MONETARY AND FISCAL POLICY INTERACTIONS:

EVIDENCE FROM EMERGING EUROPEAN ECONOMIES

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Abstract

This paper examines the interactions between fiscal and monetary policy for some former transition, emerging European economies over the 1995Q1-2010Q4 period by using a Markov regime-switching model. We consider the monetary policy rule proposed by Taylor (1993) and the fiscal policy rule suggested by Davig and Leeper (2007) in accounting for monetary and fiscal policy interactions. Results suggest that monetary and fiscal policy rules exhibit switching properties between active and passive regimes. Empirical results suggest that the Czech Republic, Estonia, Hungary, Poland followed both active and passive monetary policies whereas Slovenia and the Slovak Republic followed passive monetary rules. As for fiscal policy, Estonia, Hungary, Poland, and Slovenia seem to have alternated between active and passive fiscal regimes while the Czech and Slovak fiscal policies can be characterized by a single fiscal regime. The policy mix and the interactions between monetary and fiscal policy point a diverse picture in our sample countries. Estonia, Hungary and Poland seem to have followed monetary and fiscal policy combinations that were not sustainable. These countries had major episodes where fiscal and monetary policies were active pointing to serious problems with respect to debt sustainability. Overall these countries would face serious constraints if they were to join the euro zone.

JEL Classifications.: E52, E62, E63, C22, P52

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1. Introduction

Due to the global financial crisis, a large number of developed and developing countries have focused on economic stabilization instead of debt stabilization by using several fiscal stimulus packages and pursuing an active expansionary fiscal policy. However, there is no consensus in the literature on the effects of expansionary fiscal policy on economic stabilization. For instance, the traditional view suggests that an expansionary fiscal policy financed by debt raises income (and hence private consumption). However, standard IS-LM theory suggests that without an appropriate monetary expansion, a fiscal stimulus leads to significant increases in aggregate demand which increases long-term interest rates and crowds out private investment. However empirical results show that model results are sensitive to specific statistical methods used and hence the effect of fiscal expansion on crowding out is inconclusive. In addition, the Ricardian view contests the effects of expansionary fiscal policy financed by debt on output and consumption because rational individuals would anticipate future tax increases by saving the respective amount. Hence, the usual Ricardian debt neutrality holds where under broad conditions, government finance and timing of taxes do not matter, because the effect on demand is the same.

Fiscal policy is also relevant in determining the path of prices in an economy and several authors emphasize the effects of fiscal policy on the price level. While the traditional theory assumes that the money stock is the most important determinant of the price level in an economy, advocates of the Fiscal Theory of the Price Level (FTPL) contend that price stability requires not only an appropriate monetary policy but also an appropriate fiscal policy. In the traditional view, it is assumed that the primary surplus is adjusted by the government to guarantee solvency for any price level. On the other hand, the FTPL argues that if governments adjust primary surpluses independently of government debt, the presence of significant effects of fiscal shocks on the price level may be expected and hence, FTPL suggests the possibility that the primary surplus can be set independently from accumulated government debt. Hence, the price level will adjust to make government's intertemporal budget constraint to hold at any point of time. These two cases of fiscal authority behavior (namely, the traditional theory and FTPL) are dubbed "Ricardian" and "non-Ricardian" in Woodford (1995), or "passive" and "active" in the terminology of Leeper (1991) where the fiscal authority sets primary surpluses due to government debt in the passive ("Ricardian") fiscal policy and the active or "non-Ricardian" fiscal policy refers to the other case. It should be noted that intertemporal budget constraint may hold in equilibrium in both cases. Therefore, when monetary policy is active and fiscal policy is passive, fiscal policy shocks cannot affect the price level and the policy combination (active monetary and passive fiscal policy) is appropriate for inflation targeting.

In a sense, the behavior of fiscal authority is as important as the monetary authority in conducting desirable monetary policy rules, particularly, monetary policy rules that involve inflation targeting. Moreover, expansionary fiscal policy can affect monetary policy and lead to deviations from policy targets in the developed and developed countries. It is well known that several developed and developing countries have started to pursue inflation targeting policies at beginning of 1990's. For instance, monetary authorities in the Czech Republic and Poland have pursued inflation targeting regimes since 1998. Hungary and the Slovak Republic have started to conduct an inflation targeting regime as a monetary policy rule in 2001 and 2005, respectively (Roger, 2010).[1] At the end of 2011, deviations from inflation targets are observed in these countries except for the Slovak Republic and this lends support to the FPTL theory as expansionary fiscal policy makes it difficult to control of the price level.

Recent studies that focus on fiscal policy and monetary policy rules indicate that fiscal and monetary policy regimes are not fixed over time and hence fiscal and monetary rule equations should be estimated in a stochastic framework (Favero and Monacelli, 2005; Davig and Leeper, 2007 and 2011; Afonso et al., 2011; Doi et al., 2011; Thams, 2006; Dewatcher and Toffano; 2011; Ito et al., 2011). These studies employ a two-state Markov regime-switching model to examine active and passive fiscal and monetary regimes. Steuerle (2006) emphasized two political views that cause regime changes in fiscal policy (Davig and Leeper, 2007). The first one was named "bargain lunch" and implies that policy makers try to make tax cuts or expenditure increases appear to be costless. The latter is called "green eye-shade" in which policy makers are ever-wary of the balance-sheet requirements associated with fiscal choices and hence this view suggests taxes rise with increases in government debt. In addition, Davig and Leeper (2007) indicate that monetary and fiscal policy rules show dramatic changes between wartime and peacetime. Also, local and global financial crises may cause the change in fiscal and monetary policy rules.

The main objective of this paper is to contribute to the literature by examining the interactions between the fiscal and monetary policy rules for some former transition,

[1] Note that the Slovak Republic abandoned the inflation targeting regime at beginning of 2009 as the Slovak Republic adopted the Euro.

emerging European economies by using a Markov regime-switching model. We consider the monetary policy rule proposed by Taylor (1993) and the fiscal policy rule suggested by Davig and Leeper (2007) in accounting for monetary and fiscal policy interactions. To the best of our knowledge, this is the first investigation of the interactions between fiscal and monetary policy regimes for the Czech Republic, Estonia, Hungary, Poland, Slovenia and Slovak Republic. Our focus on former transition economies is motivated by several reasons. First, the Czech Republic, Hungary, Poland and Slovak Republic have pursued 'inflation targeting' as a monetary policy rule and hence it is important to understand interactions between fiscal and monetary policy regimes for these countries. Second, these countries are part of the European Union and those which are not part of the euro zone are aspiring to adopt the Euro. Hence understanding interactions between policy regimes are particularly important in the absence of monetary policy instruments which would disappear if those countries were to join the Euro zone. Finally, given the ongoing problems associated with the sovereign debt crisis in Europe, understanding the dynamics of fiscal and monetary policy would provide a framework for understanding the limits of such policies.

2. Econometric Methodology

In this study, we examine the presence of policy interactions between monetary and fiscal rules by means of a Markov regime-switching model. To that end, we consider the monetary policy rule proposed by Taylor (1993) and the fiscal policy rule suggested by Davig and Leeper (2007). Taylor (1993) proposed a reaction function for the Federal Reserve Bank of the U.S. (the Fed hereafter) for the 1987-1992 period as follows;

$$i_t^T = \overline{r} + \pi^* + \alpha_1(\pi_t - \pi^*) + \alpha_2 y_t \qquad (1)$$

where i_t^T is the desired interest rate, $\overline{r}$ is the the equilibrium real rate, π_t is inflation rate, π^* is target value of inflation and y_t is the output gap. Taylor considered the short term interest rate as the monetary policy instrument and hypothesized that the federal funds rate would increase if inflation rises above target or if output increases above its trend value. It should be noted that Taylor did not estimate Equation (1) econometrically but set α_1 and α_2 equal to 0.5. After the seminal work by Taylor (1993), central bank (CB) reaction functions have been widely examined across countries and over different time periods and coefficients for deviations of inflation from target and output gap are found to vary across countries and over time. One interpretation of the Taylor rule is that the weight on the inflation gap should exceed unity and the coefficient on the output gap should be positive to stabilize monetary policy. Moreover, when the estimated coefficient for the inflation gap is greater than unity, the CB pushes up the real rate in response to higher inflation and this is dubbed an active monetary policy. A positive coefficient on the output gap entails a lower interest rate in situations where output is below normal and thus has a stabilizing effect on the economy.

Since the central banks do not adjust short term interest rates to their desired level (due to interest rate smoothing), the presence of autocorrelation in interest rate may be expected. Therefore, the dynamics of adjustment of the actual level of the interest rate to the target interest rate is modeled as follows:

$$i_t = \left(1 - \sum_{i=1}^{n} \rho_i\right) i_t^T + \sum_{i=1}^{n} \rho_i i_{t-1} \quad \text{where } 0 < \sum_{i=1}^{n} \rho_i < 1 \qquad (2)$$

The lag length for the interest rate in Equation (2) is determined to render residuals white noise. If Equation (1) is substituted into Equation (2), the following policy rule model may be written:

$$i_t = \left(1 - \sum_{i=1}^{n} \rho_i\right) \left[\overline{r} + \pi^* + \alpha_1 \left(\pi_t - \pi^*\right) + \alpha_2 y_t\right] + \sum_{i=1}^{n} \rho_i i_{t-1} \qquad (3)$$

As in Assenmacher-Wesche (2006), we assume that the long-run real interest rate and the inflation target are embedded in the constant term such that $\alpha_0 = \overline{r} - \left(\beta - 1\right)\pi^*$ and hence Equation (3) can be written as follows:

$$i_t = \left(1 - \sum_{i=1}^{n} \rho_i\right) \left[\alpha_0 + \alpha_1 \pi_t + \alpha_2 y_t\right] + \sum_{i=1}^{n} \rho_i i_{t-1} + u_t \qquad (4)$$

Recently, Engel and West (2006) augmented the monetary policy rule by adding the behavior of the real exchange rate to the equation. They show that the augmented monetary policy rule model outperforms the conventional one particularly in open economies. This is particularly relevant for our sample countries as they heavily trade with the eurozone countries and they are small, open economies. Therefore, we consider following monetary policy rule:

$$i_t = \left(1 - \sum_{i=1}^{n} \rho_i\right) \left[\alpha_0 + \alpha_1 \pi_t + \alpha_2 y_t + \alpha_3 ex_t\right] + \sum_{i=1}^{n} \rho_i i_{t-1} + u_t \qquad (5)$$

A large body of literature shows that the monetary policy rule exhibits regime-switching properties (Altavilla and Landolfo, 2005; Clarida et al., 1999 and 2000; Kuzin, 2006;

Assenmacher-Wesche, 2006; Zheng et al., 2012). For instance, Muscatelli et al. (2002) confirmed the presence of structural breaks in estimated interest rate rules for a number of countries. Clarida et al. (2000) and Judd and Rudebusch (1998) showed that the Fed's reaction function depends on chairmen of the Fed and hence the weights for the inflation and output gap displayed changing properties. Neumann and von Hagen (2002) showed that the weights for inflation and the output gap have changed due to introduction of inflation targeting regimes in six countries that followed such policies. In addition, Demers and Rodriguez (2001), Kuzin (2006) and Assenmacher-Wesche (2006) found that a Markov regime-switching model outperforms a single regime in estimating monetary policy reaction functions. Based on this evidence, we employ the following model in estimating monetary policy rules in our sample countries:

$$i_t = \alpha_0(s_t) + \alpha_1\pi_t(s_t) + \alpha_2 y_t(s_t) + \alpha_3 ex_t(s_t) + \sum_{i=1}^{n}\rho_i i_{t-1} + u_t \qquad (6)$$

where i_t is the nominal interest rate, π_t is inflation rate, y_t is output gap, ex_t is the deviation of real exchange rate (vis-à-vis the US Dollar) from its trend and u_t is the innovation process. As in Doi et al. (2011) and Ostry et al. (2012), the trend real GDP and trend real exchange rate is calculated by using HP filter. We further assume that lags of the interest rate are time invariant[2]. In Equation (6), if the estimated coefficient on the inflation rate is greater than one it would suggest an active monetary policy regime ($\alpha_1 \geq 1$). On the other hand, the regime can be named a passive monetary policy regime in which the estimated coefficient for the inflation rate is less than one ($\alpha_1 < 1$).

Although there is no widely accepted model for fiscal policy rules, the specification proposed by Davig and Leeper (2007) has been widely utilized to characterize fiscal policy regimes in the literature. As such we employ the following fiscal policy rule suggested by Davig and Leeper (2007):

$$\tau_t = \gamma_0(s_t) + \gamma_1(s_t)b_{t-1} + \gamma_2(s_t)y_t + \gamma_3(s_t)g_t + \sum_{i=1}^{k}\rho_i\tau_{t-i} + \varepsilon_t \qquad (7)$$

where τ_t is the ratio of tax revenue to GDP, b_{t-1} is lagged debt to GDP ratio, y_t is output gap (output gap is calculated as deviation from real GDP by using Hodrick-Prescott filter), g_t is the government expenditures to GDP ratio and ε_t is the innovation process. We also include lags of the ratio of tax revenue to GDP in the fiscal policy rule in order to remove

[2] We also consider monetary policy rule model where interest rate lags are time-varying. Model selection criteria such as AIC and SBC suggest time invariant model for lags of interest rate.

autocorrelation from residuals. According to the terminology adopted by Leeper (1991), a "passive fiscal policy regime" requires that the estimated coefficient of lagged debt to GDP ratio to be positive and statistically significant ($\gamma_1 > 0$) so that an increase in the stock of public debt outstanding leads to a significant decrease in government deficits. Conversely, if $\gamma_1 \leq 0$, the state can be named an "active fiscal policy" regime where the policymaker does not feel constrained by the level of government debt.

The unobserved state variable in the monetary and fiscal policy rule model, s_t, evolves according to a first order Markov-switching process described in Hamilton (1994):

$$
\begin{aligned}
&P\left[s_t = 1 \middle| s_{t-1} = 1\right] = p_{11} \\
&P\left[s_t = 1 \middle| s_{t-1} = 2\right] = 1 - p_{11} \\
&P\left[s_t = 2 \middle| s_{t-1} = 2\right] = p_{22} \qquad (8) \\
&P\left[s_t = 1 \middle| s_{t-1} = 2\right] = 1 - p_{22} \\
&0 < p_{11} < 1 \quad 0 < p_{22} < 1
\end{aligned}
$$

where p_{ij} are the fixed transition probabilities of being in the first or second state, respectively. Note that the mean duration of staying in a regime can also be calculated as $d = 1/\left(1 - p_{ii}\right)$.

Davig and Leeper (2007 and 2011) proposed that the joint transition matrix for monetary and fiscal policy can be calculated as follows:

$$P = P^M \otimes P^F \qquad (9)$$

where, P^M and P^F indicate the transition matrix for monetary and fiscal policy, respectively and the joint transition matrix (P) gives us policy mix of monetary and fiscal policy rules as in the following table:

		MONETARY POLICY	
		Active	*Passive*
FISCAL POLICY	*Active*	Explosive	FTPL
	Passive	Ricardian	Indeterminacy

For instance, Davig and Leeper (2007 and 2011) proposed that an active monetary and passive fiscal regime combination is "Ricardian" while a passive monetary regime and an active fiscal regime can be called “Fiscal Theory”. If both monetary and fiscal policy regimes are active, the monetary and fiscal policy combination cannot be sustained and hence this policy mix is “explosive”. Finally, when both monetary and fiscal policies are passive, the policy mix is referred to as “indeterminacy.”

Equation (6) and Equation (7) can be estimated by using the maximum likelihood method based on the Expectation-Maximization (EM) algorithm discussed in Hamilton (1994) and Krolzig (1997). The EM algorithm is an iterative maximum likelihood estimation technique designed for a general class of models where the observed time series depends on some unobservable stochastic variables. Iterations in the EM algorithm consist of two steps: In the expectation step (E), the unobserved states (s_t) are estimated by using their smoothed probabilities. The conditional probabilities are calculated with the BHLK (Baum-Hamilton-Lee-Kim) filter and smoother by using estimated parameter vector ($\lambda^{(j-1)}$) of the last maximization step instead of the unknown true parameter vector (λ). In the maximization step (M), an estimate of λ is derived as a solution $\tilde{\lambda}$ of the first order conditions, where conditional regime probabilities are replaced with the smoothed probabilities of the last expectation step (Krolzig, 1997).

3. Data and Empirical Results

In this study, we examine the interactions between monetary and policy regimes and determine the policy mix regimes for the Czech Republic, Estonia, Hungary, Poland, Slovenia and Slovak Republic. The sample country selection is based on data availability. Quarterly data are used for monetary and fiscal variables over the 1995Q1-2010Q4 period. The sample period starts in 1995 to remove the impact of the early transition period during which there had been major fluctuations in data. Fiscal variables such as the ratio of tax revenue to GDP, debt to GDP ratio are obtained from the OECD database and variables that are related to monetary policy rule are collected from the IMF’s International Financial Statistics CD-ROOM, and Eurostats database. Due to data availability, the data set starts from 1995Q4 for Estonia, Hungary and Slovenia. Since the Slovak Republic and Slovenia adopted the Euro at the beginning of 2009 and 2007 respectively, we estimate the Taylor rule for these countries separately where the sample period ends at 2006Q4 for Slovenia and 2008Q4 for the Slovak Republic. In order to account for any seasonal effects, the data are seasonally adjusted using the Tramo/Seats method.

We start our analysis by first estimating a two-state Markov regime-switching model for the monetary policy rule to determine active and passive policy regimes. The lag lengths for the interest rate are chosen by the Akaike information criterion (AIC) considering up to four lags. The AIC selects one lag for the Czech Republic and Poland, two lags for Slovak Republic, three lags for Slovenia and four lags for Estonia and Hungary.[3]

Maximum likelihood estimates of the Markov regime-switching model for the monetary policy rule are reported in Table 1. The estimated coefficients for the Central Bank reaction functions are quite different across regimes and countries. Except for Slovenia and the Slovak Republic , the states can be classified as active and passive monetary regimes because the coefficient of the reaction of the interest rate to inflation exceeds one in the first regime. On the other hand, the estimated coefficient for the response of the interest rate to inflation is less than one; hence the second state can be characterized as a passive monetary regime. Notice that the reaction of the interest rate to inflation is less than one in both states for the Slovak Republic and Slovenia which suggests the lack of an active monetary policy rule in these countries[4]. In a sense this is not surprising since both countries entered ERM II as part of the accession to the euro zone (Slovenia on 28th of June 2004 and the Slovak Republic on 28th of November 2005) and implemented monetary policies consistent with the discipline that is a prerequisite of a fixed exchange rate regime. In the active monetary policy regime, the reaction of the interest rate to inflation range from 1.32 for Hungary to 3.24 for Estonia. However, except for Estonia, estimates of interest rate reactions to inflation are within the [1.3, 1.7] range for the active monetary policy regime in all countries.

In the passive monetary regime, the estimated coefficients for the interest rate response to inflation range from -5.24 for the Czech Republic to 0.87 for Poland. Specifically, the weight of inflation in the Central Bank reaction function is negative for all countries except for Poland. Note that Central Banks seem to have focused on the output gap instead of inflation in passive monetary regimes as the weights for the output gap are higher than that of inflation in all countries except for Poland. This phenomenon is noted by Owyang and Ramey (2004) who dubbed it a “dove regime” where output stabilization relative to inflation targets receives higher attention by the Central Bank[5].

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[3] Other criteria such as BIC fail to eliminate serial correlation in the residuals. Therefore, we use AIC for determining the lag length.

[4] We also estimated monetary policy reaction functions for Slovenia and the Slovak Republic over the entire sample period and found similar results.

[5] The Owyang and Ramey (2004) model has an inflation target that involves a trade-off between inflation and unemployment, captured by a preference parameter that follows an independent two-state Markov process

The transition probabilities for the monetary policy rule in Table 1 indicate that the active monetary policy regime is more persistent than the passive monetary policy regime in all countries except for Estonia. The probability of remaining in an active monetary policy regime at time t, when the series is also in an active monetary policy rule regime at time t-1 is above 90 percent for all countries except for Estonia. On the other hand, the probability of remaining in a passive monetary policy regime at time t when the series is also in a passive monetary policy rule regime at time t-1 is above 70 percent for all countries except for Slovenia and Hungary. Also, the mean duration of an active monetary policy regime varies between 4.67 (in Estonia) and 27.5 (in the Czech Republic) quarters. On the other hand, the passive monetary policy regime duration is generally longer than four quarters (except for Hungary where it is 2.25 quarters).

Table 1: Markov Regime Switching Model Results for the Monetary Policy Rule

	Czech Republic		**Estonia**		**Hungary**	
	Regime 1: Active Monetary Policy	**Regime 2: Passive Monetary Policy**	**Regime 1: Active Monetary Policy**	**Regime 2: Passive Monetary Policy**	**Regime 1: Active Monetary Policy**	**Regime 2: Passive Monetary Policy**
$\alpha_0\ (s_t)$	-0.029** (0.012)	0.783 (0.865)	-0.054 (0.072)	0.023*** (0.006)	-0.071* (0.042)	0.385*** (0.000)
$\alpha_1\ (s_t)$	1.767*** (0.457)	-5.239 (8.790)	3.243*** (1.171)	0.188*** (0.057)	1.318*** (0.447)	-0.533*** (0.008)
$\alpha_2\ (s_t)$	0.041 (0.036)	7.454 (5.441)	-0.400 (0.921)	0.336*** (0.048)	0.554*** (0.137)	0.470*** (0.001)
$\alpha_3\ (s_t)$	0.0057 (0.094)	-1.723 (5.129)	-0.002 (0.448)	-0.012 (0.028)	0.779*** (0.258)	-1.481*** (0.001)
$\sigma\ (s_t)$	0.003	0.053	0.021	0.002	0.006	0.000
ρ_1	0.930*** (0.024)		1.060*** (0.024)		1.224*** (0.000)	
ρ_2			-0.778*** (0.032)		-0.452*** (0.000)	
ρ_3			0.852*** (0.038)		0.588*** (0.000)	
ρ_4			-0.363*** (0.035)		-0.410 (0.000)	
p_{ij}	0.979	0.862	0.706	0.904	0.936	0.556
d	27.50	8.00	4.67	10.75	12.00	2.25
P-χ^2	14.809 [0.191]		9.252 [0.321]		12.590 [0.126]	
N-χ^2	6.171 [0.045]		0.214 [0.898]		0.519 [0.771]	
H-χ^2	6.424 [0.893]		13.188 [0.355]		9.781 [0.640]	
	Poland		**Slovak Republic**		**Slovenia**	
	Regime 1: Active Monetary Policy	**Regime 2: Passive Monetary Policy**	**Regime 1: Passive Monetary Policy**	**Regime 2: Passive Monetary Policy**	**Regime 1: Passive Monetary Policy**	**Regime 2: Passive Monetary Policy**
$\alpha_0\ (s_t)$	0.006 (0.009)	-0.048* (0.027)	0.008 (0.009)	0.361*** (0.062)	-0.101*** (0.002)	0.026 (0.018)
$\alpha_1\ (s_t)$	1.729*** (0.265)	0.870*** (0.131)	0.133*** (0.034)	-0.492 (0.134)	0.714*** (0.019)	0.076 (0.054)
$\alpha_2\ (s_t)$	0.115* (0.061)	-0.336*** (0.102)	0.004** (0.002)	0.014 (0.016)	0.121*** (0.002)	-0.009 (0.017)
$\alpha_3\ (s_t)$	0.140 (0.088)	-0.162 (0.146)	0.051*** (0.010)	-0.060 (0.121)	-0.288*** (0.005)	0.037* (0.020)
$\sigma\ (s_t)$	0.0057	0.0051	0.003	0.013	0.0003	0.006
ρ_1	0.831*** (0.024)		0.818*** (0.018)		0.806*** (0.027)	
ρ_2					-0.013 (0.034)	
ρ_3						
p_{ij}	0.942	0.765	0.946	0.788	0.500	0.911
d	16.33	4.67	13.00	4.67	2.25	8.50
P-χ^2	18.370 [0.073]		12.105 [0.335]		10.319 [0.413]	
N-χ^2	4.962 [0.083]		1.054 [0.590]		3.313 [0.190]	
H-χ^2	19.169 [0.084]		23.053 [0.027]		9.006 [0.702]	

Note: The figures in parentheses give the standard errors of coefficients. σ (s_t) gives the standard error of regression for the regimes. p_{ii} indicate regime transition probabilities. d is the mean duration of regimes. P-χ^2 indicates the Portmanteau serial correlation test, N-χ^2 indicates the normality test and H-χ^2 indicates the heteroskedasticity test of the residuals (for more details on these tests, see Krolzig (1997)). ***, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

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reflecting periodic shifts in the natural rate of unemployment.. In the “dove regime” the central bank accommodates increases in the natural rate, and a “ hawk regime” where there is less accommodation.

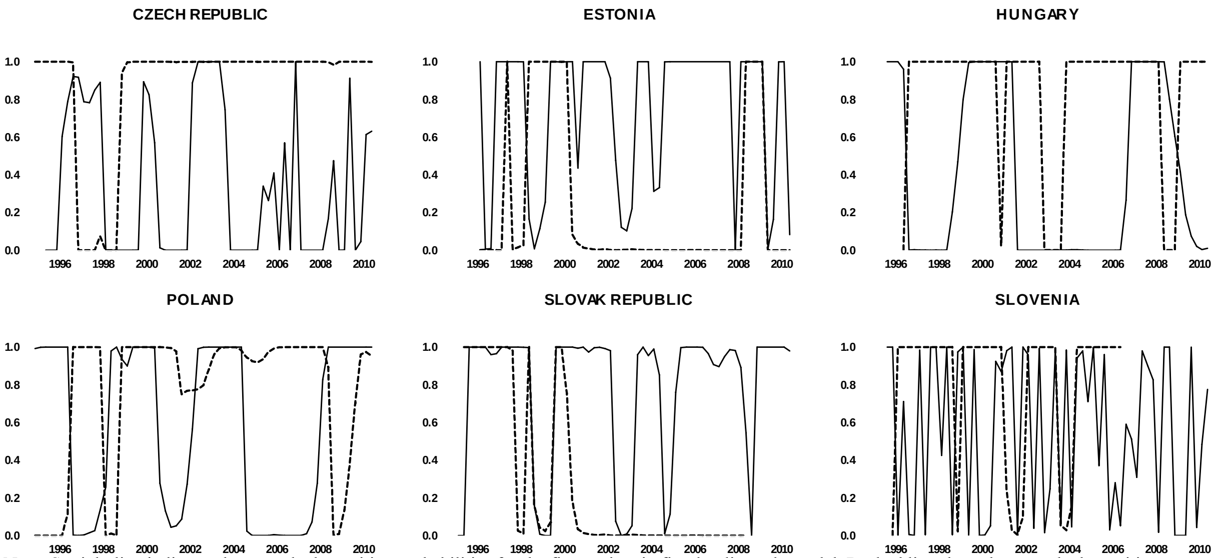
As a result, active monetary policy rule regime is more persistent than a passive monetary policy regime for the Czech Republic, Hungary and Poland. On the other hand, the passive monetary policy regime exhibits more persistence in Estonia. Our results also show that monetary policy has not been active in the Slovak Republic and Slovenia. This is not surprising since both countries went through ERM 2 in anticipation of the accession to the Euro zone and had to pursue policies consistent with convergence criteria. Finally, residual diagnostics such as normality, serial correlation and heteroskedasticity of the Markov regime switching model are also reported in Table 1. These tests indicate that the Markov regime switching model passes all diagnostic tests.

Maximum likelihood estimates for the fiscal policy rule model are presented in Table 2. We assume that fiscal policy follows two regimes as in monetary policy and the states can be characterized as active and passive fiscal policy regimes consistent with the Leeper terminology. Empirical results in Table 2 confirm the presence of two regimes in fiscal policy for all countries except for the Czech and Slovak Republics. While the estimated coefficient of the lagged debt to GDP ratio is negative or statistically insignificant in the first state (this result implies an active fiscal policy regime), the estimated coefficient of lagged debt to GDP ratio is positive and statistically significant in the second state (and hence the second state is a passive fiscal policy regime) for all countries except for the Czech and Slovak Republics.

The estimated coefficients for the government expenditure to GDP ratio are positive and statistically significant in the active fiscal regime for Estonia and Poland. These results imply that an increase in government expenditure to GDP ratio raises tax revenue in the active fiscal regime. On the other hand, the estimated coefficient for the government expenditure to GDP ratio is negative and statistically significant in the active fiscal regime for Slovenia. Furthermore, we find a negative and statistically significant relationship between government expenditure-GDP ratio and tax revenue-GDP ratio in the passive fiscal regime for all countries except for the Czech Republic and Slovenia. Note that although the estimated coefficients of the government expenditure -GDP ratio are negative, they are not statistically significant for the Czech Republic and Slovenia.

We present smoothed transition probabilities for the first regime obtained from the monetary and fiscal policy rule models (equations 6 and 7 above) in Figure 1. The smoothed transition probabilities in Figure 1 present a clear picture regarding the timing of regime switches of monetary and fiscal policies in each country.

Figure 1: The Smoothed Transition Probabilities for the First Regime



Note: Straight line indicates the smoothed transition probabilities for the first regime in fiscal policy rule model, Dashed line show the smoothed transition probabilities for the first regime in monetary policy rule model.

As Leeper (1991) emphasized, monetary and fiscal policy must be consistent to sustain the policy rule; as such, regime switches between fiscal and monetary rule should be synchronized. Note that fiscal policy in general in the Czech Republic is consistent with monetary policy results. Even though we find both active and passive monetary policy in the Czech Republic, passive monetary regime seems to be short lived (about two years) and it is confined to a single period (1997-1999). Hence one can deduce that active monetary policy over the sample except for 1997-1999 is likely to have required fiscal policy to be passive in both regimes. Moreover, in both states fiscal policy seems to be active in the Slovak Republic and this is supported by a passive monetary policy in both states.

The estimated transition probabilities in Table 2 show that the active fiscal policy regime is more persistent than the passive fiscal policy regime for Estonia, Poland and Slovenia. On the other hand, the passive fiscal policy regime is more persistent for Hungary. The mean duration of an active fiscal policy regime varies between 1.74 (in Slovenia) and 9.80 (in the Slovak Republic) quarters. Also, the passive fiscal policy regime duration varies between 1.50 and 12.33 quarters. Note that an active fiscal policy where tax revenues fall in response to increases in government debt is not necessarily unsustainable since the intertemporal budget constraint can still hold if the monetary authority “acts passively.” A monetary authority acting passively will allow the price level to adjust appropriately so as to equate the value of outstanding government debt to the discounted present value of future expected primary surpluses (and this is consistent with the fiscal theory of the price level).

Debt sustainability hence requires looking at the interactions of monetary and fiscal policy and discerning policy mixes that allow for such revenue and/or price adjustments.

Table 2: Markov Regime Switching Model Results for the Fiscal Policy Rule

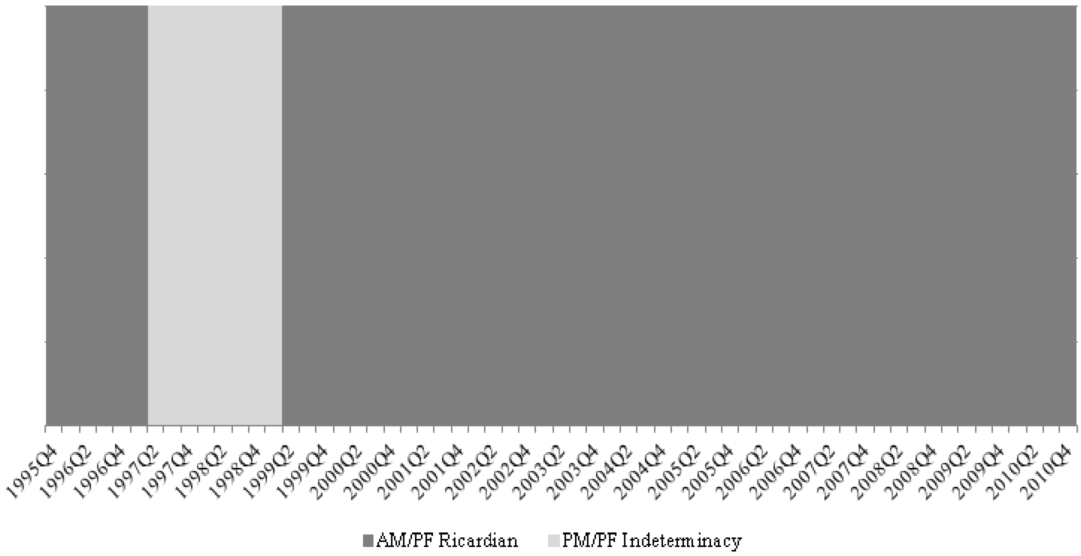
	Czech Republic		Estonia		Hungary	
	Regime 1: Passive Fiscal Policy	**Regime 2: Passive Fiscal Policy**	**Regime 1: Active Fiscal Policy**	**Regime 2: Passive Fiscal Policy**	**Regime 1: Active Fiscal Policy**	**Regime 2: Passive Fiscal Policy**
$\gamma_0 (s_t)$	-0.122 (0.011)	0.155*** (0.018)	0.019** (0.008)	0.054*** (0.004)	0.128* (0.073)	0.092* (0.047)
$\gamma_1 (s_t)$	0.033*** (0.004)	0.023** (0.008)	-0.093 (0.058)	0.769*** (0.028)	0.045 (0.036)	0.086*** (0.015)
$\gamma_2 (s_t)$	0.394*** (0.024)	0.009 (0.036)	0.161*** (0.021)	-0.076*** (0.008)	0.355** (0.167)	0.339*** (0.075)
$\gamma_3 (s_t)$	0.054*** (0.002)	-0.003 (0.003)	0.003** (0.001)	-0.002*** (0.000)	0.002 (0.006)	-0.031*** (0.008)
σ	0.001	0.003	0.003	0.0004	0.004	0.004
ρ_1	0.484*** (0.071)		1.372*** (0.060)		0.261*** (0.088)	
ρ_2	0.183** (0.083)		-0.386*** (0.115)			
ρ_3	-0.090 (0.062)		-0.183** (0.068)			
p_{ij}	0.504	0.799	0.830	0.503	0.872	0.941
d	3.29	5.43	5.13	2.13	7.67	12.33
P-χ^2	10.530 [0.309]		15.745 [0.072]		16.289 [0.130]	
N-χ^2	0.832 [0.659]		0.118 [0.738]		1.028 [0.597]	
H-χ^2	15.512 [0.214]		5.441 [0.065]		13.695 [0.320]	
	Poland		**Slovak Republic**		**Slovenia**	
	Regime 1: Active Fiscal Policy	**Regime 2: Passive Fiscal Policy**	**Regime 1: Active Fiscal Policy**	**Regime 2: Active Fiscal Policy**	**Regime 1: Active Fiscal Policy**	**Regime 2: Passive Fiscal Policy**
$\gamma_0 (s_t)$	-0.039** (0.018)	0.125*** (0.012)	0.014 (0.012)	0.016*** (0.004)	0.090*** (0.023)	0.109*** (0.025)
$\gamma_1 (s_t)$	-0.081*** (0.026)	0.040*** (0.012)	-0.034*** (0.010)	-0.003 (0.006)	0.002 (0.009)	0.047*** (0.011)
$\gamma_2 (s_t)$	0.463*** (0.062)	-0.023 (0.050)	0.090*** (0.028)	0.038** (0.017)	-0.081*** (0.024)	0.005 (0.028)
$\gamma_3 (s_t)$	0.023** (0.010)	-0.006** (0.003)	-0.010** (0.005)	0.005*** (0.001)	-0.003** (0.001)	-0.002 (0.002)
σ	0.062	0.001	0.003	0.003		
ρ_1	0.667*** (0.043)		0.584*** (0.053)		0.707*** (0.049)	
ρ_2			0.318*** (0.047)			
p_{ij}	0.912	0.879	0.906	0.619	0.461	0.358
d	9.00	9.00	9.80	2.60	1.74	1.50
P-χ^2	11.695 [0.387]		9.180 [0.515]		11.126 [0.432]	
N-χ^2	10.001 [0.006]		1.827 [0.401]		9.954 [0.006]	
H-χ^2	0.013 [0.908]		0.066 [0.515]		0.723 [0.399]	

Note: The figures in parentheses give the standard errors of coefficients. σ (s_t) gives the standard error of regression for the regimes. p_{ii} indicate regime transition probabilities. d is the mean duration of regimes. P-χ^2 indicates the Portmanteau serial correlation test, N-χ^2 indicates the normality test and H-χ^2 indicates the heteroskedasticity test of the residuals (for more details on these tests, see Krolzig (1997)). ***, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

To investigate the policy mix and monetary fiscal policy interactions, we calculate the joint transition matrix in Equation (9) and the results on the timing of joint monetary-fiscal regimes are illustrated in Figures 2-7.[6] The results in Figure 2 show that monetary policy was active during the sample period except for 1997-99. The Czech Republic experienced a major economic crisis in 1997 and the Russian crisis in 1998 affected many economies. It seems both monetary and fiscal policies were passive during those periods in the Czech Republic. From a monetary policy standpoint, in crisis periods central bankers are less concerned with price stability and are likely to follow expansionary policy to ease the constrains on aggregate demand. Also empirical results for the Czech Republic imply consistent monetary and fiscal policy regimes.

[6] We consider 50 percent as the threshold level for the smoothed transition probabilities to determine active and passive policy regimes in Figure 2-7.

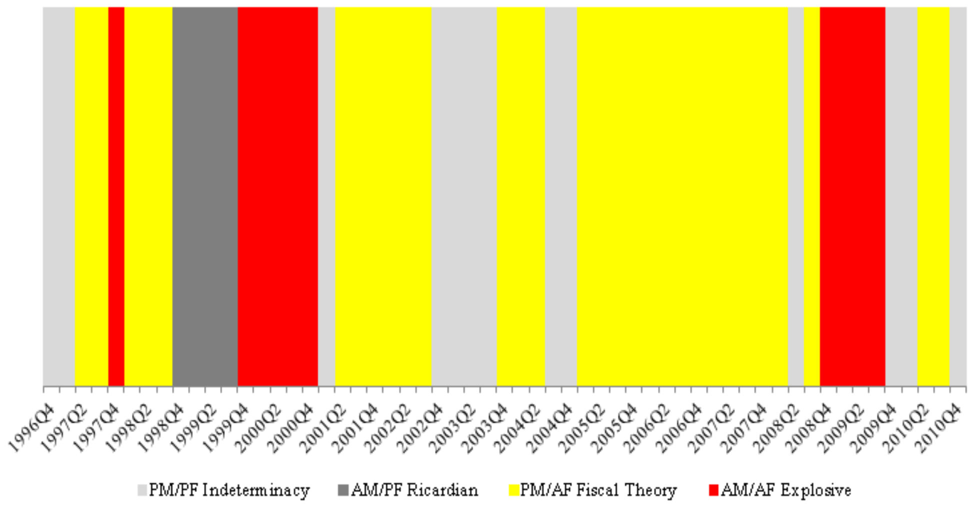
Figure 2: Estimated Monetary and Fiscal Regimes for the Czech Republic



Note: AM indicates active monetary regime, PM indicates passive monetary regime, AF indicates active fiscal regime and PF indicates passive fiscal regime.

The policy mix for Estonia in Figure 3 shows that fiscal policy was generally active over the sample period. Although monetary and fiscal policies were passive on the eve of transition, fiscal policy turned active in 1997-98. Then, policy mix turned to active monetary and passive fiscal policy but after a year (1998-99), fiscal policy turned to an active policy. There seems to be three periods where the policy mix is explosive using the Leeper terminology and these periods correlated with the crises in the Czech Republic and Russia and the global financial crisis. Empirical results in Figure 3 suggest that regime switches in monetary and fiscal policy were not well coordinated in Estonia over the sample period.

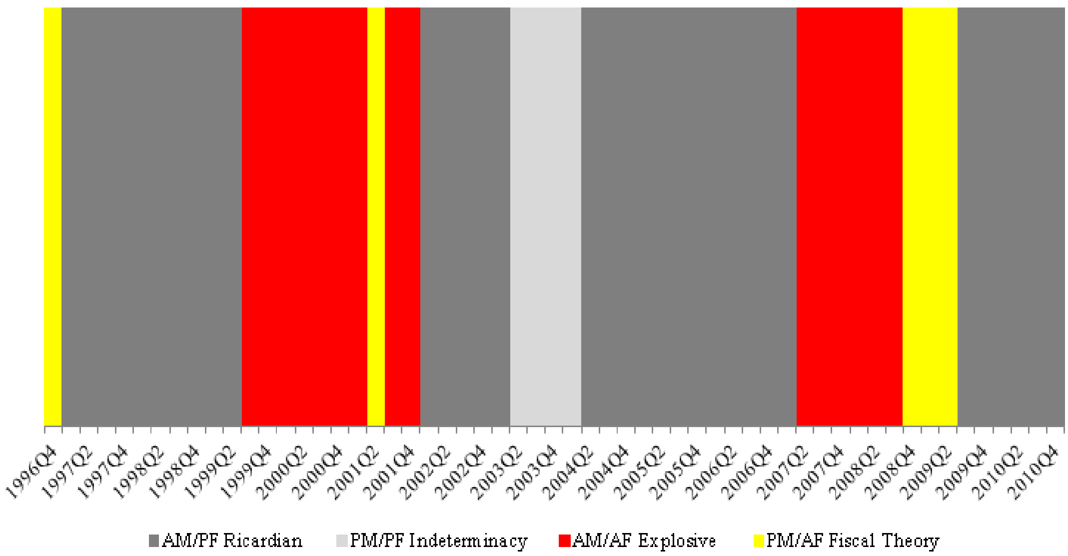
Figure 3: Estimated Monetary and Fiscal Regimes for Estonia



Note: AM indicates active monetary regime, PM indicates passive monetary regime, AF indicates active fiscal regime and PF indicates passive fiscal regime.

The policy mix seems to have alternated between four possible policy specifications in Hungary as can be seen in Figure 4. For instance, the policy rule was passive monetary and active fiscal regime in the late 1996, after which the policy mix turned to Ricardian until the middle of 1999. Thereafter fiscal policy switched to an active one in Hungary and the policy mix turned to "explosive". In the 2002-2007 period, fiscal policy turned to passive indicating a Ricardian stance except for 2003. In 2007-2009, policy mix was explosive in Hungary due to the global financial crisis. However, monetary policy has turned active and fiscal policy has switched to a passive stance in the middle of 2009 and hence policy mix can be characterized as Ricardian in Hungary recently.

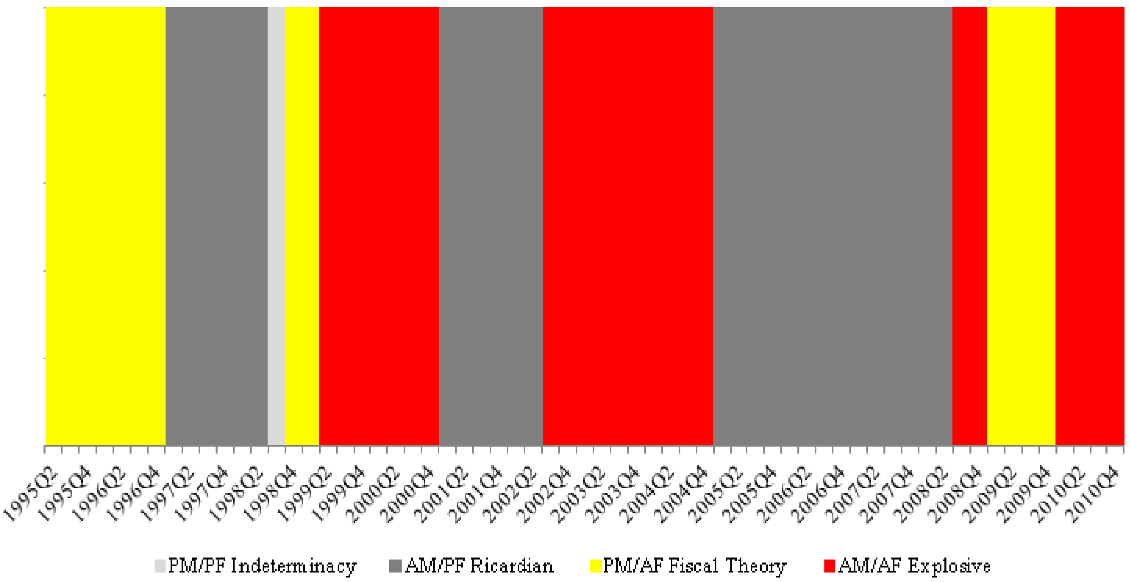
Figure 4: Estimated Monetary and Fiscal Regimes for Hungary



Note: AM indicates active monetary regime, PM indicates passive monetary regime, AF indicates active fiscal regime and PF indicates passive fiscal regime.

The results in Figure 5 show that monetary and fiscal policies were not perfectly consistent with debt sustainability over the sample period in Poland. At the beginning of the sample period, a passive monetary and active fiscal policy regime was pursued in Poland. Then, monetary policy switched to active and fiscal policy turned passive and hence the policy mix can be characterized as Ricardian during 1997. Note that there were three periods where the policy mix was explosive in Poland and even though these periods were related to the Russian crisis and the global financial crisis respectively, they cast a doubt on the sustainability of public debt.

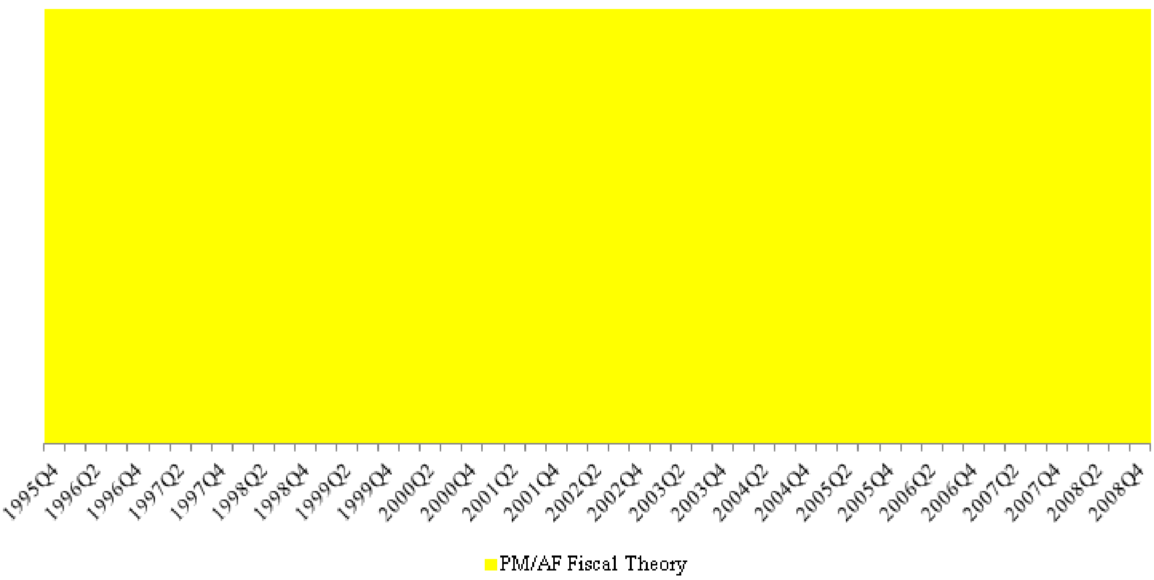
Figure 5: Estimated Monetary and Fiscal Regimes for Poland



Note: AM indicates active monetary regime, PM indicates passive monetary regime, AF indicates active fiscal regime and PF indicates passive fiscal regime.

Since our results indicated a single regime in monetary policy and a single regime in fiscal policy (passive monetary policy and an active fiscal regime), the policy mix is consistent with the Fiscal Theory in the Slovak Republic. With this policy mix the intertemporal budget constraint holds and debt is sustainable; however, the price level is adjusting so as to satisfy the intertemporal budget constraint.

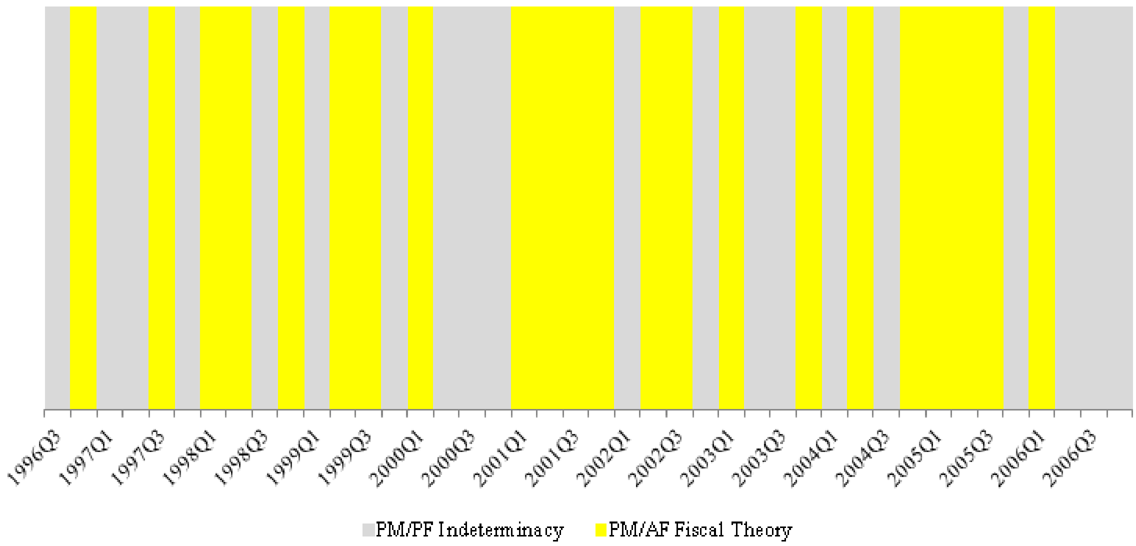
Figure 6: Estimated Monetary and Fiscal Regimes for the Slovak Republic



Note: AM indicates active monetary regime, PM indicates passive monetary regime, AF indicates active fiscal regime and PF indicates passive fiscal regime.

Finally, since monetary policy was passive in the entire sample in Slovenia, the policy mix is determined by fiscal policy in Slovenia. The results in Figure 7 show that policy mix switched between fiscal theory and indeterminacy over the sample period in Slovenia.

Figure 7: Estimated Monetary and Fiscal Regimes for Slovenia



Note: AM indicates active monetary regime, PM indicates passive monetary regime, AF indicates active fiscal regime and PF indicates passive fiscal regime.

Conclusions

In this paper, we examine the interactions between fiscal and monetary policy rules for some former transition, emerging European economies by using a Markov regime-switching model. As the basis for monetary policy, we estimate a variant of the monetary policy rule proposed by Taylor (1993). For the fiscal policy rule, and in order to account for monetary and fiscal policy interactions we use the framework proposed by Davig and Leeper (2007). Our sample consists of the Czech Republic, Estonia, Hungary, Poland, Slovenia and the Slovak Republic in the post-transition period and is determined by the data availability.

Empirical results suggest that the Czech Republic, Estonia, Hungary, Poland followed both active and passive monetary policies whereas Slovenia and the Slovak Republic followed passive monetary rules. Also active monetary policy regimes seem more persistent and have higher duration than passive monetary regimes for all countries except for Estonia. It seems all countries except Poland pursued "dove regimes" per Owyang and Ramey (2004) terminology where output stabilization took priority over inflation targets. As for fiscal policy, Estonia, Hungary, Poland, and Slovenia seem to have alternated between active and passive fiscal regimes while the Czech and Slovak fiscal policies can be characterized by a single fiscal regime; the Czech Republic pursuing passive fiscal policy and the Slovak Republic following an active fiscal policy. Moreover, active fiscal policy is more persistent in Estonia, Poland and Slovenia than the other countries. The global financial crisis seems to have turned the fiscal policy rule to an active regime in all countries except for the Czech Republic.

The policy mix and the interactions between monetary and fiscal policy point a diverse picture in our sample countries. These findings are consistent with work on other European countries. For instance, Thams (2006) finds the presence of an unsustainable policy combination for Spain. In addition, Semmler and Zang (2004) show that interactions between monetary and fiscal policies are not strong for Germany and France. They also indicate that the two policies have not been accommodative but counteractive to each other. Our results show that Estonia, Hungary and Poland followed monetary and fiscal policy combinations that were not sustainable. These countries had major episodes where fiscal and monetary policies were active pointing to serious problems with respect to debt sustainability. Overall these countries (Estonia, Hungary and Poland) would face serious constraints if they were to join the euro zone.

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