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Regime Switches in Pakistan's Fiscal Policy: Markov-Switching VAR Approach

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Abstract

Pakistan's economy experienced many ups and downs during the last four decades. These structural shifts (asymmetries) cannot be detected via linear econometric models. This paper employs the Markov Regime-Switching vector autoregression (MS-VAR) model with time-varying transition probabilities to identify the high and low growth regimes. After establishing structural shifts in the data, next, we estimate the linear VAR model in each regime to test the effects of fiscal shocks on output, and we also test the twin deficit hypothesis as well as the crowding-out investment effect. Different specifications of MS-VAR models with Constant Transition Probability (CTP) and time-varying transition probability (TVTP) were tested, among which the best fit model with four regimes is chosen for analysis. The four regimes identified are the low growth regimes from 1973 to 1979 and from 1989 to 1999 and the high growth regimes from 1980 to 1988 and from

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2000 to 2010. The results from the subsample analysis show that the response of output to positive spending shock is increasing in high growth regimes and decreasing in low growth regimes. Similarly, a tax shock has a statistically insignificant impact on output except for the last regime where a tax shock is positively associated with output growth. An expansionary fiscal policy crowds-out private investment in low growth regimes (i.e. in first and third regimes) while a positive effect on private investment is observed during high growth regimes (second and fourth regimes). Lastly, twin deficit is observed in all regimes.

Keywords: fiscal policy, twin deficit hypothesis, Markov-switching VAR
JEL Classification: E62, H6, C24

1. Introduction

Are the effects of fiscal shocks (government spending and taxes) on output and other macroeconomic variables (investment, consumption, exchange rate, exports, imports) different over the business cycle distinguished by the periods of recession and expansion? What is the role of fiscal shocks in smoothing business cycles? Are the effects of fiscal policy shocks on output state (regime) specific? Also, are twin deficit and crowding-out investment regime (recession and expansion) phenomena? These are macroeconomic policy-relevant questions that are highly controversial in the literature. More specifically, the hotly debated topic in the literature is the size, timing, and policy mix of the optimal fiscal policy action.

Given the historical background, several questions arise, for instance, why did the growth rate not sustain itself? Why is it that growth under dictatorships soon disappears and the progress seems to be a growth bubble instead of a real sectoral development trend? The answers to these questions need to analyze the effects of different policies on the fundamentals of the economy. There is a growing number of empirical studies (Ismail & Hussain, 2012; Khalid, Malik, & Satter, 2007; Shaheen & Turner, 2010; Subhani & Ali, 2010; Nazir, Anwar, Irshad, & Shoukat, 2013; Javid & Arif 2009) in Pakistan that analyze the effects of fiscal policy on aggregate economic activity by covering its various aspects. These studies have neither examined the effect of fiscal policy on

economic activity in the subsample period nor allowed for structural changes endogenously[1] in their empirical models.

Due to the unpredictable and unstable nature of the economy, it cannot react optimally to changes in fiscal policy, because the nature of the fiscal policy is time-varying, i.e. the value of the fiscal policy tool that the fiscal policy authority chooses in response to some indicator of economic conditions. Fiscal interventions to control the direction of an economy in terms of magnitude as well as in terms of fiscal policy instruments (spending or tax) are based on the government policy objectives. The fiscal interventions vary in response to changes in the macroeconomic environment along, and it depends on the state of public finance. The changes in the nature and stance of the fiscal policy shift are better described by economic and political circumstances and therefore can be better understood by relating it to different regimes.

There are two manners through which researchers model such changes. The first empirical approach examines the asymmetric impacts of fiscal changes on macroeconomic variables between two regimes[2] defined by the researcher a priori. The structural breaks (shifts) in this approach are captured by dummy variables. This allows the fiscal multipliers to depend on the level of the exogenous variable. An alternative approach in which the fiscal rules are governed by a two-state Markov chain variable is the regime-switching regression. While taking decisions, agents make a probabilistic inference regarding the future rule and state of the economy. Asymmetric information is assumed between private agents (households and firms) and government in these models. The future expected regime variable is generated through a maximum likelihood procedure in the latter approach based on which agents make their consumption and investment decisions.

We use the latter approach in this study to investigate the regime-specific effects of the fiscal instrument on macroeconomic variables during recession and expansion periods because it is assumed here that uncertainty faced by private as well as public agents is the root cause of the differing fiscal effects. The regime shift is usually different from standard business cycle periods

[1] One of the important aspects of the theoretical literature in endogenous growth models is the regime-switching approach to model the fiscal policy regime. The well-known fiscal policy regimes found in the literature are Keynesian vs. Ricardian regimes, low debt-output vs high debt-output regimes, active vs. passive fiscal policy regimes.

[2] The most often used regimes are expansion and recession phases in the business cycle, times of fiscal contractions and fiscal expansions, regimes of active and passive fiscal rules, large and persistent or small and non-persistent fiscal impulses, times of binding liquidity constraints and “good” times, among others.

because the regimes (and their duration) are unpredictable, sudden, and infrequent and are characterized by huge depression. In such circumstances, the government should not adopt fixed-regime rules but rather should show greater flexibility in fiscal policy rules characterized by frequent switches in regimes. The current decisions about expansionary and/or contractionary fiscal policy should be based on the expected generated future state of the economy. Thus, the decisions relating to information about the future state of the economy and/or fiscal policy can be better described in a framework involving the Markov-switching variable.

Keeping these underpinnings in mind, this study attempts to inspect the time-varying effects of fiscal policy on the macroeconomic environment of Pakistan by estimating a Markov-Switching Vector Autoregressive (VAR) model. In the first step, the study aims to measure the asymmetric impact of fiscal policy on aggregate economic activity to identify the high and low growth periods endogenously. Allowing for endogenous changes in the financial instrument will identify the time of possible shift in policy variables. Further, by knowing how much time a certain policy remained active will be helpful for effective policy formulation. In the second step, the benchmark model is extended to gauge the fiscal effect on the other variables through the recursive approach of VAR methods proposed by Sims (1980). Particularly, the effect on consumption and investment is investigated through expansionary fiscal shocks. The second direction aims to explore the twin deficit hypothesis, which maintains that budget deficit leads to a worsening of trade balances.

These investigations are useful for the Pakistani economy because political regimes (autocratic and democratic) in Pakistan remain dominant in influencing the economic outcomes. Among these regimes, autocratic regimes show good economic performance characterized by low and stable inflation, healthy growth, and fiscal consolidation. Relatively higher revenue generation is observed in autocratic regimes than in democratic regimes. The democratic regimes had macroeconomic instability due to the inefficient tax and expenditure structure that resulted in slow economic growth. The better performance of autocratic regimes is further characterized by a relatively stable external sector and low trade deficit along with high capital inflows in the form of foreign direct investments and portfolio investments. The levels of confidence of foreign investors to invest in the domestic economy remain high during autocratic regimes. The different episodes of democratic regimes did not deliver economic relief due to several internal and external factors, and so the key economic indicators have generally deteriorated.

The rest of the study is structured as follows. Section 2 discusses the macroeconomic performance during the sample period, Section 3 formulates the methodology adopted in the study. Descriptive analyses, interpretation of results, and regime-wise evaluation of impulse responses are provided in Section 4. Finally, Section 5 concludes the study.

2. Insights from the literature

Linear models to examine the effect of fiscal policy instruments on economic activity ignore the potential asymmetry in business cycles. The statistical approach of identifying whether an economy is in a phase of recession or expansion was started by Hamilton (1989). Thereafter, this statistical approach was adopted in many academic studies, especially for business cycle research. There is a wide range of theoretical and empirical literature on VAR that investigated and inspected the consequences of fiscal shocks on the macroeconomy. Apart from other shortcomings of VAR, it has a disadvantage of not detecting nonlinear responses that have the power to explain the nature of the effects of the fiscal policy depending on the state of the business cycle.

The literature from the near past shows that the attention of researchers has remained to specify fiscal policy in terms of reaction functions. Similarly, Afonso and Toffano (2013) estimated the reaction function of fiscal policy and found evidence of policy shifts during the sample period. The authors observed passive policy in the UK during the period 1992–1996, while regimes were active during the whole sample in Germany indicating sustainable fiscal policy. However, in the case of Italy, a mix of *active* and *passive* policy remained in place during different periods. On other hand, the US fiscal policy remained *active* from the 1960s to 1980s but then turned slowly towards passive policy in the early 1990s and then switched back to active in 2001 (Favero & Monacelli, 2005). In the same fashion, the study by Ito, Watanabe, & Yabu (2007) rejected the view that fiscal policy was fixed in Japan and suggested that Japan adopted Ricardian and non-Ricardian regimes during different periods.

Hellwig and Neumann (1987) and Giavazzi and Pagano (1990) found evidence of fiscal stabilization in Ireland (1987–1989) and Denmark (1983–1986), respectively. The factors responsible for stabilization are wealth effect that an increase in the real interest rate causes capital gains and hence raising consumption. Similarly, people tend to import durable goods as the

exchange rate appreciates and causes a consumption boom. Some studies[3] found inconsistent Keynesian regimes during subsample periods.

Ito et al. (2007) estimated the Markov-Switching model through a Bayesian method to estimate fiscal policy feedback rules in Japan, United States, and the United Kingdom for more than a century, allowing for stochastic regime changes. Their study concluded that Japanese data rejected that the fiscal policy regime is fixed, implying that the Japanese government has adopted a regime that is either Ricardian or non-Ricardian throughout the entire period. The Japanese results are in sharp contrast with the results for the US and UK.

Chibi, Benbouziane, & Chekouri (2014) used the MS-VAR model to examine the effect of fiscal policy on Algerian economic activity. The study found that fiscal policy in Algeria behaves asymmetrically during different phases of the business cycle. The study found that government spending policy is more effective to stabilize the economic activity in the short run during recessions than tax policy.

In the case of Pakistan, policy effectiveness was investigated by several studies. Studies asserted that the fiscal deficit has a key role in affecting economic growth in Pakistan (Shabbir, Mahmood, & Niazi, 1992; Khilji, Mahmood, & Siddiqui, 1997; Iqbal & Bilquees, 1994; Iqbal & Zahid, 1998). The debate on fiscal policy is growing concerning Pakistan by covering its various aspects, especially its effects on aggregate output and its components.

Investigation of dynamic effects of government spending and tax shocks on aggregate output was examined by Shaheen and Turner (2010). The study utilized the VAR model with Blanchard and Perotti (2002) type identification and find a statistically significant role of government spending and taxes in explaining the changes in output. A positive government expenditure shock raises real GDP after the second quarter and remains persistent over five years. Government expenditure adversely affects net-tax revenue up to 12 quarters, and thereafter it raises net-tax revenue and remains significant for the next eight years. The study found that positive shock in tax revenue reduces government expenditure, and this result is statistically insignificant, while GDP responds positively to tax shock.

Fiscal policy in Pakistan plays a discretionary role as pure competition rarely exists in the world, so the private sector alone cannot handle the fluctuation in economic activity (Khalid et al., 2007; Ismail & Hussain, 2012). Fiscal policy is discretionary in Pakistan, but it has a statistically

[3] Ihori, Nakazato and Kawade (2003); Miyazaki (2010); Ko and Morita (2013)

insignificant impact on output, employment, and inflation. Furthermore, their findings suggest that spending policy is pro-cyclical in boom only while tax policy is pro-cyclical in the boom as well as in recession. However, Javid et al. (2008) argued that there is a need for fiscal sustainability for which certain forms of fiscal control prove to be a very important subject matter for Pakistan while searching for price stability.

Malik (2013), while investigating the linear as well as the nonlinear impact of fiscal policy variables on private investment in Pakistan, found two basic conclusions. First, development expenditures stimulate investment until the optimum level of operation is reached and become harmful thereafter. Second, on the revenue side, there exists an inverted U-shaped relationship between direct taxes and private investment, but the relationship between indirect tax and private investment is U-shaped.

There is little empirical evidence on the relationship between disaggregated fiscal policy instruments and external variables in Pakistan. Still, a number of studies using different methods and datasets researched the phenomena of the twin deficit hypothesis and found different results (Burney, Akhtar, & Qadir, 1992; Burney & Yasmeen, 1989; Kazmi & Shabbir, 1992; Aqeel, Nishat, & Qayyum, 2000; Mukhtar, Zakria, & Ahmed, 2007; Hakro, 2009; Saeed & Khan, 2012).

The above review of empirical literature explored the various aspects of fiscal policy in terms of impact for different fiscal policy instruments. The review has some limitations; one, no study in Pakistan has examined the impact of fiscal policy on aggregate output and its components; second, most of the studies did not allow for endogenous changes in fiscal instruments which will identify possible shifts in policy variables.

3. Methodology

3.1 Markov-Switching VAR Model

The conventional Markov-switching model proposed by Goldfeld and Quandt (1973) to econometrics and popularized by Hamilton (1989) is based on the idea that economic series adopt different regimes related to events such as financial crises and unexpected changes in economic policy. The probabilistic inference about shifting from one state of the economy to another in the future is assumed exogenous in these models. It can be inferred that the effect of the fiscal stance on the macroeconomy can be better depicted through time-varying transition probabilities (TVTP) introduced by Filardo (1994). This model poses additional information about when a particular

regime has occurred by incorporating the financial time series data into the conventional Markov regime-switching model.

If the effect of fiscal policy on aggregate output is subject to regime change, then the transition probabilities are time-varying rather than time-invariant[4]. In other words, the transition probabilities are associated with some informational variables which contain sufficient information to anticipate a shift in the regime and hence work as the leading indicator for the unobserved regimes. This leading indicator will endogenize the Markov regime-switching process (Kim, 2003). The application of the Expectation-Maximization (EM) algorithm to the TVTP case is perceived by the choice of a leading indicator. It is shown by Filardo and Gordon (1998) that the conditional homogeneity between the informational variables and the stochastic regime induce that the EM algorithm is the valid technique to estimate the parameters in the Markov-switching model with time-varying transition probabilities (TVTP).

Since the effect of a fiscal instrument on economic activity is different during different phases of a business cycle, it is necessary to monitor the country's economic activity by a leading indicator. Now, which variable contains sufficient information to explain time-varying transition probabilities (TVTP) as opposed to constant transition probabilities (CTP) is a theoretical question. Different studies use different indicator variables, e.g. Estrella and Hardouvelis (1991) use the differential between short term and long-term interest rates as the information variable while Doniak (2001) uses the term structure of interest rate as the leading indicator to monitor economic activity. In Pakistan, the key macroeconomic indicator is monitored by the State Bank of Pakistan (SBP) policy rate, so this policy rate is used as the informational variable in TVTP.

Equation (1) describes the relationship between the unobservable state S_t and the variable that governs the transition from one regime to another z_t as follows:

$$s_t = \begin{cases} 1, if\ \eta_t \prec a\left(s_{t-1}\right) + z_t^{/} b\left(s_{t-1}\right) \\ 0, if\ \eta_t \geq a\left(s_{t-1}\right) + z_t^{/} b\left(s_{t-1}\right) \end{cases} \quad (1)$$

The transition probabilities are defined accordingly as follows:

[4] The details about modeling Markov switching with TVTP can be found in Diebold, Lee and Wienbach (1993) and Filardo (1994).

$$\begin{cases} p\left\{s_t = \dfrac{0}{s_{t-1=j}}, z_t\right\} = p_{1j}\left(z_t\right) = \varnothing\left(a_j + b_j z_t^{/}\right) \\ p\left\{s_t = \dfrac{1}{s_{t-1=j}}, z_t\right\} = p_{2j}\left(z_t\right) = 1 - \varnothing\left(a_j + b_j z_t^{/}\right) \end{cases} \quad (2)$$

where $\varnothing$ is the standard logistic distribution function and $j = 0,1$? There is a negative relationship between the sign of the coefficient of the variables in z_t and the likelihood of a transition from one regime to another. If the value of the coefficient is greater than zero, then a positive change in the set of variables z_t reduces the likelihood of a transition from one regime to another and vice versa.

Therefore, the following relationship can be considered in which the influence of the explanatory variables on endogenous variables is regime-dependent as follows:

$$y_t = \begin{cases} x_t^{/}\beta_1\left(s_t\right) + \sigma_1\left(s_t\right)\varepsilon_t \; with \quad a \quad probability \quad p_1\left(z_t\right) \\ x_t^{/}\beta_2\left(s_t\right) + \sigma_2\left(s_t\right)\varepsilon_t \; with \quad a \quad probability \quad p_2\left(z_t\right) \end{cases} \quad (3)$$

where ε_t is a normally distributed white noise error term with mean zero and constant variance, i.e. $\varepsilon_t \sim N(0,1)$. Similarly, the conditional probabilities that govern the transition from one regime to another are represented by $p_1\left(z_t\right)$ and $p_2\left(z_t\right)$.

The Markov-switching, regime-dependent intercept, heteroskedastic, order-p vector autoregression model of m regimes, i.e. MSIH(m)-VAR(p) in the terminology of Krolzig (1997), is given as follows:

$$y_t = v + \sum_{i=1}^{p} A_i Y_{t-i} + \varepsilon_t \quad (4)$$

where $y_t = \left[y_{1t}, y_{2t}, y_{3t}.....,y_{kt}\right]'$ is a k-dimensional vector of three variables, i.e. output, spending, and taxes, while parameters such as intercept (v), autoregressive parameters (A_i), and variance of error terms all are subject to regime change.

In matrix notation, the two-state Markov process is written as follows:

$$p = \begin{bmatrix} p_{11} & p_{12} & \cdots\cdots & p_{1m} \\ p_{21} & p_{22} & \cdots\cdots & p_{2m} \\ . & . & & . \\ . & . & \cdots\cdots & . \\ . & . & & . \\ p_{n1} & p_{n1} & \cdots\cdots & p_{mn} \end{bmatrix} \quad (5)$$

It is assumed here that each element of this matrix, i.e. p_{ij}, is less than 1 so that the regime is persistent rather absorbent[5]. The unobservable variable s_t takes the value 1 for low growth periods and 2 for high growth periods. Thus, the VAR in the above system can be considered as two VARs: one that holds for when $s_t = 0$ and one that holds for $s_t = 1$.

The MS-VAR model is composed of two components, i.e. the Gaussian VAR model and the Markov chain. The first component is characterized by the conditional data generating process whereas second is the regime generating process. The estimation of both components is based on the maximum likelihood estimate; specifically, the model parameter is obtained by the expectation-maximization (EM) algorithmic rule, proposed by (Hamilton, 1989) following (Diebold, Lee, & Weinbach,1993). The EM algorithm rule is aimed for a general class of models where the observed variable is governed by some unobservable random variable such as the regime variable S_t. This method starts with the initial estimates of the hidden information and iteratively produces a joint distribution that will increase the probability of observed information. In general, the EM algorithm maximizes the incomplete-data log-likelihood via the iterative maximization of the expected complete-data log-likelihood, conditional upon the observable data. Given the observed data and some initial estimates of the parameters in the model, the EM algorithm begins by calculating the smoothed state probabilities.

The above estimation procedure will give us filter probabilities $pr\left(s_t = \frac{i}{z_t}\right)$, where *i* is the number of regimes. The filter probabilities are responsible for the information on which regime the observed series is most likely to have been in at every point in the sample. But the filtered probabilities use only the current information up to time $t = 1,2,\ldots\ldots,T$ to represent an optimal

[5] Once the system reaches a regime, it stays there infinitely.

inference. The smoothed probabilities $pr\left(s_t = \frac{i}{z_T}\right)$, on the other hand, use full information about the sample. For the implementation of the EM algorithm, a Matlab, code[6] is used.

3.2 VAR Modeling

We assume the following VAR model specification for empirical characterization of crowding-out investment and twin deficit hypotheses

$$X_t = A(L)X_{t-1} + U_t \tag{6}$$

where the vector of endogenous variables is $X_t = [G, ER, M, X]$. For policy analysis, the significant response function is the structural shock not the shock to a reduced form residual U_t in which case the response of endogenous variables to a shock is meaningless. These two shocks are correlated with each other and need to be isolated. For this purpose, we pre-multiply equation (6) by the $(k \times k)$ matrix A_0 to transform it into a structural model as follows:

$$A_0 X_t = A_0 A(L) X_{t-1} + Be_t \tag{7}$$

where the relation between reduced-form residuals and structural residuals is given by $Be_t = A_0 U_t$. It is assumed here that the variance-covariance matrix of structural disturbances is diagonal, meaning that they are uncorrelated with each other. For identification of the structural model in equation (7), we need some restrictions on parameters of the matrices A_0 and B. For restriction, we follow the recursive approach of Sims (1980), which restricts matrix A_0 to be a lower triangular matrix and restricts matrix B to be an identity matrix. This approach demands that the model variables be ordered from most exogenous to most endogenous (Caruana, 2008). We ordered the variables as follows $\{G, \mathrm{X}, \mathrm{M}, \mathrm{ER}\}$. In matrix notation, the relationship between reduced form disturbances and structural disturbances is written as follows:

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ \alpha_{X,\mathrm{G}} & 1 & 0 & 0 \\ \alpha_{\mathrm{M,G}} & \alpha_{\mathrm{M,X}} & 1 & 0 \\ \alpha_{\mathrm{ER,G}} & \alpha_{\mathrm{ER,X}} & \alpha_{\mathrm{ER,M}} & 1 \end{bmatrix} \begin{bmatrix} U^G \\ U^X \\ U^M \\ U^{ER} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e^g \\ e^x \\ e^m \\ e^{er} \end{bmatrix} \tag{8}$$

[6] The access to the Matlab codes of MS-VAR with TVTP (Ding (2012) modified codes of Marcelo Perlin) is made possible through Marcelo Perlin's official website. The author is thankful to both of them for open access of their codes.

4. Results and discussion

Testing nonlinearity in data is the pre-requisite in Markov regime-switching models. According to Hansen (1996), because of the presence of nuisance parameters[7] while testing the null hypothesis of linearity against the nonlinearity, the likelihood ratio test is not valid. This study utilized the Hansen (1996) standardized likelihood ratio (LR) test to test for nonlinearity, which handles the presence of nuisance parameters while testing the null hypothesis of linearity. The results (see Table 1) indicate that the null of one state is rejected in all cases against two states.

Table 1: Standardized likelihood ratio test for testing the null of linearity

	Hansen's LR Test	P-Value				
		M=0	M=1	M=2	M=3	M=4
Output	2.5342	0.016	0.015	0.014	0.011	0.003
Spending	2.6534	0.088	0.082	0.067	0.081	0.057
Taxes	1.8989	0.106	0.104	0.108	0.12	0.14

To avoid misspecification of the model, i.e. to decide which parameters are regime-dependent once a second regime is recognized, following Krolzig (1997) a bottom-up procedure and successively a general specification of the MS-VAR are tested against each other, comprising MSIH(2)-VAR(1) and MSIAH(2)-VAR(1) against the initial illustration of MSI(2)-VAR(1). To fix the suitable specification between alternative models assuming the constant number of regimes, the LR test is used and the log-likelihood values of the different specifications are given in Table 2. Based on this bottom-up strategy, the selected specification is MSIAH(2)-VAR(1). The two modeled regimes are thus low growth regime, in which the mean and volatility[8] are larger, and high growth regime, in which the mean and volatility are low.

[7] Hansen pointed out that the nuisance parameters P_{11} and P_{mn} are not identified under the null hypothesis. These unidentified nuisance parameters make the quasi-log-likelihood function flat, and so there is no unique maximum. Secondly, when there are nuisance parameters under the null hypothesis, then the null hypothesis produces a local optimum or inflection point. In these circumstances, the asymptotic distributions of the usual tests (likelihood ratio, Lagrange multiplier, Wald tests) are nonstandard.

[8] The mean and volatility of the endogenous variables including GDP, expenditure and taxes depend on the leading variable/informational variable, i.e. State Bank of Pakistan policy rate.

4.1 Results of Markov Regime-Switching

We estimated different specifications of the MS-VAR model with TVTP and CTP. The best fit model is chosen, i.e. the MSIAH (2)-VAR(1) model, for analysis based on the maximum likelihood ratio test value (see Table 2). The coefficients of the MS-VAR(1) model in the recessionary phase are negative, and its volatility is also higher. On the other hand, the second regime catches the expansion phase of the fiscal instrument with a positive sign and lower volatility. It is also seen from Table 3 that the probability of staying in regime 1 is higher — $pr\left(s_{t+1}=0/s_t=0\right)$ is 0.8043 — as compared to the probability of staying in regime 2 — $pr(s_{t+1}=1/s_t=1)$ is 0.6236 — which proposes that regime 1 is more persistent as compared to regime 2.

Table 2: Different specification, log-likelihood value, likelihood ratio test and their expected duration

	Log-Likelihood value	LR Test	Expected Duration of Regime	
			State 1	State 2
CTP				
MSI(2)-VAR(1)	363.5869	398.430	16.84	2.62
MSIH(2)-VAR(1)	371.2691	0.689	19.43	8.89
MSIAH(2)-VAR(1)	723.5347	18.938	18.41	11.18
TVPT				
MSI(2)-VAR(1)	1226.7657	19.912	16.84	2.62
MSIH(2)-VAR(1)	1165.0787	58.232	28.54	3.38
MSIAH(2)-VAR(1)	2413.8284	16.860	159.534	4.62

Table 3: Results of MSIAH(2)-VAR(1) Markov Regime Switching

Coefficients	$\Delta spending$	$\Delta taxes$	ΔGDP
	Regime-dependent means		
Mean($s_t=0$)	-0.036181 (-0.0065)	-0.756890 (-.4203)	-0.437270 (-.1821)
Mean($s_t=1$)	0.767584 (.3439)	1.247934 (0.4288)	0.023325 (0.00778)
	Coefficients		

$\Delta spending(-1)$	0.977801 (.3948)	1.730688 (.2073)	0.218928 (0.0846)
$\Delta taxes\ (-1)$	0.002117 (0.3887)	-0.121612 (-2.3436)	0.004954 (0.5952)
$\Delta GDP(-1)$	0.637715 (0.1715)	4.667273 (2.1878)	0.402002 (.1552)
	Regime-dependent variances		
$\sigma^2(s_t = 0)$	3.86	7.26	6.35
$\sigma^2(s_t = 1)$	2.35	2.69	2.55
Log-likelihood			
	Transition function		
Transition variable/parameter	$interest\ rate$	$interest\ rate$	$interest\ rate$
a_0	2.073 (0.15)	1.73 (1.33)	0.128 (.02)
a_1	2.283 (0.80)	1.29 (0.32)	2.326 (0.59)
b_0	5.064 (0.31)	5.53 (0.27)	5.504 (1.48)
b_1	10.42 (2.13)	1.21 (0.91)	0.04 (0.95)
P_{ij}	State 1	State 2	
State 1	0.8043	0.3764	
State 2	0.1957	0.6236	
Duration of regime	5.87	2.35	
Final Log-Likelihood	2413.8284		

Note: Standard error is given in parenthesis.

The forecast of the future state of the economy (future regimes) is obtained by utilizing the smoothed probabilities with different specifications (see Figures 1 to 4). By analyzing the lag coefficients of the endogenous variables, we can observe that shock in government spending and GDP in the *t-1* period produce a positive effect on government spending and GDP in period *t*. Similarly, the autoregressive coefficient of lag 1 for taxes produces a positive but statistically insignificant effect on taxes in period *t*. The coefficient of the logistic function (control variable) also suggests some inference about the transition probabilities of switching the two growth states, low

growth–high variance and high growth–low variance. The estimates of a_1 are positive and statistically significant, indicating that the likelihood of staying in the low growth–high variance state is increasing. Similarly, the estimate of b_1 being positive and statistically significant also suggests that the chances of switching from one regime to another are high.

The plot of the smooth regime probability tells us at which point in time all the series follow the same behavior, which is either all the series are increasing (regime 2) or decreasing (regime 1). Figure 1 shows that the predicted periods for low growth are from 1973 to 1979 and from 1989 to 1999. Similarly, the predicted periods for high growth are from 1979 to 1989 and from 2000 to 2009. These predicted periods of low growth and high growth regimes are consistent with democratic and autocratic regimes, respectively.

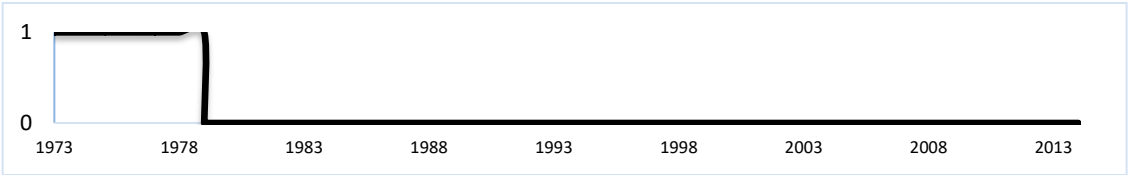

Figure 1: Smoothing probability of regime 1

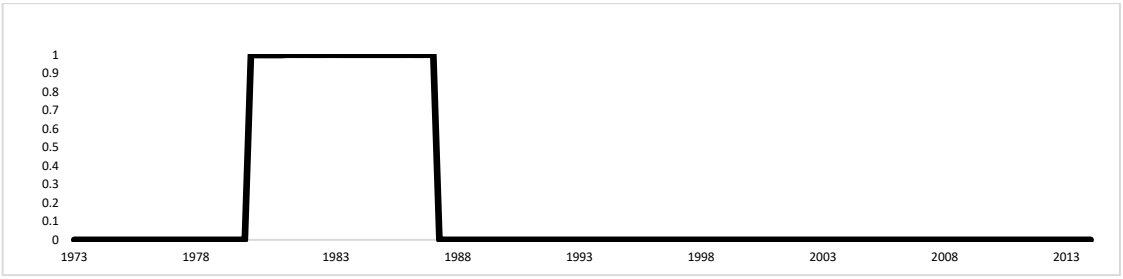

Figure 2: Smoothing probability of regime 2

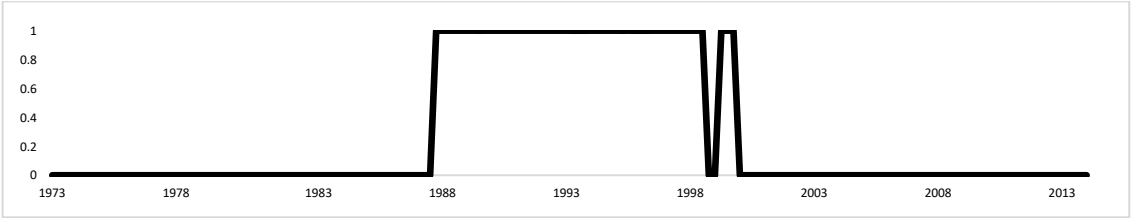

Figure 3: Smoothing probability of regime 3

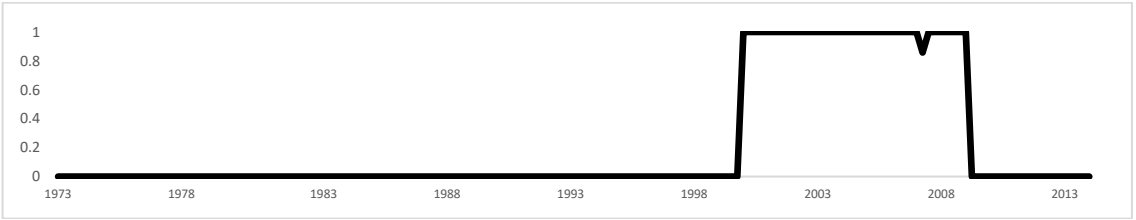

Figure 4: Smoothing probability of regime 4

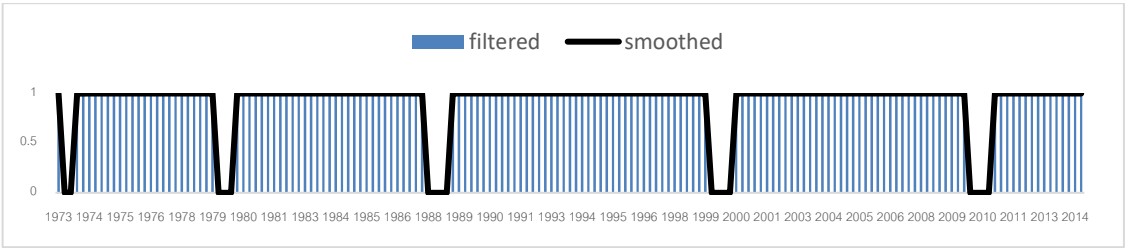

Figure 5: The filtered and smoothing probability of MSIAH (2)-VAR (1) with TVTP

The transition of the state of the economy from one regime to another is given by transition probabilities. The elements on the principal diagonal of the transition probability matrix tell us that the probability of the future state of the economy will remain constant. In other words, these principal diagonal elements tell us that the economy will remain in the same state as it was in the previous state. It is the off-diagonal elements of the transition probability matrix that tell us about the transition of the economy from one state to another. Table 4 shows that the probability of remaining within the same state is high while the probability is low for the transition from one state to another, except the specification MSIAH(2)-VAR(1)[9] for which the probability is comparatively high. All the models are estimated for only two states.

4.2 Subsample Analysis Based on VAR Model

4.2.1 Results of VAR model (Responses of GDP and Taxes to Spending Shock)

The estimated impulse responses of each dependent variable to a one-percent government spending shock in the four regimes are reported in Figure 6. The impulse responses are collected for 12 quarters of the whole sample in each regime. Each row shows the responses of variables to a one-percent shock in government spending, while in columns we arrange the impulses for each regime.

[9] The specification in which all the parameters are subject to regime shift.

Looking at the impulse responses in regime 1, the response to a government spending shock, government spending increases initially and then falls continuously reaching zero in the fifth quarter and then rises thereafter. In the second row, output decreases significantly and remains negative until the ninth period and then rises again thereafter. In response to a spending shock, the tax revenue increases in the initial period and remains positive until the fifth quarter which discourages private consumption, and it remains negative until 10 quarters and then rises again thereafter. The unfavorable effect on GDP maybe because of the initial increase in taxes.

In the second regime, the discretionary government spending shock has a non-Keynesian effect on output in the initial period. This non-Keynesian impact on output maybe because of higher taxes initially in the same period. As compared to regime 1, taxes and spending initially remain high and then converge to the new steady-state level. The impulse responses in regime 3 are mostly similar to regime 1, as can be seen in the third column. The most important characteristic of 1990 is that a positive government spending shock has a contractionary effect on output until period 7 and remains zero thereafter. The tax and spending responses are almost the same as in the 1970s.

Returning to the 2000s, it is observed that government spending reaches its highest level in response to a positive government spending shock. But the important feature of this regime is that this discretionary increase in government spending has a substantial Keynesian effect on output up to the eighth period and then starts falling. The responses in this regime are almost similar to the responses during the 1990s for spending and taxes. It is seen that in response to a spending shock, the output does not increase persistently in any regime, although it increases in the 1980s and 1990s, and thus the stimulus effect is short-lived.

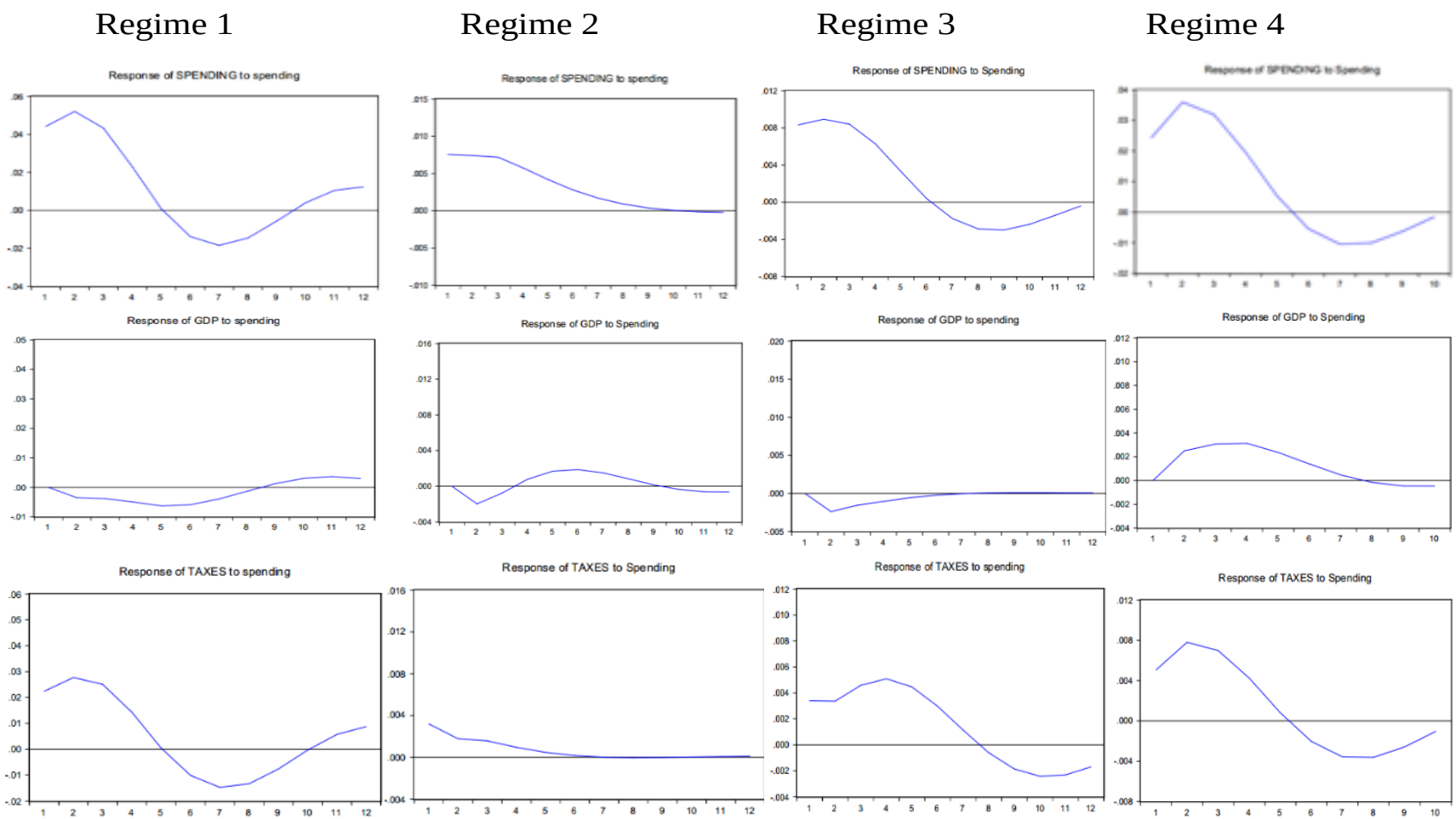

Figure 6: Impulse responses to government spending shock, four-regime model (Response to structural one SD innovations)

Note: Impulses for each regime are given in columns, responding variables in rows.

Two types of multipliers are computed, i.e. the impact multiplier and the cumulative multiplier. For the impact multiplier, we use the first-period impulse responses.[11]

The cumulative multiplier is computed by using the sum of 12-period impulse responses. In the upper panel, the impact multiplier in both regimes 1 and 3 is negative. The impact multiplier in regime 2 is significantly larger than 2 while it is around 80 percent (0.8) in regime 4.[12]

The impact of the multiplier is the highest in regime 2. As shown in Figure 7, all the cumulative multipliers are positive, while the highest cumulative multiplier is observed in regime 4.

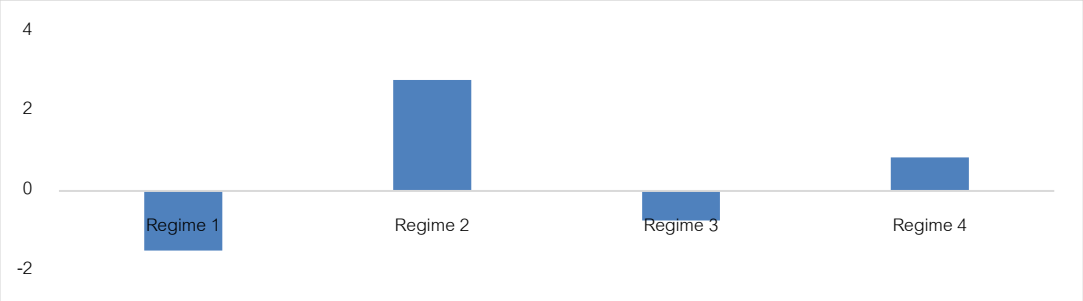

Figure 7-A: Impact multiplier, four-regime model

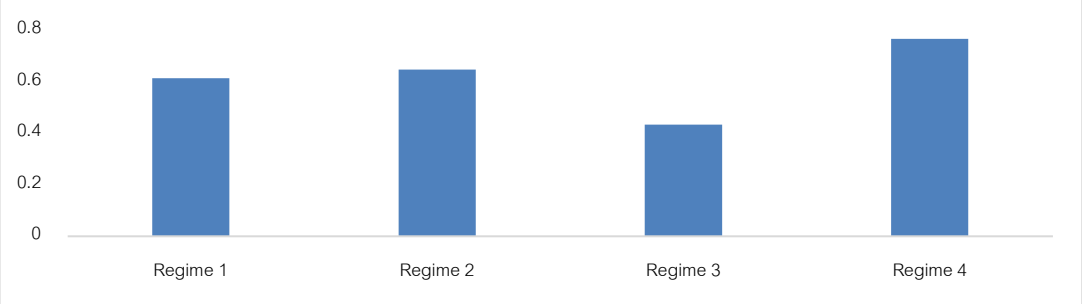

Figure 7-B Cumulative multiplier, four-regime model

The responses to a one-percent tax shock are given in Figure 8. The tax shock consistently decreases government spending in the first three regimes. The only exception is regime 4 where the tax shock increases government spending. The output is nonresponsive to tax shock in most of the cases, while in regime 4 output increases until the 10th quarter and becomes insignificant thereafter. In general, it is concluded that tax spurs relatively depress the macroeconomy in the first three regimes.

[11] The multipliers are computed using $\frac{\text{IRF of GDP}}{IRF\ of\ Gov.Exp.} \cdot \frac{Y}{G}$.

[12] Syed et al. (2011) estimate the multiplier from the Keynes income determination model, and it varies in magnitude from 0.319 to 2.02.

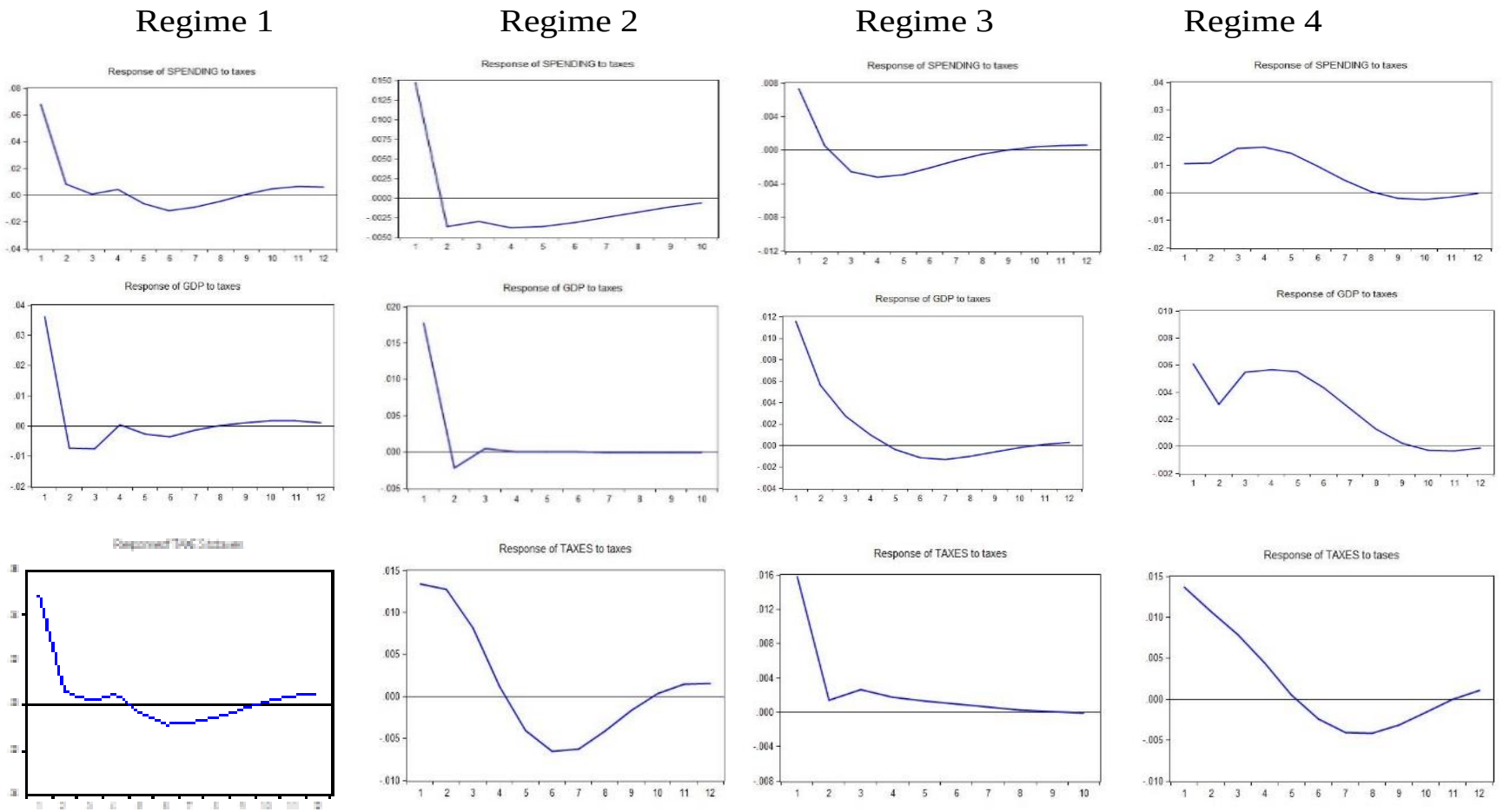

Figure 8: Impulse responses to tax shock, four-regime model (Response to structural one SD innovations)

Note: Impulses for each regime are given in columns, responding variables in rows.

4.2.2. Forecast Error Variance Decomposition (FEVD)

The forecast error variance decomposition is computed to explore the relative contribution of fiscal shocks to output fluctuations. The shares of each identified structural shock in explaining the fluctuations in GDP over a 12-quarter horizon is displayed in figure 9.

The key outcomes from FEVDs are summarized as follows. The relative contribution of fiscal shocks varies among regimes. The spending shock and tax shock in regime 1 explain roughly 20 percent and 70 percent variation in output in the short run and the long run, respectively. Among these two fiscal shocks, the contribution of spending is statistically significant, contributing about 15 percent in the short run and around 50 percent in the long run. On the other hand, government spending does not account significantly in explaining the output variation in the other three regimes. In regime 4, the two shocks in the short run explain about 15 percent variation while in the long run, the contribution surges to 60 percent. One more surprising finding is that in regime 3 the tax shock explains a large fraction of output fluctuations, but in regime 2 and to some extent in regime 4 the role of the two shocks is not statistically significant.

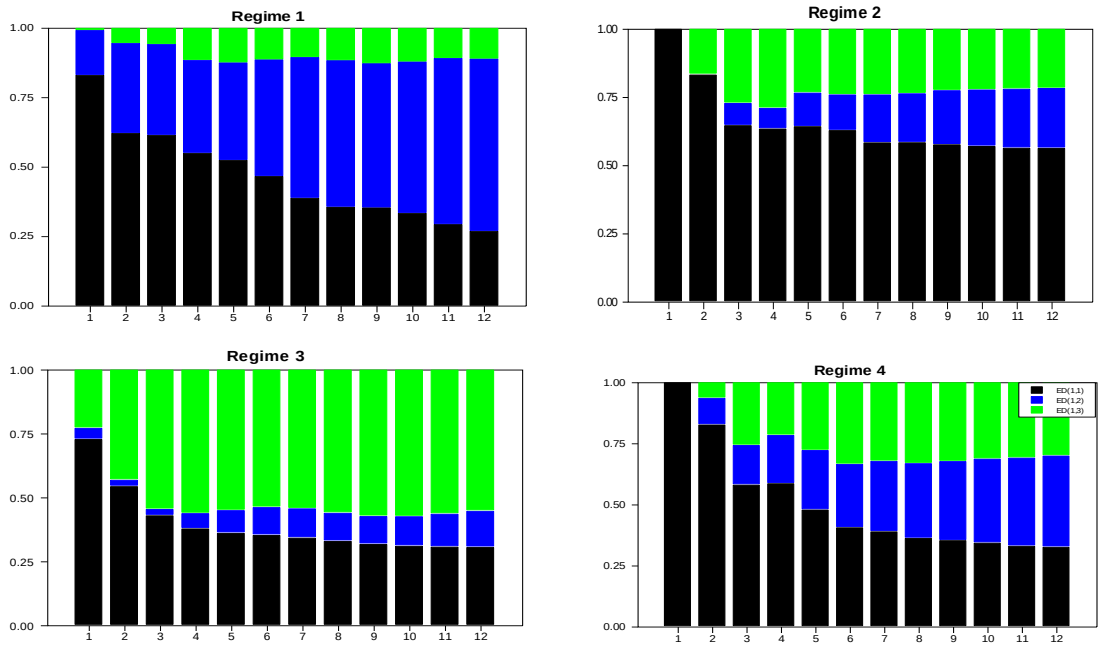

Figure 9: Forecast error variance decomposition

Note: ED(1, 1) is GDP shock, ED(1, 2) is spending shock and ED(1, 3) is tax shock.

4.2.3. Historical Variance Decomposition

Historical decomposition of moving average (MA) representation is part of the VAR methodology. The MA representation is divided into two parts which make the evolution of series over time to be given as follows:

$$Y_{t+k}^{/} = \sum_{s=0}^{k-1} \varepsilon_{t+k-s}^{/} \Psi_s + \sum_{s=k}^{\infty} \varepsilon_{t+k-s}^{/} \Psi_s \quad (9)$$

The base projection or dynamic forecast of the endogenous variables at time *t+k* conditional on the given information at time *t* is given in the second part in the above equation. The first part represents the difference between the observed series and dynamic forecast owing to shock in variables in time *t+1* to *t+k*. Thus, the role of shocks to each series can evaluate the gap between dynamic forecast and observed series in the analysis. Since the observed series is the combination of dynamic forecast and contribution of innovations, the dynamic path of variables included in the VAR model can be explained by the historical decomposition (HD) procedure.

In this section, our objective is to analyze the relative importance of each shock in explaining the path of output. The solid lines in Figure 10 represent the historical evolution of output (seasonally adjusted log difference of GDP) of the structural shocks, where the spikes show the contribution of each shock. Tax shock has a substantial role in increasing output until 1980, a negative effect on output until 1990, a positive effect in 1998, negative until 2008 and positive effect thereafter. The role of spending shock remains positive until 1990 and thereafter hurts output.

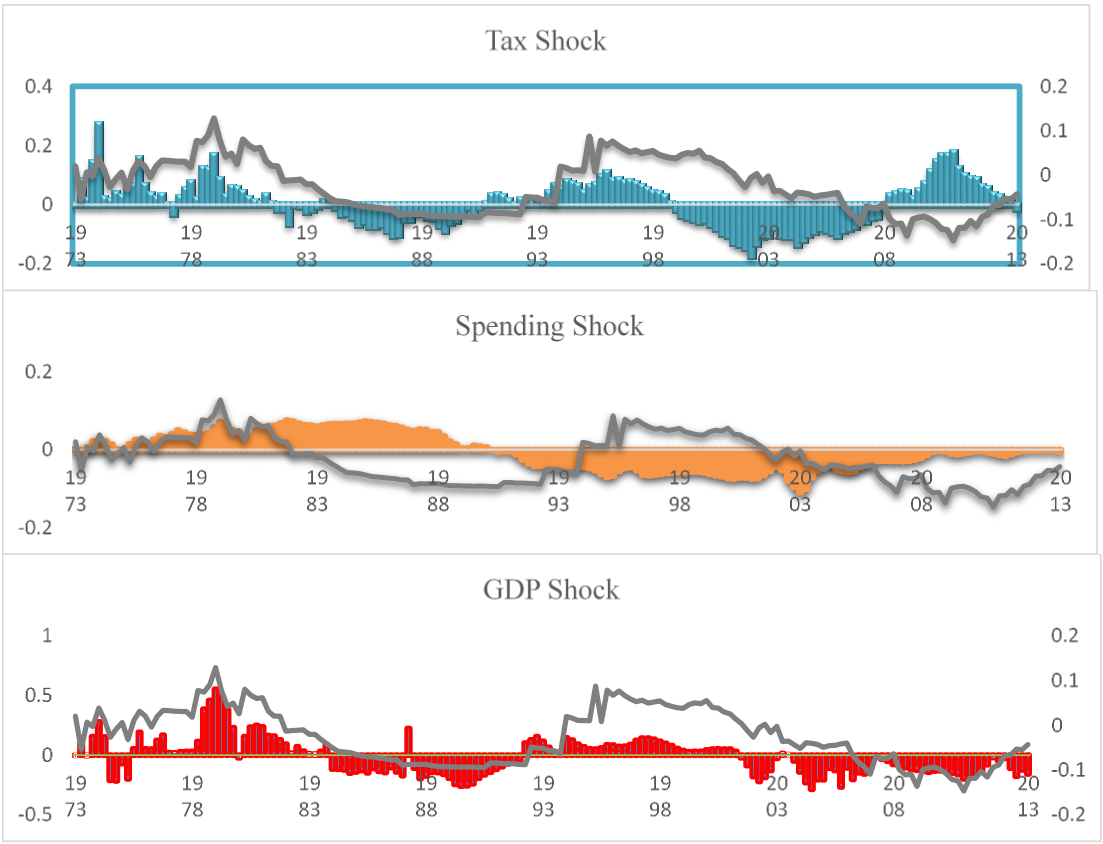

Figure 10: Historical variance decomposition

4.2.4. Results of VAR model (Effects on Investment and Consumption)

This and the following sections examine the responses of GDP on consumption and investment as well as the effect of external variables on trade balances. To know each component effect, the four-variable VAR model is estimated.

The responses of private investment to government spending shock are given in the third row of Figure 11. In response to government spending shock, private investment decreases in regimes 1 and 3 while it increases in regimes 2 and 4. So, our findings suggest that there is crowding-in in regimes 2 and 4 and crowding-out in regimes 1 and 3.

The responses of consumption to fiscal shocks are investigated thereafter. According to standard new classical models, fiscal shocks have negative effects on private consumption[13]

[13] Baxter and King (1993) among others examined this negative effect on consumption.

, whereas Keynesians find it the opposite. Figure 11 shows that a positive spending shock decreases private consumption at the impact period in regimes 1 and 4, while in the long run private consumption increases substantially in regime 4 and moderately in regime 1. In regimes 2 and 4, fiscal shocks have a contractionary effect on consumption in the short run, while in the long run, the effect is insignificant. In response to spending shock, an increase in private consumption in regime 4 reconfirms the consumption bubble. In regime 3, the negative responses of output and private consumption assert that fiscal expansion in the 1990s was insufficient to induce the Pakistani economy.

The results show that the Pakistani economy shifted from Keynesian economics to the neoclassical economy with the onset of regimes 2 and 4. This contractionary effect on the macroeconomy could be explained by various reasons. This contractionary effect may be due to the non-Keynesian effect on demand, as in response to fiscal expansion private consumption falls when consumers believe that this fiscal expansion will reduce the lifetime income of the household. Our speculation from the discussion so far is that sluggish economic growth was observed during this regime and that due to inadequate fiscal expansion the lifetime income of households remains low.

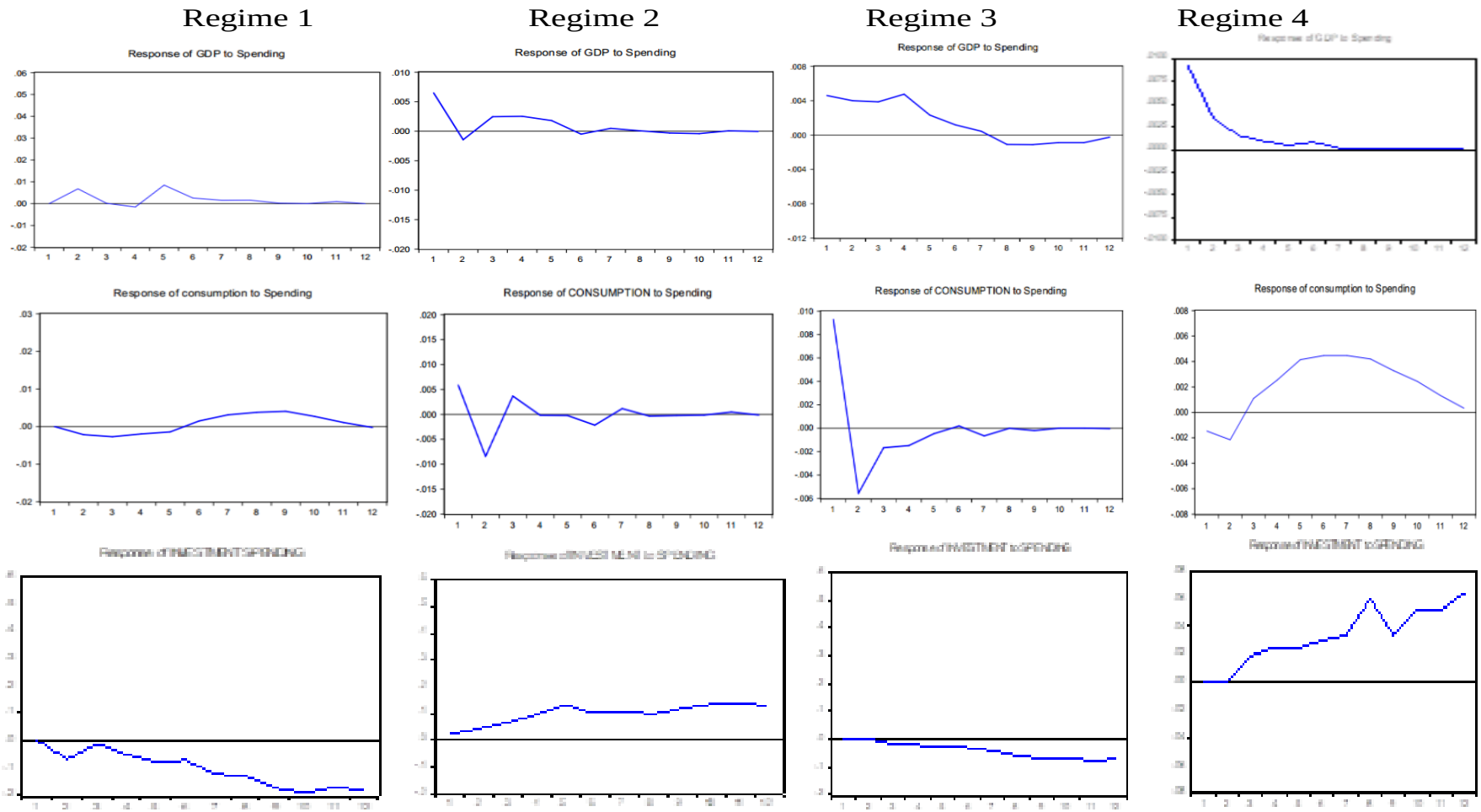

Figure 11: Impulse responses to government shock, four-regime model (Response to structural one SD innovations)

Note: Impulses for each regime are given in columns, responding variables in rows.

4.2.5. Results of the VAR model (Twin Deficit Hypothesis)

The twin deficit hypothesis suggests that there is strong casual links between current account deficit and budget deficit and is caused by a large government tax cut. The responses of imports, exports, and real exchange rates to a one-unit innovation in government expenditure are displayed in Figure 12, which shows that exports decrease and imports increase in almost all regimes. Exports increase at the impact period in regimes 3 and 4 but remain negative after the fourth quarter. These results are in line with twin divergence in the Pakistani economy. The real exchange rate depreciates in response to spending shock in regimes 2 and 1, whereas in regimes 3 and 4 the exchange rate appreciates. Generally, it is observed from findings that the results are in line with the Mundell–Fleming model in regimes 1, 3, and 4, which reconfirms the twin deficit hypothesis. Several studies confirm that in response to increases in government spending, the exchange rate depreciates in the first case while it appreciates in later case (Corsetti, Meier, & Muller, 2012; Kim & Roubini, 2008; Monacelli & Perotti, 2010; Ravn, Schmitt-Grohe, & Uribe, 2007; Beetsma, Giuliodori, & Klaassen, 2008; De Castro & Garrotte, 2015). However, few empirical studies are found for the Pakistani economy. Among those, Javid, Arif, and Satter (2008) find that government deficit shock depreciates the exchange rate, and hence they find evidence of twin convergence.

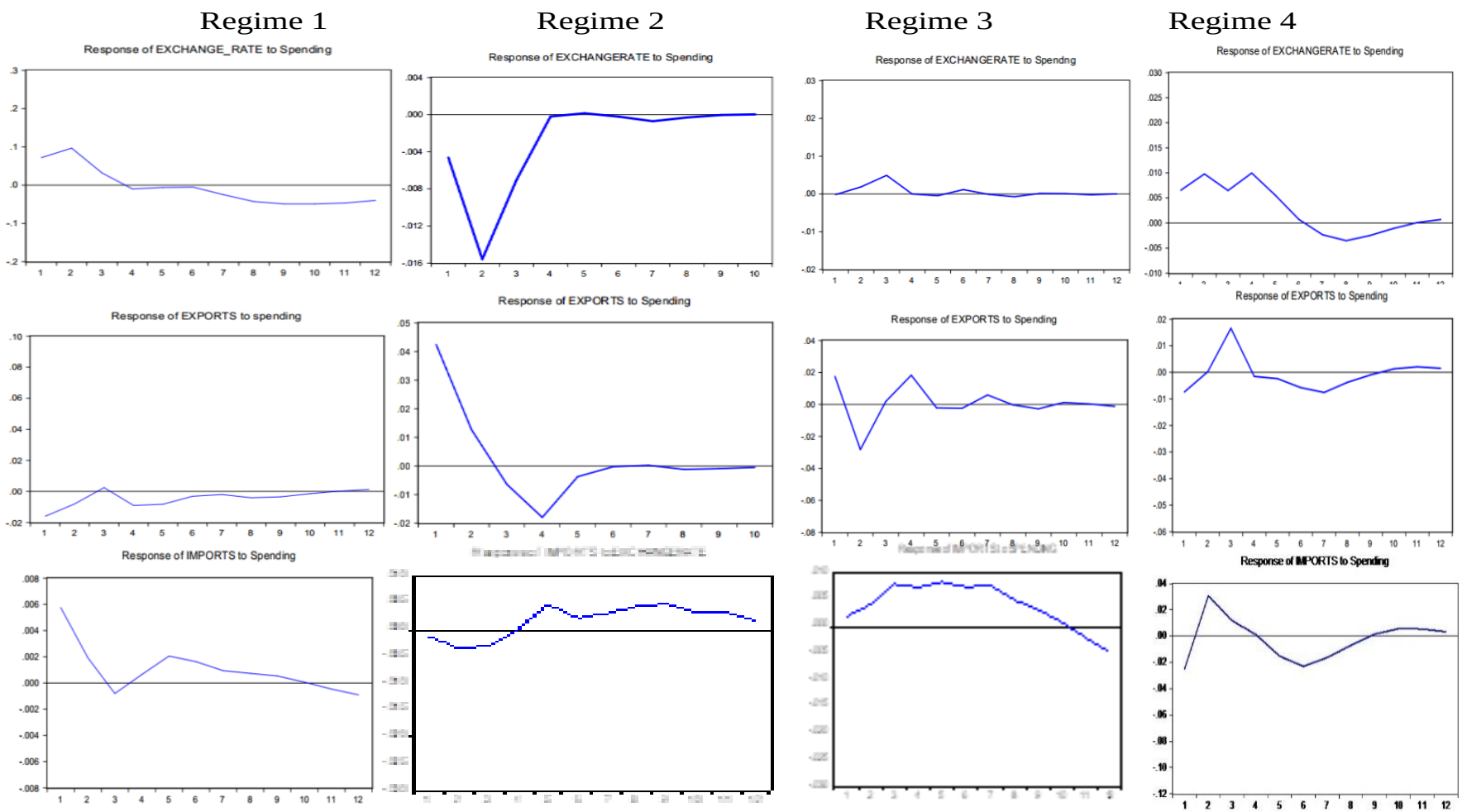

Figure 12: Impulse responses to government shock, four-regime model (Response to structural one SD innovations)

Note: Impulses for each regime are given in columns, responding variables in rows.

5. Conclusion and policy outcomes

There are many ups and downs in the Pakistani economy since its inception. The primary objective of this paper is to detect the turning points in Pakistan's economic activity. The examinations of the different relationships in the business cycle phases are the second objective of the study. The results confirm the business cycle asymmetries, i.e. it identifies the low and high growth regimes. The timing of these changes in regimes is early 1980, late 1988, in 2000 and early 2010, which is consistent with democratic and autocratic regimes, respectively. A positive shock to government spending increases output in the 1980s and the 2000s while it decreases output in the 1970s and the 1990s, but the size of the government spending multiplier (impact and cumulative) is significantly different among the regimes. The response of output to tax shock in most cases is statistically insignificant and negative, except in the 2000s in which output increases due to one unit tax shock until the 10th quarter and then becomes statistically insignificant due to the inelastic nature of the tax-to-GDP ratio. Government spending policy during a recession is more effective than tax cut policy as tax shocks have a mostly statistically insignificant effect on output.

The study then extended the benchmark model to four variable VAR models. The results suggest that private investment was crowded-out during the 1970s and 1990s while it was crowded-in during the 1980s and in the 2000s. In response to a positive spending shock, private consumption decreases at the impact period in the 1970s and during the 2000s, while in the long run private consumption increases substantially during the 2000s and moderately in the 1970s. In the 1980s and 2000s fiscal shocks have a contractionary effect on consumption in the short run, while in the long run, the effects are statistically insignificant. In response to spending shock, an increase in private consumption during the 2000s confirms the consumption bubble. In the 1990s, the negative responses of output and private consumption assert that fiscal expansion in the 1990s was insufficient to induce the Pakistani economy. It is concluded that the Pakistani economy shifted from Keynesian economics to the neoclassical economy in the 1980s and 2000s, whereas twin deficit is found in all regimes.

The results of the study conclude that spending policy during a recession is more effective as compared to tax policy in the context of stabilization strategies. Due to the inelastic, regressive, and non-buoyant tax structure, tax policy has a statistically insignificant and negative effect on output and other macroeconomic variables. The government deficit financing through domestic borrowing could create competition with the private sector for scarce funds available for

investment, therefore increasing interest rates and reducing private investment or consumption. The crowding-out effect on the private sector may be reduced by diversifying the bond market so that the government borrows from the private and banking sectors as well. Control on the double depreciation problem through hedging (elimination of financial risk) and on the capital flight may also be helpful to keep the trade deficit within the limit.

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