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Sectoral Business Cycle Asymmetries and Regime Shifts: Evidence from Turkey

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Abstract

The aim of this paper is to fit Markov regime switching behavior models to the sectoral GDP growth rates in Turkey for the period 1998: Q1 to 2019: Q2. The findings support the existence of two regimes as low-growth and high-growth for all three sectors. The mean growth rate of the total GDP is closer to the mean growth rate of the industry sector than to the mean growth rate of the agricultural and services sectors. Moreover, the regime volatilities are higher in the low-growth regime for the industry and services sectors and vice versa for the agricultural sector and the total GDP. The results also show that the high-growth regime periods are longer than the low-growth regime periods. Finally, it is observed that there are more frequent fluctuations in the agricultural sector than the other sectors' cycles based on the smoothed probabilities for low-growth regime. Moreover, since 2016 till now, the services sector's regime switching behavior is associated with the low-growth regimes of GDP, which indicates that Turkey's largely free-market economy is driven by the services sector. The findings also show that Markov switching model used in this study provides an advantage to model the nonlinearities in GDP fluctuations which assume different behaviors in different regime periods.

Keywords: business cycle, growth, Markov regime switching model

JEL Classification: E32, C13, C22, C40

1. Introduction

It is crucially important to investigate the properties of business dynamics in an economy both theoretically and empirically. The knowledge of the patterns and determinants of such business cycles is essential for policymakers. This cyclical asymmetry refers to the movements from the bottom of the previous business cycle to the peak of the current cycle (expansion) or vice versa (recession). Generally, expansion phases of a business cycle tend to be longer than recession phases due to general occurrence of upward long-term trend in GDP growth series but either phase must be persistent and pervasive enough to allow for recurrent and not periodic cycles (Zarnowitz & Ozyildirim, 2006). To capture these deviations, regime switching models have become a significant area of research within modeling shifts in GDP growth, inflation and interest rates. The goal of regime switching models is to capture the asymmetry during the "ups and downs" in an economic activity. Theoretically, as Hamilton pointed out, "departures from linearity are an important feature of many key macroeconomic series"; that is growth rate dynamics might be regime dependent (Hamilton, 1989, p. 358). His approach is to use the Goldfeld and Quandt (1973) switching model in which parameters switch between regimes. In this sense, fluctuations corresponding to business cycles can be explained by an autoregressive process depend upon unobservable economic regimes. Regime switching is a time series model in which parameters are allowed switching in the parameters for any number of explanatory variables as a powerful dynamic regression analysis for applied studies. The switching regimes were obtained by allowing a given variable to follow a different time series process over time and switch between regimes.

Even though different classifications exist, the three sectors constituting an economy are agricultural, industry and services sectors. However, what question should be asked is that whether the sectors of an economy go up and down together or not. This work aims to explain business cycles under sectoral diversification by detecting which sector in Turkish economy is contracting or expanding more, or which sector is leading or lagging the whole economic activity. Therefore, this study aims to investigate the dynamics of the cyclical fluctuations by diversifying of the real GDP per capita to three main sectors – agricultural, industry and services. Drawing upon macroeconomic models in the presence of asymmetry, nonlinear regression models are used routinely in a wide range of finance and economics for forecasting and policy analysis. In this sense, two regimes are auumed with different average growth rates, expansion and contradiction. The parameters are estimated using the regime switching model to determine a set of probabilities to indicate the likelihood of the regime changes and switching points for the real sectoral gross domestic product (GDP) growth series in Turkish economy.

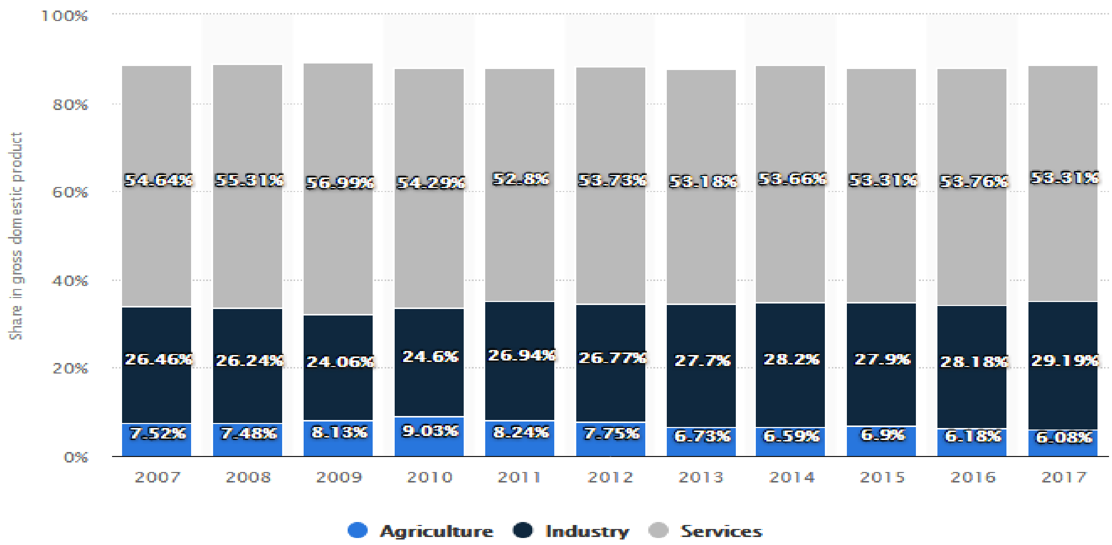

Figure 1. Shares of economic sectors in GDP

Source: World Bank (2018)

Turkey, a dynamic and emerging economy in the world, has the opportunity to capitalize on a growing, skilled labor force to sustain long-term economic growth since 2000 and made great economic strides in recent years. Turkey was contracted by 9.5% in 2001; the wholesale price index rose by 88.6% and the consumer price index rose by 68.5%. The reason for the contraction is the November 2000 and February 2001 crises. The Central

Bank has gained its independence in 2001. As a result of the implementation of new macroeconomic policies and structural reforms, the economy entered a recovery process; inflation was 30.8% and growth was 7.8%. While the growth rates for the years 2007, 2008, 2009 and 2010 were 4.7, 0.7, -4.8, 8.9%, the inflation rates were 5.94, 8.11, 5.93, 8.87%. Turkey was one of the fastest growing emerging economies in 2017. The main drivers of this growth were government expenditures and credit growth. The financial fluctuation experienced in the third quarter of 2018 caused the exchange rates to increase very rapidly and the decrease in the purchasing power of TRY. Besides, higher interest rates increase the cost of borrowing and caused the domestic demand to be suppressed. In addition to the contraction in domestic demand, the increase in interest rates slowed down the credit cycle, which led to a significant contraction in the domestic market in general, mainly in sectors experiencing higher currency and interest sensitivity. Shortly, as Binici et al. (2016) showed, the contraction periods experienced in Turkish business cycles usually end with entering the growth phase; the stress periods experienced in the credit markets in 1994, 2001 and 2009 generally disappeared at the end of the third quarter, by entering the growth phase.

Sectors such as financial services, real estate and construction have the potential to drive this growth and have shown strong growth with an average annual real GDP growth rate of more than 6 %. Figure 1 presents the shares of agricultural, industry and services sectors in gross domestic product (GDP) in Turkey between 2007 and 2017. The composition of general export and agricultural sector has made an important contribution to the Turkish economy in terms of employment (Demirbas, 2007). A significant slowdown has occurred in agricultural sector’s share in GDP since 2007 can be seen, while services and industry sectors have made a significant contribution. Having the largest share in GDP, services sector’s contribution to economic growth does not show significant change. Overall, the data indicate how the agricultural sector becomes the third engine of growth behind the services and industrial sector in Turkey, whereas the services sector has been the most important sector since 2007. In order to explain these cyclical variations in sectoral GDP, section 2 presents a review of the literature. Section 3 introduces the econometric model and methodology and section 4 presents the data and the results of the study. Finally, section 5 is the conclusion.

2. Literature review

Goldfeld and Quandt (1973) introduced a useful version of the models, in which regression models with Markov switching are developed to capture discrete changes in economic system. Another modification of the regression models with Markov switching developed by Lee and Porter (1984), Cosslett and Lee (1985), Hamilton (1989), Cai (1994), Hamilton and Susmel (1994), Engel and Hakkio (1993), Bekaert and Hodrick (2001), Edwards and Susmel (2003), Moolman (2004), Brunetti et al. (2007), Moore and Wang (2007), Chen et al. (2012) and Reyes-Heroles and Tenorio (2017). The paper by Lee and Porter (1984) extended the model by a transition matrix with two states and finally, Cosslett and Lee (1985) developed the model to the case of serially correlated errors. Hamilton (1989), Cai (1994), Hamilton and Susmel (1994) take the US short-term interest rates while investigating regime shifts using Markov regime-switching model. Edwards and Susmel (2003) examined stock market volatility for a group of Latin American countries by applying a bivariate SWARCH model. Their results show that high volatility regimes tend to be related to international crises. Layton and Katsuura (2001) compared Markov regime model with probit and logit models to determine probabilities in the US business cycles. Their findings show that Markov model with duration dependent transition probabilities provides better estimates than probit and logit model. Dahlquist and Gray (2000) and Ang and Bekaert (2002) found that short-term interest rates are well deserved by regime switching models. Several papers, such as Engel and Hakkio (1993) and Bekaert and Hodrick (2001) also showed that foreign exchange rates are subjected to regime switches. Altug and Bildirici (2010) compare business cycle turning points and estimate economic regimes for 27 developed and developing economies using a univariate Markov regime switching approach. Their results prove that the cyclical fluctuations in both developed and developing countries are driven by a world factor.

Sectoral economy related to business cycles and GDP growth can be analyzed separately. In fact, although the literature is much thinner on the analysis of sectoral business cycle fluctuations, the studies about the role of sectors and subsectors in business cycle dynamics have mostly based sectoral cycle synchronization and volatility. Phelan and Trejos (2000) explore the link between intersectoral or spatial allocative shocks and business cycles. Craigwell and Maurin (2007) examined the link aggregate output cycle and cycles of the individual sectors and showed that the sources of the fluctuation of the Barbadian economic cycles have been coming from the sectoral fluctuations. Wang (2008) studied the output of UK GDP sectoral business cycle patterns and examined cyclical similarities and differences throughout the GDP's overall business cycle dynamics. Afonso and Furceri (2009) shows that the services sector has lowest business cycle synchronization and volatility relative to industry, building and construction, and agricultural, fishery and forestry sectors in EU economies. Limited evidence supporting the systematic performance of sectors across the business cycle is found by Jacobsen et al. (2009). Devereux and Hnatkovska (2011) studied the sectoral shares at business cycle frequencies in OECD countries and find that the nontraded sector is volatile and countercyclical. Asymmetries in different phases of business cycles have recently been emphasized by Tase (2016); the correlation between sectoral dynamics and GDP growth is found higher since the 1990s. Finally, a more recent study by Matthes and Schwartzman (2019) developed a "Hierarchical Vector Auto-Regressive model" to identify the origins of business cycles in the U.S. and determine the impact of structural shocks across sectors. The major contribution of this study is that they have proved that U.S. business cycles thus have their origins more in demand fluctuations rather than supply shocks.

Acikgoz (2008) examined the empirical evidence regarding the existence of the time series behavior of the annual growth rate of Turkey's GDP and growth rate of its industrial sector GDP's for the period 1924-2005. She finds the periods 1932 and 1980, as the turning points of the Turkish economy, although these years do not represent any regime change during the growth process. Tastan and Yildirim (2008) evaluate business cycle dynamics of the Turkish economy for the post-1980 period using a Markov-switching Autoregressive (MSAR) model. They find evidence as four recessionary and five expansionary phases in the post-1980 period. Dogan and Bilgili (2014) empirically investigated the relationship between growth and external borrowing using multivariate dynamic Markov-switching model for the period 1974-2009. They found that external borrowing has a negative impact on growth both in regime at zero and regime at one.

The aim of this paper is to develop and estimate Markov regime switching model for business cycles in Turkey by decomposing sectoral growth rates into three components. To my knowledge, the Markov autoregressive process has not been applied before to identify and compare the regime changes in growth and volatility of GDP growth and its sectoral diversification for Turkey.

3. Methodology

MS-AR are non-linear models allowing one state to represent expansionary (or high growth) and the other represents recessionary (or low growth) regimes and assuming that the regime shifts evolve according to a Markov chain, as proposed by the seminal paper by Hamilton (1989). This condition is called the Markov property. The first application of this model is done by Hamilton (1989) to determine dating U.S. business cycle turning points. Hamilton’s another extension was proposed by Durland and McCurdy (1994), which allows regime shifts to be duration dependent. The model used in this study could be performed by employing other regime switching models such as endogenous threshold models, structural break models and time-varying parameter models (Jochmann & Koop, 2014). Although regime switching models are designed to capture dynamic instability in the economic mechanism assuming that a stochastic Markov chain that drives finite number of regime changes, the structural break models can capture dynamic instability by assuming shifts in parameters at a specific breakpoint with an infinite number of regimes (Koop and Potter, 2007). Nevertheless, as Song (2014) noted, since the parameters in each regime are estimated separately and regimes do not recur, they may incur loss in the estimation precision.

In this study, the real sectoral GDP is employed as the reference series for the Turkish economy. The objective of the regime switching model is to provide probabilities of the transitional phase from one regime to another. The shifts in mean growth rates are identified by fitting Markov switching model for total GDP and three main production sectors that make up total GDP. To examine the regime shifting behavior of macroeconomic and financial time series, a two-state Markov switching model, called MS(q)-AR(p) can be used to compute ML estimates of univariate and multivariate models[1]. In these models, where the finite number is assumed, the parameters are allowed to take different values at a certain time. The model, switches between the different states or regimes that cannot actually be observed but is determined by an underlying stochastic process, is discrete-valued following transition probabilities. In this study, a univariate two-state mean Markov-switching model of autoregressive order is considered. If taking into account a mean regime switching and leting Y_t represents the growth rates of GDP or one of its main sectors and S_t be the unobserved discrete variable that represents the state or regime the economy is in, the two state autoregressive model of order p for the variable can be expressed as (Clements & Krolzig, 2003):

$$Y_t = \mu_{s_t} + \sum_{k=1}^{p} \phi_k \left(Y_{t-k} - \mu_{s_{t-k}} \right) + \varepsilon_t \qquad t = 1, \ldots, T \tag{1}$$

$$\varepsilon_t | s_t \sim NID(0, \sigma_t^2) \text{ with } \sigma_t^2 = \sigma_1^2 (1\text{-S}_t) + \sigma_2^2 S_t \text{ and } \text{s}_t = 1{,}2$$

$$\mu_{st} = \begin{cases} \mu_1 \text{ if } \text{S}_t = 1 \text{ (low-growth regime)} \\ \mu_2 \text{ if } \text{S}_t = 2 \text{ (high-growth regime)} \end{cases}$$

where μ_{st} , is the estimated regime dependent intercept, p is the order of autoregressive coefficients, σ_{s_t} is the standard deviation, ϕ_{s_t} shows the autoregressive coefficients and ε_t are the residuals characterized as a random variable of zero-mean and constant variance. Equation 1 demonstrates the changes between Markov switching regimes occurred in the mean and variance.

The effect of the regime s_t on the variable Y_t is given by the conditional probability density function. Since Markov-switching models assume that s_t is unobserved random variable and follow a particular stochastic process, the switching of regimes follows a first-order Markov chain, under the assumption that p_{ij} is the probability of being in regime *j* in

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[1] "q" denotes number of regimes and p represents the autoregressive models of order $p \in \{1, 2\}$. For more details, please see (Krolzig, 1997).

period *t*, if regime *i* occurs in period *t-1*. Therefore, if assuming that the s_t is a random variable which only can be 1 or 2, the regime S_t=1 is identified as recession or low growth phase and the regime S_t=2 is expansion or high-growth phase. The change from S_t=1 to S_t=2 can be expressed as follows:

$$P(S_t = j \,|\, S_{t-1} = i, S_{t-2} = q, ..., \mathrm{ir}_{t-1}, \mathrm{ir}_{t-2}, ...) = P(S_t = j \,|\, S_{t-1} = i,) = p_{ij}$$ which satisfy $$\sum_{j=1}^{2} p_{ij} = 1$$

This probability is called the smoothed probability and can also be calculated for both states. If the probability for S_t depends only S_{t-1}, the transition probability matrix measures the persistence in the regime and can be defined as follows:

$$P = \begin{pmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{pmatrix}$$

Under this specification, following Edwards and Susmel (2003), It can be assumed as if the economy was in a high-growth regime last period (s_t = 2), the probability of changing to the low-growth regime (s_t = 1) is a fixed constant P_{21}.

4. Data and Empirical Results

Since Markov regime switching approach provides a comprehensive analysis regarding asymmetric behaviors of historical time series, this study was carried out based on MS-AR model to detect and examine the sectoral business cycle asymmetries in Turkey. Accordingly, this study uses the first difference of the log transformed chained volume series (percent change from the previous quarter) for the total GDP, the agricultural and industry sectors' nominal GDP growth rates as a proxy of sectoral growth rates for the period 1998:Q1 to 2019:Q2. Due to lack of data, the services sector's growth rate covers the period from 1999:Q1 to 2019:Q2. The data related to these variables were obtained from OECD World Development Indicators. Figure 2 shows the sectoral and the total GDP time series dynamics in Turkey. The Markov regime switching model assumes that all-time series variable in the model should be stationary. In this study, all the data are stationary or do not contain a unit-root.

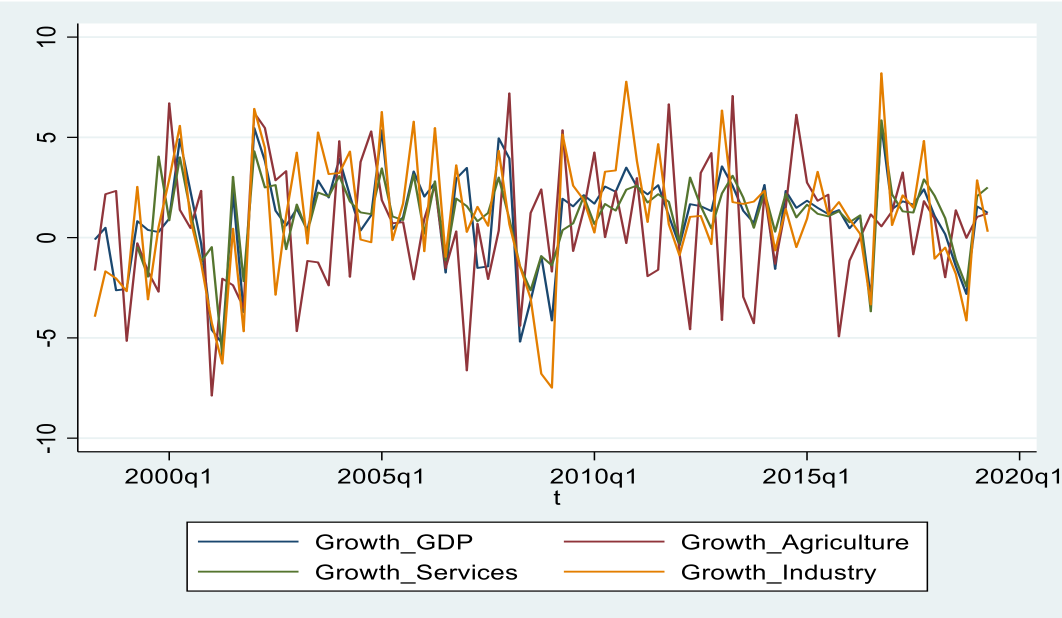


Figure 2. GDP and sectoral growth rates

The first step of MS-AR analysis is to determine model selection. The best model ranking selection is based on AIC criterion: the smaller the AIC, the better the model. However, since our sample is not large, this study skipped the higher order autoregreesive values. Furthermore, as pointed out previously by Clements and Krolzig (1998), it remains doubtful whether AIC is the right choice for selecting the lag order for the nonlinear models. The final stage of our selection procedure is to compare models with AR(1) and AR(2) under two regimes. As seen from the Table 1, since GDP series has lower AIC value in the model MS(2)-AR(2) and since this study is also looking at the statistical significance of the lags, the MS(2)-AR(2) is chosen as the final model. Furthermore, the simulation results show that MS(2)-AR(2) model captures the regime switches more significantly both for the mean and variances. Besides this, the choice of this specification also derives from the fact that by increasing the number of lags the parameters increases noticeably.

Table 1. Comparison of specification measures

	GDP		AGRICULTURE		INDUSTRY		SERVICES	
MODEL	AIC	Log L	AIC	Log L	AIC	Log L	AIC	Log L
MS(2)-AR(1)	4.445	-179.72	5.32	-216.53	5.17	-210.47	3.91	-149.74
MS(2)-AR(2)	4.046	-174.79	5.34	-213.74	5.20	-208.05	3.85	-144.24

The BDS test is performed at various embedded dimensions, developed by Brock et al. (1996), to identify if there is non-linear dependence in a time series. This test is employed to the estimated residuals in order to find out whether those residuals are independent and identically distributed (i.d.d.), as the null hypothesis assumes. If the BDS test's null hypothesis of i.i.d. assumption is rejected, then nonlinearity embedded in series may exist. As shown in Table 2, based on the corresponding amount for dimensions between 2-6, i.i.d. hypothesis can be rejected except for the agricultural sector; suggest that there may be a nonlinear relationship in the series.

Table 2. BDS test statistics

Dimension	BDS Statistics			
	Agriculture	Industry	Services	Total GDP
2	-0.0008 (0.90)	0.0288 (0.00)	0.0418 (0.00)	0.0319 (0.00)
3	-0.0101 (0.38)	0.0431 (0.00)	0.0805 (0.00)	0.0567 (0.00)
4	-0.0188 (0.17)	0.0419 (0.00)	0.0903 (0.00)	0.0682 (0.00)
5	0.0045 (0.75)	0.0404 (0.00)	0.0932 (0.00)	0.0736 (0.00)
6	0.0136 (0.34)	0.0353 (0.01)	0.0981 (0.00)	0.0777 (0.00)

Notes: *The values in parentheses are the p-values of the* test.

It is important to test the presence of structural change before estimating the regime switching parameters. The cumulative sum (CUSUM) of recursive residuals test, developed by Brown et al. (1975), is employed to assess the parameter stability; the test finds parameter instability if the cumulative sum goes outside the area between the two critical lines, up to a particular period t. As shown in Figure 3, the CUSUM plots of the variables do not cross critical bounds which indicate that no evidence of any significant instability; that is, since the estimated CUSUM lines within the critical bounds at 5% level of significance, the CUSUM test suggests the stability of the estimated parameters.

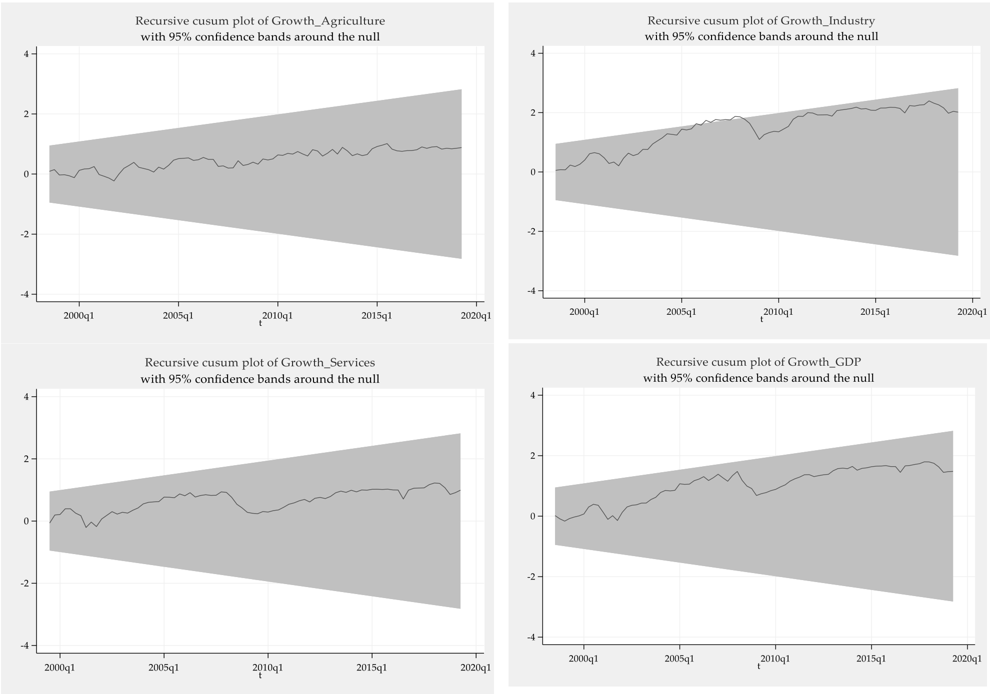


Figure 3. Plot of cumulative sum of squares of recursive residuals

As can be seen in Table 3, this study firstly note that all the regime specific mean estimates for all three sectors and total GDP in both regimes are significant at the 1% level. The mean growth rate of the total GDP is closer to the mean growth rate of the industry sector than to the agricultural and services sectors. For the agricultural sector, the mean growth rate in low-growth regime is -2.19 (negative μ_1) and the mean growth rate in high-growth regime is 1.54 (positive μ_2). Similarly, for the industry sector, the mean growth rate in low-growth regime is -3.08 and the mean growth rate in high-growth regime is 1.98; for the services sector, the mean growth rate in the low-growth regime is -1.33 and the mean growth rate in the high-growth regime is 1.78. The mean estimates for the total GDP growth are -3.33 for the low-growth regime and 1.87 for the high-growth regime. The initial results provide clear evidence for the existence of two regimes. Regime specific mean estimates are followed by the variance and expected duration for each regime and the common autoregressive coefficients (AR) estimates. Since the common AR estimates are less than one for all the three sectors and total GDP and for both regimes), it can be concluded that autoregressive common coefficients meet the stability requirements. Regime specific mean estimates are followed by regime dependent variance estimations. Allowing the variance to switch also enables us to understand whether there has been a significant change in the volatility of sectoral growth rates. In other words, the variance is assumed to be switching across the regimes; that is, the model demonstrates estimation with regime heteroskedasticity. The variance shift from one regime to another leads us to conclude that there is also an indication of a possible change in volatility dynamics. It is clear that the agricultural sector has the most volatile regimes relative to the others. Specifically, volatility, the variance of the regime, is higher in the low-growth regime for the industry and services sectors and vice versa for the agricultural sector and the total GDP. It is also observed that the high-growth regime periods are longer than the low-growth regime periods. That is, the mean expected durations of sectoral growth rates being in high-growth regime (S_t=2) are far longer than the regimes being in low-growth (S_t=1). Specifically, the agricultural sector has the shortest average period range-between 2.06 and 5.61 quarters- remaining in both regimes. The results of the diagnostic test statistics such as J-B Normality Test and ARCH-LM Test are also reported in Table 1. The ARCH test shows that the null hypothesis of homoskedasticity cannot be rejected for the agricultural and services sectors and hence reveals absence of ARCH effects; however, the results suggest the presence of ARCH effects in the industry sector and Total GDP series. Furthermore, the normality tests for the agricultural and industry sector series indicate that the residuals were found to be normally distributed; however, the hypothesis that the residuals have normal distribution is rejected for the services sector and the total GDP.

Table 3. Estimated Markov-switching MS(2)-AR(2) model

		Agriculture	*Industry*	*Services*	*Total GDP*
egime 1	μ_1	-2.19***	-3.08***	-1.33***	-3.33***
		(.83)	(1.18)	(.52)	(.37)
	σ_1	2.32***	2.71***	1.78***	1.28***
		(.54)	(.74)	(.42)	(.28)
Regime 2	μ_2	1.54***	1.98***	1.72***	1.87***
		(.59)	(.33)	(.11)	(.14)
	σ_2	2.71***	2.44***	1.09***	1.41***
		(.35)	(.27)	(.10)	(.13)
Commons	ϕ_1	-.35	-.19	-.41	.03
		(.19)	(.16)	(.12)	(.11)
	ϕ_2	-.18	-.02	.03	-.33
		(.15)	(.15)	(.10)	(.11)
Log Likelihood		-213.74	-208.05	-144.24	-174.79
Normality test $\chi 2$		0.05(0.97)	1.27(0.52)	14.27(0.00)	7.82(0.02)
ARCH-LM (1)		0.04(0.84)	9.76(0.00)	1.85(0.17)	6.91(0.00)
ARCH-LM (2)		1.30(0.52)	11.38(0.00)	2.57(0.27)	8.03 (0.01)
expected duration (regime 1)		2.06	3.21	2.75	1.84
expected duration (regime 2)		5.61	14.89	14.37	10.14

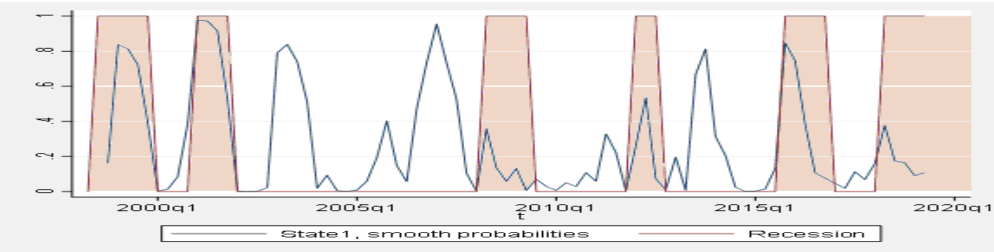
Notes: The standard errors are in parentheses below the estimates. ***, ** and * indicate significance at 1%, 5% and 10%, respectively.

Table 4 represents the transition probabilities from high (low) growth regime to low (high) growth regime and the probabilities of remaining in current regime. Based on the results obtained from the transition probability matrix, the probability that the low-growth regime tends to remain in the same low-growth regime (p_{11}) is .52 for the agricultural sector, .69 for the industry sector, .64 for the services sector and .46 for total GDP growth. Similarly, the probability that the high-growth regime tends to remain in the same high-growth regime (p_{22}) is .82 for the agricultural sector, .93 for the industry sector, .93 for the services sector and .90 for total GDP growth. It is clear that the high-growth regimes throughout Turkey's sectoral GDP business cycles were of more stable. The estimation results also suggest that the probability that the low-growth regime moves towards the high-growth regime (p_{12}) is .48 for the agricultural sector, .31 for the industry sector, .36 for the services sector and .54 for the total GDP growth. It also shows that the probability that the high-growth regime moves towards the low-growth regime (p_{21}) is .18 for the agricultural sector, .07 for the industry sector, .07 for the services sector and .10 for the total GDP growth. Therefore, following these results, this study concludes that there is a higher likelihood of moving towards high-growth regime from low-growth regime than vice versa for all sectors.

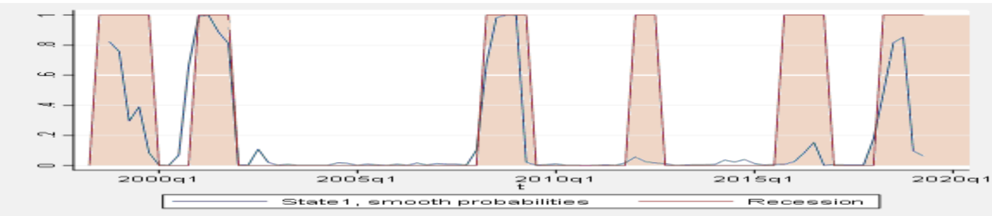
Table 4. Transition probabilities matrix

	Agriculture		Industry		Services		Total GDP	
	Regime 1	Regime 2	Regime 1	Regime 2	Regime 1	Regime 2	Regime 1	Regime 2
Regime 1	.52	.48	.69	.31	.64	.36	.46	.54
Regime 2	.18	.82	.07	.93	.07	.93	.10	.90

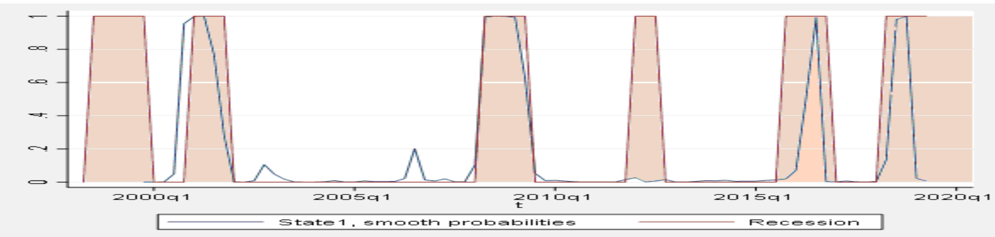
Finally, Figure 4 plots smoothed probabilities for the low growth regimes with the historical recession phases. Based on the smoothed probabilities for low growth regimes and turning points predicted by Markov model, the probability results of switching autoregressive model show that the model is able to capture the two regimes corresponding to the sectoral growth rate behavior - the length of the period in Turkish business cycles. It can be seen that economic activity shows a very volatile behavior in the agricultural sector. The high volatility in agricultural sector can be linked to high and volatile oil prices, higher input costs such as volatile feed prices, under functioning of local agricultural markets and finally low levels of technology adoption in rural areas (FAO, 2011). Contrary to agricultural sector, the low growth regimes in the services and industry sectors have a limited occurrence and generally associated with the recession phases. However, the two-consecutive low-growth periods after 2016 were associated mostly with the services sector. It is obvious that, like in many developed countries, the average length of the high-growth regimes are higher than to those in the low-growth regimes for all sectors and the total GDP (Rand & Tarp, 2002; Musso, 2003; Cotis & Coppel, 2005; Calderon & Fuentes, 2010; Male, 2011). It can be concluded that despite adverse shocks, the economic activities in Turkey have been undergoing a persistent rebalancing process under dynamic but fragmented sectoral structure.



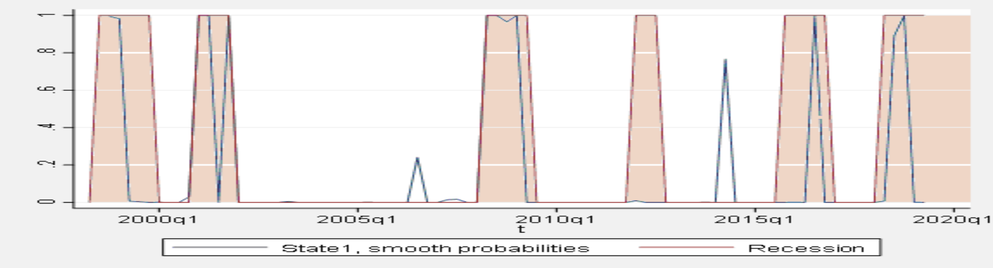
GDP_Agriculture



GDP_Industry



GDP_Services



Total_GDP

Figure 4. The smoothed probabilities of being in low growth regime

5. Conclusion

A common way to examine the growth process and to clarify the stages of business cycle is to assume that GDP growth rate follow cyclical dynamics under non-linear Markov framework. That is, this study assumes that an economy may be in a high growth or low growth regime with switching between the two regimes by the outcome of a Markov process. The purpose of this study is to investigate the behavior of regime changes of the sectoral growth rate dynamics observed in the Turkish economy on the basis of the three main sectoral distribution of Gross Domestic Product over the past twenty years. The study also provides an empirical analysis of the changes in agricultural, industry and services sectors' economic growth performance for the identification of shifts between low-growth and high-growth regimes.

The results provide clear evidence for the existence of two regimes throughout the Turkish sectoral GDP business cycles. The mean growth rate of the total GDP is closer to the mean growth rate of the industry sector than to the agricultural and services sectors. Furthermore, based on the variance coefficients and the smoothed probabilities, as seen from both Table 1 and Figure 2, it is to be observed that there are more frequent fluctuations in the agricultural sector than the other sectors' cycles. Furthermore, after the global crises of 2001 and 2008, all three sectors experienced a long period of low growth regime. Moreover, since 2016 till now, the services sector's regime switching behavior is associated with low-growth rates of GDP, which indicates Turkey's largely free-market economy is driven by services sector. The findings also show that regime switching model provides advantage to model the nonlinearities in GDP fluctuations which assume different behaviors in one sample to another. In general, the univariate autoregressive (AR) process with Markov regime switching in the mean and variance (heteroscedastic) model can be applied to macroeconomic and financial time series to identify changes of coefficient values over time and heteroscedasticity.

These are preliminary findings only and more work is needed to gain more in-depth knowledge, including shifts between production segments on the regime of business cycles taking into account productivity changes as a leading indicator throughout the regime switching in the growth rate process. Our results could also be extended to forecast turning points throughout business cycles in a Bayesian framework. Besides, for simulating complicated nonlinear dynamic patterns better, the State Space form with time-varying parameters using Kalman filter could be performed based on sub-sectoral series. So, focusing on responding to shocks with considering the regime of business cycles will improve the economic policies applied which should be at a level to compatible in both regimes.

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References

Acikgoz, S. (2008). An analysis of business cycles under regime shifts: The Turkish economy and industrial sector. *Dokuz Eylül Üniversitesi Iktisadi ve Idari Bilimler Fakültesi Dergisi, 23*(2),135-151.

Afonso, A. & Furceri, D. (2009). Sectoral business cycle synchronization in the European Union. *Economics Bulletin*, *29*(4), 2996-3014.

Altug, S. & Bildirici, M. (2010). *Business cycles around the globe: A regime switching approach* (Koç University-TÜSIAD Economic Research Forum Working Papers 1009). Retrieved from https://ideas.repec.org/p/koc/wpaper/1009.html

Ang, A. & Bekaert, G. (2002). Regime switches in interest rates. *Journal of Business and Economic Statistics, 20*(2),163-182.

Bekaert, G. & Hodrick, R.J. (2001). Expectations hypotheses tests. *Journal of Finance, 56*(4), 1357-1394.

Binici, M., Hacihasanoglu, Y.S. & Kutuk, S. (2016). *Turkiye'de Finansal Cevrimler ve Is Cevrimleri: Ne Kadar Farkli, Ne Kadar Baglantili?* (CBT Research Notes in Economics 1626). Ankara: Central Bank of Turkey.

Brock, W., Dechert, D., Sheinkman, J. & LeBaron, B. (1996). A test for independence based on the correlation dimension. *Econometric Reviews*, *15*(3), 197–235.

Brown, R.L., Durbin, J. & Evans, J. M. (1975). Techniques for testing the constancy of regression relations over time. *Journal of the Royal Statistical Society*, *37*(2), 149-192.

Brunetti, C., Mariano, R.S., Scotti, C. & Tan, A.H. (2007). Markov switching GARCH models of currency turmoil in Southeast Asia. *Emerging Markets Review, 9*(2), 104-128.

Cai, J. (1994). A Markov model of switching-regime ARCH. *Journal of Business and Economic Statistics, 12*(3), 309–316.

Calderon, C.A. & Fuentes, R. (2010). *Characterizing the business cycles of emerging economies* (World Bank Policy Research Working Paper No. 5343). Washington, DC: World Bank.

Chen, X., Kontonikas, A. & Montagnoli, A. (2012). Asset prices, credit and the business cycle. *Economic Letters, 117*(3), 857-861.

Clements, M.C. & Krolzig, H.M. (1998). A comparison of the forecast performance of Markov-switching and threshold autoregressive models of US GNP. *The Econometrics Journal*, *1*(1), 47-75.

Clements, M.C. & Krolzig, H.M. (2003). Business cycle asymmetries. *Journal of Business and Economic Statistics*, *21*(1), 196-211.

Cosslett, S. R. & Lee, L.F. (1985). Serial correlation in latent discrete variable models. *Journal of Econometrics, 27*(1), 79-97.

Cotis, J.P. & Coppel, J. (2005). Business cycle dynamics in OECD Countries:

Evidence, causes and policy implications. In C. Kent & D. Norman (Ed.), *The Changing Nature of the Business Cycle*, Proceedings of the Reserve Bank of Australia Economic Conference (pp. 8-57). Sydney, Australia.

Craigwell, R. & Maurin, A. (2007). A sectoral analysis of Barbados' GDP business cycle. *Journal of Eastern Caribbean Studies, 32*(1), 21-52.

Dahlquist, M. & Gray, S.F. (2000). Regime-switching and interest rates in the European monetary system*. Journal of International Economics, 50*(2), 399-419.

Demirbas, N. (2007). Agribusiness in the Turkish economy. *Agricultural Economics-Zemedelska Ekonomika, 53*(5), 224-229.

Devereux, M.B. & Hnatkovska, V. (2011). *The extensive margin, sectoral shares and international business cycles* (NBER Working Papers No.17289). Cambridge, MA: National Bureau of Economic Research.

Dogan, I. & Bilgili, F. (2014). The non-linear impact of high and growing government external debt on economic growth: A Markov Regime-switching approach. *Economic Modelling*, *39*, 213-220.

Durland, M. & McCurdy, T.H. (1994). Duration-dependent transitions in a Markov model of U.S. GNP Growth. *Journal of Business and Economic Statistics, 12*(3), 279-288.

Edwards, S. & Susmel, R. (2003). Interest-rate volatility in emerging markets. *The Review of Economics and Statistics,* 85(2), 328-348.

Engel, C. & Hakkio, C.S. (1993). Exchange rate regimes and volatility. *Economic Review from Federal Reserve Bank of Kansas City,* qiii, 43-58.

FAO (2011). *Price volatility in food and agricultural markets: Policy responses*. Policy report including contributions by FAO, IFAD, IMF,OECD, UNCTAD, WFP, the World Bank, the WTO, IFPRI and the UN HLTF. Washington, DC: World Bank.

Goldfeld, S.M. & Quandt, R.E. (1973). A Markov model for switching regressions. *Journal of Econometrics, 1*(1), 3–16.

Hamilton, J.D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica, 57*(2), 357-384.

Hamilton, J.D. & Susmel, R. (1994). Autoregressive conditional heteroskedasticity and changes in regime. *Journal of Econometrics, 64*(1–2), 307–333.

Jacobsen, B., Stangl. J.S. & Visaltanachoti, N. (2009). Sector rotation across the business cycle. Retrieved from SSRN: https://ssrn.com/abstract=1467457.

Jochmann, M. & Koop, G. (2014). Regime-switching cointegration. *Studies in Nonlinear Dynamics and Econometrics, 19*(1), 35–48.

Koop, G. & Potter, S.M. (2007). Estimation and forecasting in models with multiple breaks. *Review of Economic Studies*, *74*(3),763.

Krolzig, H.M. (1997). *Markov-switching vector autoregressions: Modelling, statistical inference, and application to business cycle analysis,* Berlin: Springer.

Layton, A.P. & Katsuura, M. (2001). Comparison of regime switching, probit and logit models in dating and forecasting US business cycles. *International Journal of Forecasting, 17*(3), 403-417.

Lee, L. & Porter, R. (1984). Switching regression models with imperfect sample separation information--with an application on cartel atability. *Econometrica, 52*(2), 391-418.

Male, R. (2011). Developing country business cycles: Characterizing the cycle. *Emerging Markets Finance and Trade*, *47*(sup2), 20-39.

Matthes, C. & Schwartzman, F. (2019). *The demand origins of business cycles* (2019 Meeting Papers No.1122). Retrieved from https://ideas.recpec.org/p/red/scd019/1122.html

Moolman, E. (2004). A Markov switching regime model of the South African business cycle. *Economic Modelling, 21*(4), 631-646.

Moore, T. & Wang, P. (2007). Volatility in stock returns for new EU member states: Markov regime switching model. *Interntional Review of Financial Analysis*, *16*(3), 282-292.

Musso, A. (2003). *Basic characteristics of the Euro area business cycle*. Paper presented at the 4th Colloquium on Modem Tools for Business Cycle Analysis, Luxembourg.

Phelan, C. & Trejos, A.(2000). The aggregate effects of sectoral reallocations. *Journal of Monetary Economics*, *45*(2), 249-268.

Rand, J. & Tarp, F. (2002). Business cycles in developing countries: Are they different? *World Development*, *30*(12), 2071-2088.

Reyes-Heroles, R. & Tenorio, G. (2017). *Interest rate volatility and sudden stops: An empirical investigation* (International Finance Discussion Papers No.1209). Retrieved from https://doi.org/10.17016/IFDP.2017.1209

Song, Y. (2014). Modelling regime switching and structural breaks with an Infinite hidden Markov model. *Journal of Applied Econometrics, 29*(5), 825-842.

Tase, M. (2016). *Sectoral dynamics and business cycles* (Finance and Economics Discussion Series 2016-066). Washington, DC: Board of Governors of the Federal Reserve System.

Tastan, H. & Yildirim, N. (2008). Business cycle asymmetries in Turkey: An application of Markov- switching autoregressions. *International Economic Journal, 22*(3), 315-333.

Wang, P (2008). *A spectral analysis of business cycle patterns in UK sectoral output* (Working Papers 2008-FIN-02). Paris: IESEG School of Management.

World Bank. (2018). World development indicators. Retrieved from http://www/worldbank.org

Zarnowitz, V. and Ozyildirim, A. (2006). Time series decomposition and measurement of business cycles, trends and growth cycles. *Journal of Monetary Economics*, *53*(7), 1717-1739.