Regime Switching Dynamics of the Turkish Manufacturing Industry

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Abstract

The industrial sector, especially the manufacturing industry, has great importance considering its connection with other industries for emerging market economies. In this context, industrial sector is an important indicator for analysing the economic structure and providing a basis for forward-looking economic policies. This study aims to identify and explicitly compare the cyclical dynamics for the Turkish manufacturing industry by employing regime switching models that are based on probabilistic calculations. The paper reveals the nonlinear characteristics of the manufacturing industry. The results determine the regime switching parameter estimates of the manufacturing industry, identify the regime dependent heteroskedasticity, provide the smoothed probabilities along with the transition probabilitiy estimates, and identify regime classification for each of the states defined in the study.

Keywords: Markov Switching Models, Turkish economy, Manufacturing Industry.
JEL Classification: C14, C51, L16

1. Introduction

The studies about industrial sector provide a strong inside for the production structure of the economies. Revealing information about this production structure of an economy carries great importance to design consistent policies for economic development. This is especially important for emerging markets economies, considering their required stuctural transformations as a solution to their fragile economic outlook in global markets. This study investigates the structure of production in Turkish industry and provides an insight to its dynamics. The analysis employs the manufacturing industry as a representing component with the largest proportion[1] of industrial production by this study.

There are many studies that covers in particular the industrial sector in the literature, however, studies related to analysis of the manufacturing sector are relatively not sufficient compared to the studies focusing on the total industry. O'Mahony and Robinson (2003) examines the impact of the integration of information technology into economy on output gap in manufacturing sector by comparing UK and US economies. They use the growth accounting method and industry data for the period 1988-2000. The study of Onaran and Stockhammer (2008) estimates the effect of FDI and trade openness on average sectoral wages in the manufacturing industry in the Central and Eastern European Countries in the post-transition era by utilizing a cross-country sector-specific econometric analysis based on one-digit level panel data. Their research covers the Czech Republic, Hungary, Poland, Slovakia, and Slovenia for the period of 2000–2004. In the study, the results are obtained for the short and the medium run. The studies on manufacturing sector employing Markov switching framework includes Krolzig and Sensier (2000), where they investigate the dating and interaction of the UK business cycle with changes in the industrial structure of the UK economy. The time series which used in the study are seasonally adjusted, monthly and covering from 1968(1) to 1997(12). Their study reports that the regime shifts affect the common growth rate and the sectoral allocation of industrial production.

For the case of Turkey, the studies on the Turkish manufacturing industry are not widely investigated. Eşiyok (2002) examines the developments of competitiveness in Turkey over the manufacturing industry in a descriptive framework. Küçükkiremitci (2011) studies on the structural analysis of the manufacturing industry by examining the public profile of the sub-

[1] The statistical database of Turkish Statistic Institute calcuates that the percentage of manufacturing industry as 81.51% in total industry .

sectors in the manufacturing industry. Uzay, Demir and Yıldırım (2012), examines the impact of R & D expenditures on the export performance of Turkey's manufacturing industry. Bayar and Tokpunar (2014) in their empirical study, analyzes the determinants of sub-sectors in Turkish manufacturing industry by panel data methods. Keskingöz (2014), analysis the cyclical dynamics of the manufacturing sector which based on the potential outcome and covering the period from 1963 to 2010. The study determines 8 business cycle circuit for Turkish manufacturing industry. Ongan (2003) investigates the presence and direction of cyclical relationship between the total manufacturing industry. The study identifies that the impacts differ with respect to each different sector.

On the other hand, there is no study on the Turkish manufacturing industry that employs Markov switching framework. To investigate its regime switching dynamics, this study documents the cyclical dynamics of the Turkish manufacturing industry by using non-linear Markov framework. Utilizing this framework provides the asymmetric behaviors across cyclical phases. The study employs hidden Markov models to the mean and variance at monthly frequency. It allows us to obtain a dynamic regime classification that is not sensitive to model specification.

The paper is organized as follows. Section two summarizes the general form of the model that is employed to identify the asymmetric dynamics of the manufacturing industry. Section three discusses the data and presents the empirical results. Section four concludes.

2. The Model

This study aims to identify the cyclical dynamics of the manufacturing industry by using hidden Markov switching models. Employing this framework provides a convenient path to analyze time series with state dependent dynamic. In this type of models, periodic shifts[2] are allowed to occur in the model parameters with regard to different phases of the variable that we observe. Therefore, the models are capable to capture the cyclical regime dynamics that are driven by the unobservable stochastic variable.

Let y_t represents for the Turkish manufacturing industry that can be written as the sum of two components,

[2] See for further information, Kim & Nelson(1999)

(1) $$y_t = n_t + z_t$$

where the term of n_t refers the Markov trend and the term of z_t refers the Gaussian component. The Markov trend is consists of,

(2) $$n_t = \alpha(s_t) + n_{t-1},$$

where $s_t \in \{1,\ldots,M\}$ is a latent Markov processes that determines the state of the economy and $\alpha(s_t) = \alpha_i$ for $s_t = i$, $i \in \{1,\ldots,M\}$.

It follows, then, the Markov regime switching dynamics formulates a probability rule for transition between states. The unobserved state variable, s_t, follows a first-order Markov-process, where the current regime depends only on the regime prevailing one period ago.

The rule of probability is given with,

(3) $$P[s_t = j | s_{t-1} = i, s_{t-2} = k, \ldots] = P[s_t = j | s = i] = p_{ij},$$

the probability that state i will be followed by state j is indicated by p_{ij} and $i, j, k \in \{1,\ldots,M\}$. By rules of probability, we have $\sum_{j=1}^{M} p_{ij} = 1$.

The second term in Equation (2), which is the Gaussian component, is given by:

(4) $$z_t = z_{t-1} + \phi_1(z_{t-1} - z_{t-2}) + \mathrm{L} \ + \phi_r(z_{t-r} - z_{t-r-1}) + \varepsilon_t$$

where $\boldsymbol{\varepsilon_t / \sigma(s_t)} \sim \boldsymbol{NID}(0,1)$ and is independent of $\boldsymbol{n_{t+h}}$, $\forall \boldsymbol{h} \geq 0$.[3] By differencing Equation (1) and substituting (4) we obtain,

(5) $$\Delta \boldsymbol{y_t} = \boldsymbol{\alpha}(\boldsymbol{s_t}) + \phi_1(\boldsymbol{z_{t-1}} - \boldsymbol{z_{t-2}}) + \mathrm{L} \ + \phi_r(\boldsymbol{z_{t-r}} - \boldsymbol{z_{t-r-1}}) + \boldsymbol{\varepsilon_t}$$

This model is able to identify regimes characterized by different means and variances. Considering structural breaks in the Turkish manufacturing industry due to the abrupt policy

[3] Note that this is the general form of the model. Under constant variance assumption, the model boils down to a mean-switching only specification.

changes in Turkey, the study uses a hidden Markov specification where the autoregressive terms in Equation (4) are set to zero[4].

The differenced series becomes,

(6) $$\Delta y_t = \alpha(s_t) + \varepsilon_t \ .$$

Following Hamilton (1990), we estimate the models using EM algorithm together with the nonlinear filter to find the maximum likelihood estimates of the model parameters. Note that we do not impose any a priori restrictions on model parameters and infer the states through statistical estimation. See Dempster, Laird and Rubin (1987) for a detailed description of the EM algorithm and Krolzig (1997) for its application to MS class of models.

3. Data and Empirical Results

In this study, monthly manufacturing production index is employed in order to examine the behavior of the cyclical dynamics for the Turkish manufacturing industry. The data is obtained from the statistical database of the Turkish Statistical Institute. The data consists of seasonally adjusted monthly manufacturing production index from January 2005 to September 2015. Following Stock and Watson (2005), high frequency movements in the different series of Turkish manufacturing index are smoothed out by taking twelve-month differences of the annual month-to-month growth rates in logarithms.

We first investigate the availability of unit roots in the series of manufacturing production index. We use the Augmented Dickey-Fuller test proposed in Dickey and Fuller (1981) and the Phillips Perron proposed in Phillips Perron (1998). Stationarity is obtained after taking twelve-month averages of the annual month-to-month growth rates of the Turkish manufacturing industry series.

This study intends to provide the characteristics of different phases of the Turkish manufacturing industry and provide a detailed insight about its dynamics. We test the linearity against the nonlinear Markov switching specifications. We examine nonlinearity, determine the number of regimes and identify the regime dependent variances, find the transition and smoothed probabilities, and identify regime classification for each of the defined state. The results are given

[4] See Chauvet (2002) for an application on Brazilian economy.

in Table 1. Figure 1 shows the smoothed probabilities for each different regime and the fitted values for the Turkish manufacturing industry.

Table 1 reports the estimated results for the selected model of Turkish manufacturing industry. The table shows the estimated parameters of regime dependent mean and variance, transition probabilities, AIC, HQ and SIC model selection criteria tests, Likelihood Ratio statistics, and the Davies upper bound p-values for the Turkish manufacturing industry. The asymptotic standard errors are given with the numbers in parenthesis. Likelihood ratio statistics and information criteria tests are employed to identify the number of states and to examine heteroscedasticity to identify the changes in variance structure with reference to different regimes.

According to the value of the Davies upper bound linearity is rejected in favor of the nonlinear model. The strong asymmetry is reported by the value of the upper bound and by the various significant estimates and regime probabilities across different states.

The information criteria tests and modified likelihood ratio values provide the state specification about the selected models by comparing a 3 state versus a 2 state specification. The results and the values for determining number of regimes suggest that a three-state specification fits better than a two state specification to identify the state dependent dynamics of the manufacturing industry. A three state specification decomposes the positive growth regime for the manufacturing industry into moderate and high growth regimes for the fluctuations of the manufacturing industry in Turkey.

Furthermore, we examine the nonlinear dynamics for heteroskedasticity of the Turkish manufacturing industry by employing the same specification tests. Test results strongly determine the presence of regime dependent variances. When we compare the variances of each defined regime, the estimated variance of the low growth regime for manufacturing industry is higher than the variances of moderate and high growth regimes of the manufacturing industry. Considering these results, the low growth regime for the manufacturing industry has the highest volatility compared to the moderate and high growth regimes of the manufacturing industry.

The study also determines the duration and persistence of staying in a particular regime by using the estimated transition probabilities for the Turkish manufacturing industry. The related results about that are given in the Table 2 and Table 3.

When we consider all the determinative results of this study about identifying the dynamics cyclical characteristic of the Turkish manufacturing industry, there are three regime state in manufacturing industry. The estimated growth rate of Turkish manufacturing industry in Regime 0 is -6.31%, whereas it grows by 1.38% and 4.43% in moderate and high growth phases of Turkish manufacturing industry. The average durations are 15, 12.40, and 13.33 months for low, moderate and high growth regimes, while the average percentages are 12.82%, 52.99% and 34.19% respectively. The probabilities of staying in the same regime for the next month are 0.92, 0.93, 0.92, respectively. Among these three different regimes, the low growth regime for the manufacturing industry has the longest average duration. Considering the persistences of different regime durations, the moderate growth regime for the manufacturing industry has the highest percentage for persistance.

4. Conclusion

Manufacturing industry has significant importance in terms of understanding the economic structure of an economy. Consistent analysis about the production structure provides substantial inside for forward-looking policies for the overall economy. This study reveals the asymmetric behaviour of the cyclical dynamics in the manufacturing industry by modeling the state dependent dynamics of the Turkish manufacturing industry across different phases with hidden Markov models to the mean and variance. The resuts define the state dependent dynamics across different manufacturing phases. The study estimates the model parameters using EM algorithm together with the nonlinear filter to figure out the maximum likelihood estimates without imposing any a priori restrictions on model parameters and infer the states through statistical estimation. The data set consists of seasonally adjusted monthly Turkish manufacturing production index from January 2005 to September 2015. The time series related with the Turkish manufacturing industry are smoothed out by taking twelve-month averages of the annual month-to-month growth rates. To determaine the characteristics of different regimes of the Turkish manufacturing industry and provide consistent information about its dynamics, the study examines nonlinearity, determines the number of regimes and identifies the regime dependent variances. The study identifies a three state specification to decompose the regimes into moderate and high growth states other than the low growth state. The study utilizes the estimated transition probabilities to determine the duration and persistence of staying in a each regime for the Turkish manufacturing industry. Among these three different regimes, the low growth state of the manufacturing industry has the longest average duration. In terms of the persistences for regime durations, the moderate growth regime has the highest persistancy. Our results also provide the smoothed probability sequences for each different regime along with the fitted values for the Turkish manufacturing sector.

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TABLES AND FIGURES

Table 1: MSMH(3) – AR(0) Results for Monthly Turkish Manufacturing Industry

	Turkish Manufacturing Industry
log-L	-220.977585
LRP	0.000
α_0	-6.31868
	(0.9299)
α_1	1.38925
	(0.1338)
α_2	4.43923
	(0.2517)
σ_0	3.33952
	(0.6408)
σ_1	0.958960
	(0.09839)
σ_2	1.45174
	(0.1749)
p_{00}	0.927573
	(0.07867)
p_{10}	0.0723971
	(0.07661)
p_{01}	0.0164779
	(0.01640)
p_{11}	0.936330
	(0.03324)
p_{12}	0.0769909
	(0.04408)

AIC	3.9654
SC	4.2251
HQ	4.0709

Notes: The sample period is January 2006 - September 2015. LRP denotes the upper bound for the p-value of the likelihood ratio test of linearity based on Davies (1987). Standard errors are reported in parenthesis.

Table 2. Estimated Markov probabilities of staying in the same state

dlnman_ind12	
Regime 0	0.92757
Regime 1	0.93633
Regime 2	0.92301

Note: Regime 0 represents the low growth state for the manufacturing industry, Regime 1 represents the moderate growth state for the manufacturing industry, regime 2 represents the high growth state for the manufacturing industry.

Table 3. Average durations and percentages of staying in the same state

00	**dlnman_ind12**	
	Percentage	Average Duration
Regime 0	12.82%	15.00
Regime 1	52.99%	12.40
Regime 2	34.19%	13.33

Note: Regime 0 represents the low growth state for the manufacturing industry, Regime 1 represents the moderate growth state for the manufacturing industry, regime 2 represents the high growth state for the manufacturing industry.

Figure 1: Smoothed Probabilities of Low, Moderate and High Growth States for the Manufacturing Industry and Fitted Values