.487 (4.44)
σ_2 (x 10^{-4})	0.589 (3.68)	0.630 (3.06)	0.967 (5.44)	1.732 (4.05)
R^2	0.682	0.457	0.576	0.276

Notes: T-values in parenthesis.

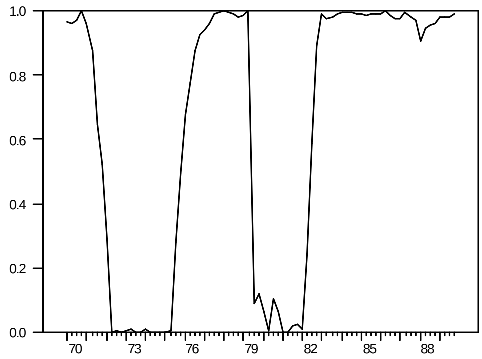
Table 2. Markov Switching Model with Time-varying Transition Probabilities

	(i) 1970-1989	(ii) 1970-1989 IV	(iii) 1970-1998	(iv) 1970-1998 IV
constant (S_t = 1)	0.008 (5.59)	0.011 (4.83)	0.002 (3.23)	0.005 (5.05)
constant (S_t = 0)	-0.001 (-0.32)	-0.005 (-1.62)	0.001 (0.92)	0.001 (0.13)
expenditure (S_t = 1)	0.206 (3.84)	0.093 (0.84)	0.127 (4.13)	0.161 (2.29)
expenditure (S_t = 0)	-0.150 (-1.98)	-0.192 (-1.39)	0.022 (0.37)	-0.069 (-0.37)
taxes (S_t = 1)	-0.107 (-2.78)	-0.157 (-1.81)	0.072 (2.88)	-0.065 (-1.15)
taxes (S_t = 0)	0.069 (1.51)	0.240 (2.04)	-0.043 (-0.88)	-0.039 (-0.28)
income	0.589 (7.33)	0.518 (2.79)	0.636 (15.55)	0.475 (4.61)
EC_{-1}	-0.381 (-5.08)	-0.591 (-4.68)	-0.188 (-4.46)	-0.170 (-3.16)
Transition probability equations				
p_1	2.041 (1.69)	2.021 (1.68)	-0.261 (0.31)	-0.027 (-0.04)
p_2 (budget deficit)	-0.650 (-0.81)	-0.729 (-0.87)	-2.012 (-4.16)	-1.549 (-3.70)
q_1	2.334 (2.97)	2.123 (2.67)	2.433 (3.41)	1.480 (2.22)
q_2 (budget deficit)	0	0	0.117 (0.31)	-0.269 (-0.67)
σ_1 (x 10^{-4})	0.419 (4.64)	0.939 (4.69)	0.247 (4.21)	0.437 (3.17)
σ_2 (x 10^{-4})	0.586 (3.57)	0.620 (2.93)	0.999 (4.06)	1.916 (4.92)
R^2	0.683	0.448	0.581	0.211

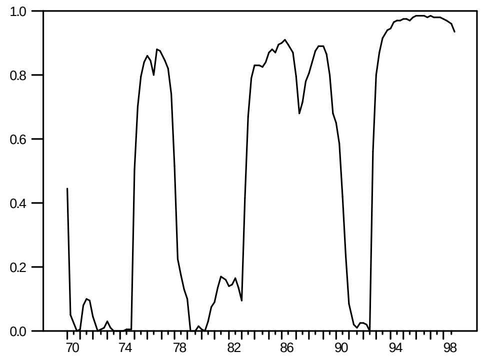
Notes: T-values in parenthesis. If the parameter for q_2 did not converge, it was restricted to 0.

Fig 1. Markov Switching Model with Constant Transition Probabilities

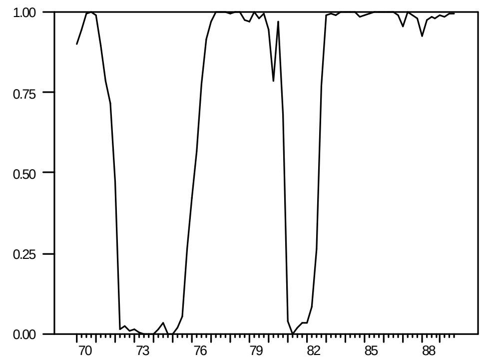
(i) 1970-1989



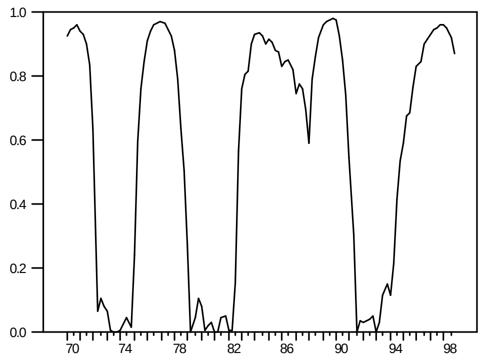
(iii) 1970-1998



(ii) IV, 1970-1989



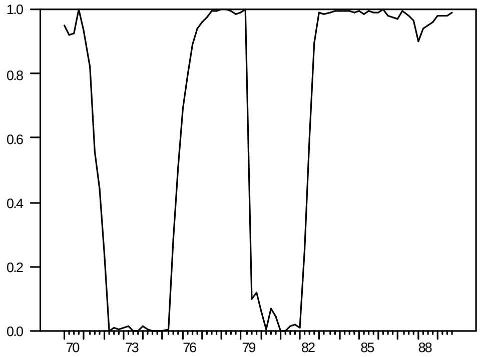
(iv) IV, 1970-1998



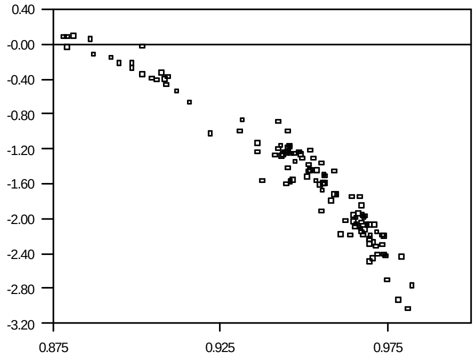
Notes: Smoothed transition probability of being in regime 1.

Fig. 2. Markov Switching Model with Time-varying Transition Probabilities

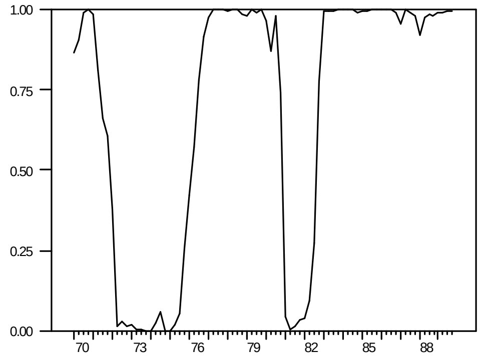
(i-a) 1970-1989



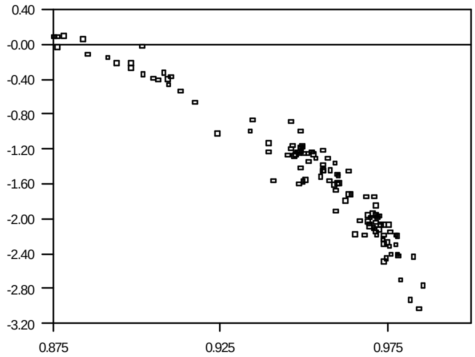
(i-b) 1970-1989



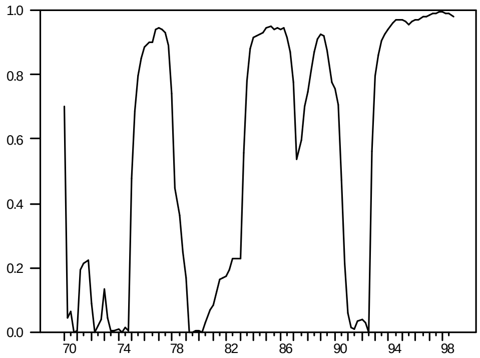
(ii-a) IV, 1970-1989



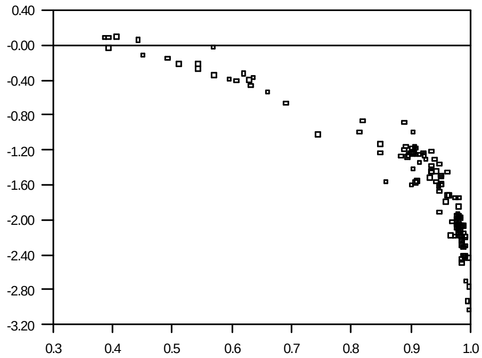
(ii-b) IV, 1970-1989



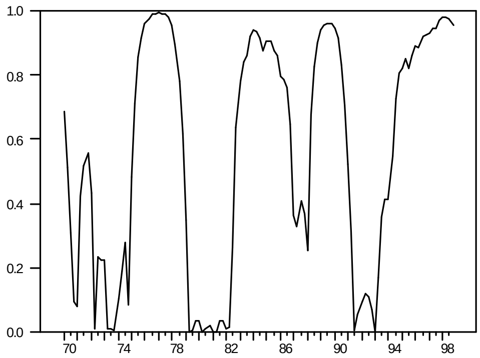
(iii-a) 1970-1998



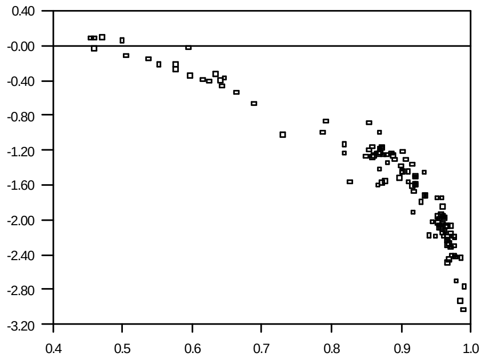
(iii-b) 1970-1998



(iv-a) IV, 1970-1998



(iv-b) IV, 1970-1998



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 budget deficit.