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An analysis of regime shifts in the Turkish economy ☆

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Abstract

We use a time-varying dynamic factor model with regime switching to construct and estimate the leading indicators of the currency crises in Turkey. After that, we analyze the business cycles of the Turkish economy, by using a three-state univariate Markov-switching model. Both models capture the observed dynamics of the Turkish economy over the period 1987–2002.

JEL classification: E44; E52; E62

Keywords: Currency Crisis; Markov-switching; Time-varying parameter; Three-state model; Turkey

1. Introduction

Currency crises and business cycles have been very attractive fields of study for economists especially after the huge crises in Latin America and Asia. which had destructive consequences in those regions. As an emerging market economy, Turkey also experienced two serious currency crises in 1994 and 2001 together with several business cycles.

This paper analyzes both the currency crises and the business cycles of the Turkish economy over the period 1986–2002. The first part of the study aims to find the indicators of currency crises in Turkey by following the studies such as Engel and Hamilton (1990), Bollen et al. (2000) and, Chauvet and Dong (2004). Specifically, we apply a time-varying dynamic factor model with Markov regime switching to find the indicators of currency crises in Turkey. The aim of the model is to generate regime probabilities from the indicators that can be used to signal increases in country risk and potential currency crises.

The second part of the study aims to analyze the business cycles of Turkey. The two-state Markov switching models have been widely applied to business cycle studies after the influential study of Hamilton (1989). Due to their two-state nature, these studies analyze the cycles in two states, namely recessionary and non-recessionary states.[1] Following the

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[1] See Kim and Nelson (1999) for detailed models of business cycles. See Yilmazkuday (2008) for an alternative regime-shifting approach based on the Turkish, Korean and Czech economies.

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idea of Garcia and Perron (1996), this study employs a three-state univariate Markov switching model to analyze the business cycles in Turkey. The three-state model enables us to decompose the non-recessionary state further into two sub states, namely the high-growth and low-growth states. The aim of the model is to generate regime probabilities from the real GDP data and make comparisons about the sequence of these states.

The rest of the paper is organized as follows: Section 2 gives an overview of the Turkish economy over the period 1980–2001. Section 3 analyzes the currency crises the Turkish economy has experienced during 1986–2001, while Section 4 analyzes the business cycles of Turkey over the period 1987–2002. Section 5 concludes.

2. An overview of the Turkish economy: 1980–2001

Before 1980, Turkey had a relatively closed and heavily regulated economy for which the main development strategy was import substitution. As a result, the economy was almost immune to external shocks and did not have business cycles in the traditional text-book sense. After a profound debt and balance of payments crisis in late 1970s, Turkey initiated a stabilization program in 1980. Apart from economic stabilization, the program aimed at the adoption of an export-led growth strategy. To this end, the economy was liberalized by means of market-based structural reforms.

2.1. The success years (1980–87)

By the end of 1987, Turkey had turned into an exemplary market economy with a strong macroeconomic stance. The inflation was brought down from three digit levels in 1980 to about 30% in 1982 with a small output loss (Akyüz and Boratav, 2001). Thanks to the rapid increase in exports fuelled by real exchange rate depreciation and export promoting strategies, the average GDP growth rate between 1983 and 1987 was above 6% per annum. During the first two years of the program, the current account deficit was halved from a level of 5% of GDP, and the public sector borrowing requirement (PSBR) fell from 10% of GNP to less than 4% (Akyüz and Boratav, 2001).

2.2. Populism, capital account liberalization and fiscal imbalances (1988–93)

After a prolonged period of high growth, the economy experienced a slow-down for the first time in 1988. Starting from that year, the volatility of economic growth increased and the average growth rate fell until after the financial crisis in 2001. The slowing down of the economy continued in 1989 but gave way to a rapid recovery in 1990. However, the Gulf War in 1991 caused a sudden capital outflow and dragged the economy into another recession. During the following two years the economy enjoyed high growth rates again mainly thanks to the resumption of capital inflows, but could not avoid a severe crisis in 1994.

During the success years, Turkey had been ruled first by a military government (1980–83) and then by a civilian government elected in a repressive political environment (1983–87). The parliamentary democracy was fully restored only in 1987, when the extremely populist political leaders of the pre-80s regained their political rights and took an active part in the hotly debated elections that took place in that year. In order to counteract the populist strategies employed by the old political leaders and to compensate for the effects of the restrictive wage policies of the stabilization era, the government started a new populist cycle in 1989. As a matter of fact, the government had already eased the fiscal policy stance starting from 1985 (Boratav et al., 1996). In 1989, public-sector employees were granted a huge pay rise and agricultural prices went up considerably. According to Boratav et al. (2001), real wages in manufacturing increased by 90% from 1988 to 1991.

The year 1989 is also one of the turning points in Turkish economic history, because it is the year in which the capital account was completely liberalized and tariffs were lowered to a great extend.[2] The government took this bold step in an economic environment in which inflation was still high, foreign exchange reserves was not very large and, most importantly, financial markets were not properly regulated and still fragile. One of the reasons for this haste was the government's desire both to invigorate the already stagnant economy and to finance the populist expansion with

[2] The foreign exchange regime had already been liberalized in 1984.

capital flows and hence to avoid crowding-out of the private investment (Celasun, 2002). During 1988–89, the average growth rate had declined to 1.6% from 6.4% in 1983–87, and the net capital inflow was below $1 billion.

The liberalization of the capital account had profound impacts that would shape the macroeconomic profile of Turkey throughout the 1990s. Most important of all, the macroeconomic performance of Turkey became extremely dependent on capital flows, and in complete contrast with its semi-autarchic existence before 1980, the country became fully exposed to ups and downs of the global economy. Because Turkey was unable to attract foreign direct investment due to its inadequate infrastructure and financial and institutional weaknesses, capital inflows mainly took the form of short-term financial investments.

The capital account liberalization in 1989 also shaped the mechanism by which the Treasury conducted domestic borrowing. During 1980s, the financing of the public deficit became increasingly dependent on domestic borrowing mostly as a precaution against inflationary dynamics. After the capital account liberalization, the banking system rapidly assumed the role of an intermediary between foreign financial investors and the government. During the 1990s, the primary function of the banking system was to lend the government the short-term credit obtained from the foreign markets. This strategy caused the banks to hold uncovered short-positions in foreign exchange and take big exchange rate risks that would play a very important role in the two financial crises that followed. Moreover, because of this strategy, the primary objective for monetary policy became the maintenance of the stability of the financial system, so that the domestic borrowing process would not be interrupted (Celasun, 2002). Hence, during the 1990s, governments could not use monetary policy as a tool against inflation.

The liberalization of capital flows in 1989 ended the trend in exchange rates that had prevailed since the beginning of the stabilization program in 1980. The Turkish Lira appreciated in real terms by about 20% during 1989–90 (Celasun, 1998). This reversal in the exchange rate trend and the increased cost of labor caused the economy to be less competitive after 1989. As a result, the export-led growth of the 1980s started to give way to domestic demand-led growth and both the trade deficit and current account deficit started to increase.

As a result of populist policies, the PSBR and the primary deficit rose steadily between 1989 and 1993. The increase in the interest rates that followed the capital account liberalization and the rise in interest payments, especially after 1992, played an important role in the worsening of the fiscal balances. Moreover, the term structure of the domestic debt was getting shorter as the public deficit was being financed by the short-term funds the banking system obtained from abroad.

2.3. The 1994 crisis

By the end of 1993, the fundamentals of the Turkish economy had considerably worsened. The most important of these fundamentals included: 1) a continually increasing primary deficit, 2) decreasing competitiveness due to high labor costs and appreciated currency, and 3) an unprecedentedly high level of current account deficit.

At the end of 1993, the government made a very grave policy mistake: despite this economic environment and the presence of speculative capital flows, it decided to lower the high levels of domestic public debt stock by cutting the interest rates on treasury bills and hence to switch to a policy of financing the deficit through Central Bank resources (Ozatay, 2000).[3] To this effect, the Treasury first started to accept only a small amount of the offers in the auctions for government papers, and then, it cancelled most of the auctions in November and December 1993. Finally, at the end of that year, the government declared that it was going to introduce a 5% income tax on government securities, which had been exempt from taxes till then. As a result of this policy change, the net domestic borrowing became negative and the CB advances (as a percentage of GNP) rose to unprecedented levels in the third and fourth quarters of 1993.

The huge injection of liquidity into the economy and the government's wish to lower the interest rates and change the maturity structure of the government debt triggered a rush to foreign currency. The result was a net capital outflow of $4.2 billion in 1994. In the middle of January, the Lira was devalued against the US dollar by 19%. By the end of the first quarter, the Turkish Lira had been devalued by more than 50% against the US dollar. On the 11th of March, the overnight rate jumped to a record level of 700% in simple terms.

In April 5, the government announced a new stabilization program according to which public sector wages were to be frozen for one year and the planned consolidated government deficit was to be halved. However, the stabilization of the Turkish Lira could be achieved only in May. The Treasury resumed domestic borrowing but at a much higher cost.

[3] In 1993, the amount of net capital inflow was approximately $9 billion.

Even though the economy went through one of its worst recessions in history and shrunk by 6% in 1994, it recovered very rapidly and grew about 8% the following year. This rapid recovery can be attributed to the facts that the banking system came out of the crisis relatively unharmed and that the private sector regained external borrowing opportunities very quickly (Celasun, 2002). The real depreciation of the Turkish Lira was also helpful.

2.4. The after-crisis years: 1996–99

During this period, the ups and downs of the economy were mainly shaped by the net capital inflows (dominated by short-term financial capital flows), and therefore, the business cycle was closely related with the international financial conjuncture. As mentioned above, mainly thanks to the return of the capital flows, the economy recovered itself rapidly and enjoyed a growth in excess of 7% during 1995–97. Even though the Turkish economy avoided the first shocks of the Asian crisis in 1997, it was hit hard by the Russian crisis in 1998. The net capital inflow slowed sharply and fell to 1.8% of GDP from 5.8% in the previous year. The increase in the interest rates forced the government to tighten fiscal policy to control the rise in the budget deficit. As a result of the fall in demand, mainly caused by the contractionary fiscal policies of the government and the drastic fall in the trade with Russia, the GDP growth rate – which had been approximately 7% for the previous three years – fell to 3.1%. The major earthquake in 1999, combined with the after effects of the Russian crisis and a sharp decrease in tourism revenues due to political reasons, caused the GDP to shrink by 4.7%.

Even though the economic turbulence in 1998–99 did not bring about a financial crisis in Turkey, the banking system went through difficult times due first to the impact effects of the external shock and then to the contraction in the economic activity that followed it. Eight insolvent banks were taken over by the state and this led to a further deterioration of the fiscal stance of the government.

After the 1994 crisis, the dynamics of the public debt changed considerably. Before the crisis, public debt stock was rising due to high deficits in the primary balance. After the crisis, the factor behind the rising debt stock became the rapidly growing interest payments on public debt. Between 1989 and 1994, the primary deficit had been continuously on the rise and this had led to a rapid deterioration of the public sector balance. After the crisis, the primary deficit improved significantly. However, the increasing gap between the real interest rates and the growth rate of the economy quickly worsened the debt dynamics, especially after 1997. What made things worse was that the government was not able to lengthen the term structure of the public debt, because the inflationary expectations and the level of currency substitution were very high.

Another harmful effect of the combination of high levels of currency substitution and inflationary expectations was the constraint it imposed on the economic policy: the monetary authorities were no longer able to use monetary policy to stabilize either output or the prices (Akat, 2000). Cutting back interest rates to counteract the fall in aggregate demand would inevitably cause a speculative attack on foreign currency jeopardizing the stability of the financial markets and interrupting the main mechanism by which the public deficit was being financed. Throughout this period, monetary policy was conducted mainly to stabilize the financial markets and to hold the real exchange rate relatively constant. This policy helped reinforce the inflationary expectations and increased the inflationary inertia (Celasun, 2002).

2.5. The exchange-rate-based-stabilization program and the financial crisis: 2000–01

On the eve of year 2000, Turkish economy was still suffering from high and chronic inflation, steadily worsening public debt position and increasing fragility in the banking sector. During the second half of 1990s, the destabilizing effects on the economy of chronic inflation had become very clear. As a result, by the end of 1999, for the first time in many years, a strong political will to lower inflation had emerged. So, in December 1999, the government signed a three-year Standby Agreement with IMF and initiated an exchange-rate-based stabilization (ERBS) program. Other than lowering inflation to single-digit figures, the program aimed at carrying out extensive structural reforms mainly in public finance. It was thought that even though there was no problem in the current account front, IMF's support would still be needed especially for maintaining credibility which was *sine qua non* for ERBS programs (Calvo and Vegh, 1999).

During the following ten months, the economy went through the well-known stylized phases of ERBS programs (Calvo and Vegh, 1999): nominal interest rates fell, domestic credits and private consumption expenditures exploded,

domestic currency appreciated steadily and the current account deficit increased to historical levels. The real appreciation was due to the slow fall in inflation which signaled and reinforced the lack in credibility. The staggering pace in the implementation of structural reforms weakened the program's credibility further. These disappointing developments, along with the economic situation in Argentina and the disclosure of irregularities in the banking system, led to a rapid capital outflow in November 2000 (Akyüz and Boratav, 2001). Interest rates hiked to four-digit levels as international reserves depleted and the banking system which relied on foreign funds went through a severe liquidity crunch. The financial markets were stabilized to some extent only after a new agreement with IMF was reached in December. Thanks to the IMF's support facility, capital outflows stopped and international reserves increased.

By mid-January, the international reserves had risen to their pre-November level, and interest rates had fallen to below 60%. However, the turbulence in November had impaired the already weakened credibility of the program in an irrevocable way, and the real appreciation of the domestic currency was continuing because of the sluggish fall in inflation. Moreover, in January 2001, the first signs of an economic slow down started to appear. In late January, maturities in Treasury bill auctions started to shorten, and in February, interest rates rose to 70%, threatening the sustainability of the domestic public debt.

Finally, on the 19th of February, a harsh dispute between the Prime Minister and the President sparked the most severe financial crisis the country has ever faced. Just a few hours after the dispute was announced to the public, the major index of the Istanbul Stock Exchange dropped by 14%. A massive capital flight caused the international reserves to deplete by $5 billion even though the overnight rates reached a historic level of 6,200% (Ozatay and Sak, 2002). The rapid drying up of liquidity threatened the whole financial system, and on the 23rd of February, the government abandoned the peg and let the currency float. On that single day, the currency depreciated by nearly 30%. The rapid depreciation of the domestic currency damaged the balance sheets of the private sector, and especially those of the banking system which had already been shattered by the interest rate shocks (Celasun, 2002).

As a result of those adverse effects on both the demand and supply fronts, Turkey's real GDP collapsed by 7.5% in 2001, inflation rate jumped to 73.2%, and the unemployment rate rose from 5.5% in 2000 to the peak of 12.3% after the crisis.

3. Currency crisis analysis

In this section, we develop a model to capture the currency crises experienced by the Turkish economy. We start by introducing our model. Then, we introduce our data, and finally we depict the results.

3.1. The model

We consider the following model with Markov-switching heteroscedasticity and time-varying parameters (TVP):

$$\begin{aligned} \Delta N_t &= X_t \beta_{S_t} + e_t \\ \beta_{S_t} &= \beta_{S_{t-1}} + v_t \\ e_t &\sim \text{i.i.d. } N\left(0, \sigma^2_{S_t}\right) \\ v_t &\sim \text{i.i.d. } N(0, Q) \end{aligned} \tag{1}$$

where N_t is the (log) nominal exchange rate, thus, ΔN_t is the percentage change in the nominal exchange rate; X_t is the matrix of explanatory variables; and Q is a positive definite matrix. β_{St} is the vector of time-varying coefficients defined as follows:

$$\beta_{S_t} = (1 - S_t)\beta_{0t} + S_t \beta_{1t} \tag{2}$$

and, σ^2_{St} is defined as follows:

$$\sigma^2_{S_t} = \sigma^2_0 (1 - S_t) + \sigma^2_1 S_t \tag{3}$$

where $S_t \in \{0,1\}$ is the unobserved two-state Markov-switching variable that evolves according to the transition probabilities given below:

$$p = \begin{pmatrix} p_{00} & p_{01} \\ p_{10} & p_{11} \end{pmatrix} \tag{4}$$

where

$$\begin{aligned} p_{00} &= \Pr[S_t = 0 | S_{t-1} = 0] \\ p_{01} &= \Pr[S_t = 0 | S_{t-1} = 1] \\ p_{10} &= \Pr[S_t = 1 | S_{t-1} = 0] \\ p_{11} &= \Pr[S_t = 1 | S_{t-1} = 1] \end{aligned} \tag{5}$$

and

$$\begin{aligned} p_{00} + p_{10} &= 1 \\ p_{01} + p_{11} &= 1 \end{aligned} \tag{6}$$

According to this setting, if we define $S_t=0$ as the non-crisis state, in which the exchange rate market is under low speculative pressure, and $S_t=1$ as the crisis state, in which the exchange rate market is under high pressure to devaluate, we can conclude that $\beta_{St}=\beta_{0t}$ and $\sigma^2_{St}=\sigma^2_0$ in the non-crisis state; and that $\beta_{St}=\beta_{1t}$ and $\sigma^2_{St}=\sigma^2_1$ in the crisis state. This is the logic behind the regime-switching model.

3.2. Data and methodology

Here, we estimate the model given by Eqs. (1)–(6). In our analysis, we use a monthly data set covering the period 1986:2–2001:10. The percentage change in the nominal exchange rate, ΔN_t, is calculated as the first log difference of the nominal exchange rate defined as the value of a U.S. dollar in terms of Turkish Lira.[4] The matrix of explanatory variables, X_t, consists of the data vectors of the net international reserves, the domestic credit and a vector of constants. In particular, we use the percentage change in these variables calculated as first log differences. Following Chauvet and Dong (2004), we have chosen these indicators according to two criteria, namely the correlation of these variables with ΔN_t, and their ability to Granger cause ΔN_t.[5] Since we use monthly data in order to get a higher frequency, availability of data in monthly basis has been another factor influencing our choice of indicators. All data have been obtained from the website of The Central Bank of the Republic of Turkey (CBRT).[6]

The particular model we estimate is the following:

$$\begin{aligned} \Delta N_t &= \beta_{0t,S_t} + \beta_{1t,S_t}\Delta NIR_t + \beta_{2t,S_t}\Delta DC_t + e_t \\ \beta_{it,S_t} &= \beta_{it,S_{t-1}} + v_{it} \\ \beta_{it,S_t} &= (1 - S_t)\beta_{it,0} + S_t\beta_{it,1} \\ e_t &\sim \text{i.i.d. } N\left(0, \sigma^2_{S_t}\right) \\ v_{it} &\sim \text{i.i.d. } N\left(0, \sigma^2_{vi}\right), \quad i = 0,1,2 \end{aligned} \tag{7}$$

where ΔN_t is the first log difference of nominal exchange rate, ΔNIR_t is the first log difference of net international reserves; ΔDC is the first log difference of domestic credit; $\beta_{it,St}$ is the time-varying coefficient following a Markov-switching process for $i=0,1,2$; v_{it} is the error term for $i=0,1,2$; and $S_t \in \{0,1\}$ is as defined above.

[4] In particular, we take the average of daily nominal exchange rate to find the monthly rate. In order to find the daily nominal exchange rate, we take the average of the buying and the selling price of the nominal exchange rate.

[5] By taking into account the monthly data availability, we choose these variables from the list of the indicators presented by Kaminsky and Reinhart (1999), and Kaminsky et al. (1997). Our preferred list consists of the change in output, the private bank credits from the Central Bank, the trade deficit, the change in money supply (M1), the change in consumer price index (i.e., the CPI inflation rate), (domestic credit)/output, net foreign assets, net foreign exchange reserves, gross foreign exchange reserves, domestic credit, private banks foreign liabilities, real exchange rate, and (money supply)/(gross international reserves). We control for the nominal exchange rate in the relevant variables.

[6] The website of CBRT is http://www.tcmb.gov.tr/.

Table 1
Estimates of the currency crisis model

Parameters	Estimates	Standard Errors	p-values
p_{00}	0.942620**	0.022230	0.000000
P_{11}	0.675360**	0.092757	0.000000
σ_0	0.792668**	0.087198	0.000000
σ_1	2.719765**	0.243092	0.000000
σ^2_{v0}	0.273915*	0.116664	0.019914
σ^2_{v1}	0.013189	0.021615	0.542476
σ^2_{v2}	0.022123	0.023844	0.354683
Log-likelihood	−284.1277		

Notes: * and ** indicate significance at the 5% and 1% levels, respectively. Estimation is by maximum likelihood. Heteroskedastic-consistent standard errors according to White (1982) are shown. For convergence, we use 100 times the data matrix. The sample size is 189. We use the first 12 observations in order to get the initial parameter values and the remaining observations in order to get the results in this table.

3.3. Estimation results

The results of our estimation are given in Table 1.[7] The results in the first two rows of Table 1 are of particular interest to us. Note that p_{00} is the probability of being in state 0 in the current period, given that the economy is in state 0 in the previous period. Similarly, given that the economy is in state 1 in the previous period, p_{11} is the probability of being in state 1 in the current period. By using these estimates, we can calculate the expected duration of a non-crisis state and the expected duration of a crisis state. As shown by Kim and Nelson (1999, pp.71–72), the expected duration formula is given by:

$$E(D_j) = \frac{1}{1 - p_{jj}} \tag{8}$$

where $E(D_j)$ represents the expected duration of state j. Thus, we can calculate the expected durations of state 0 and state 1 as follows:

$$\begin{aligned} E(D_0) &= \frac{1}{1 - p_{00}} \approx 17 \\ E(D_1) &= \frac{1}{1 - p_{11}} \approx 3 \end{aligned} \tag{9}$$

Eq. (9) tells that the expected duration of a non-crisis state is about 17 months, and the expected duration of a crisis state is about 3 months.

The estimated values for the time-varying parameters, namely the constant ($\beta_{0t,0}$ and $\beta_{0t,1}$), the coefficient of ΔNIR_t ($\beta_{1t,0}$ and $\beta_{1t,1}$) and the coefficient of ΔDC_t ($\beta_{2t,0}$ and $\beta_{2t,1}$) are plotted in Figs. 1, 2 and 3, respectively. Since these parameters follow a Markov-switching process, in the figures, there are two plots for each parameter: one for state 0 and the other for state 1. In each figure, the solid line represents the value of the parameters in state 0 (i.e., the non-crisis state), and the dashed line represents the value of the parameter in state 1 (i.e., the crisis-state). In each figure, the vertical axis represents the value of the parameter and the horizontal axis represents time.

Finally, Fig. 4 plots the filtered probability of currency crisis for Turkey. In particular, the solid line represents the probability of a currency crisis, and the shaded areas show the currency crises defined as the circumstances in which the nominal depreciation of the currency is at least 6.5 percentage points, quarterly. The probability is quite stable and close to zero for most of the sample period except for the currency crisis periods.

The periods of crisis, which are represented by the jumps in the solid line of Fig. 4, match with the three big crisis the Turkish economy went through during the period we analyze. In particular, our indicators capture the high probability of the March 1991 crisis, which is caused by the sudden and huge reversal in capital flows following the Gulf War, two months before the realization, they perfectly match the January–April 1994 currency crises caused by a huge capital

[7] For the estimation, we have modified the MATLAB codes in the Econometrics Toolbox produced by James P. LeSage. This toolbox can be downloaded at http://www.spatial-econometrics.com/.

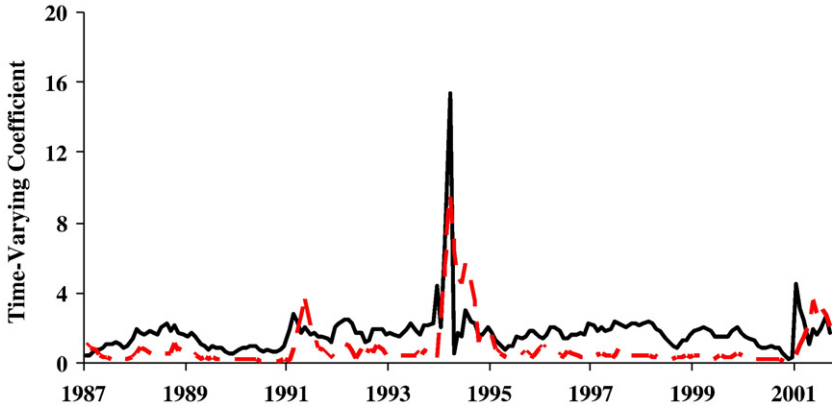

Fig. 1. The estimate of time-varying constant with Markov-switching process.

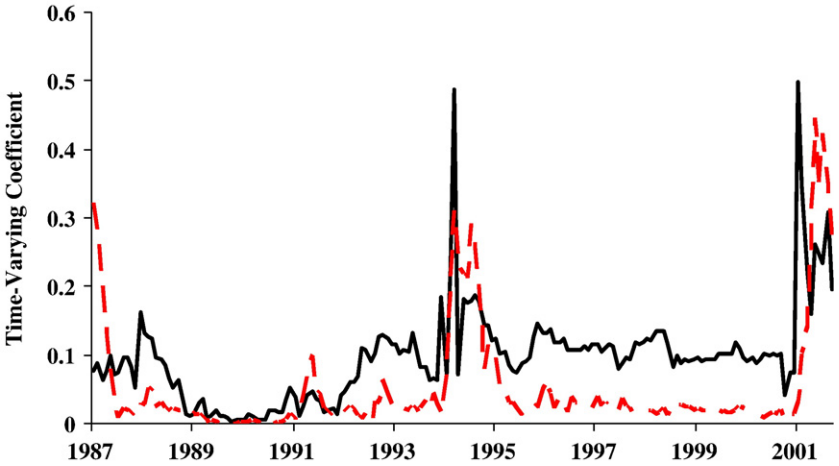

Fig. 2. The estimate of time-varying coefficient of ΔNIR with Markov-switching process.

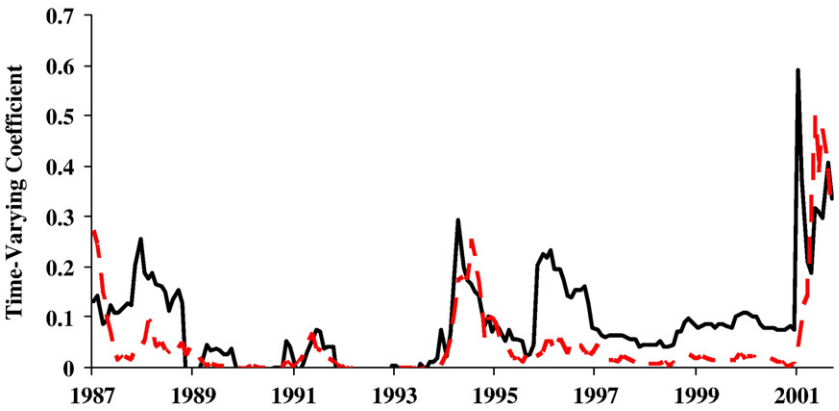

Fig. 3. The estimate of time-varying coefficient of ΔDC with Markov-switching process.

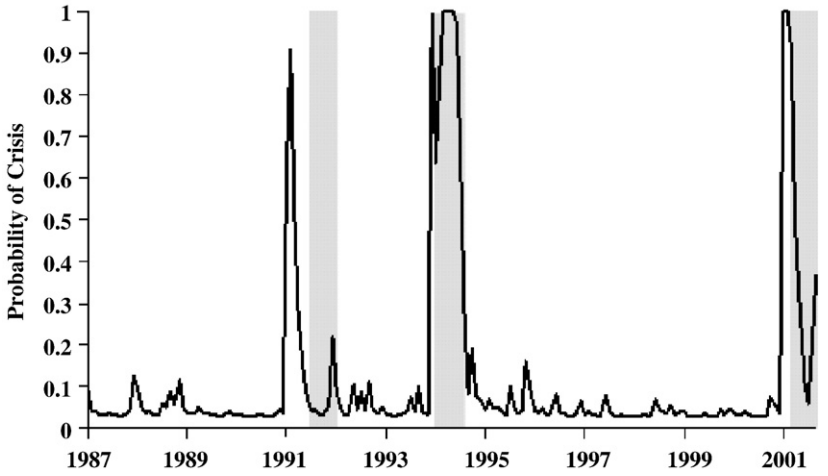

Fig. 4. Filtered probability of currency crisis. Notes: The solid line represents the probability of a currency crisis, and the shaded areas show the currency crises defined as the circumstances in which the nominal depreciation of the currency is at least 6.5 percentage points, quarterly.

outflow following a policy mistake by the government, and finally, they capture the February 2001 currency crisis, which ended the exchange-rate-based-stabilization program that had been in effect for about a year, one month before the realization. Thus, we can conclude that our estimation results capture the three main economic crises that took place during the period in question.

In order to justify the usage of Markov-switching approach for the currency crisis analysis, we compare the performance of TVP model and Markov-switching TVP model in Table 2. According to our model selection criteria, Markov-switching TVP is chosen. Moreover, log-likelihood ratio (LR) test supports our result by rejecting the null hypothesis of TVP model. However, the *LR*-test has been criticized by Hansen (1992, 1996), among others, because the standard regulatory conditions for the likelihood based inference are violated. Several attempts have been made to find the best powerful test that considers this violation (see Hansen, 1992, 1996; Gong and Marioano, 1997; Garcia, 1998; Ryden et al., 1998; Carrasco et al., 2004; Cheung and Erlandsson, 2005; Di Sanzo, 2007).

Following the lead of Di Sanzo (2007), we use the bootstrap approach to further justify the usage of Markov-switching approach. In particular, we derive the empirical distribution of the *LR*-statistic, which we then use to determine the significance of the statistics computed from the actual data. As shown by Di Sanzo (2007), the bootstrap approach is the best procedure compared to the approaches of Hansen (1992, 1996) and Carrasco et al. (2004). In particular, the bootstrap approach works well when the size of the sample is small, parameter changes are moderate, or the Markov chain is not persistent. Di Sanzo (2007) also shows that the bootstrap method has the higher power compared to other methods mentioned above.

In particular, we apply the following steps for our bootstrap analysis: (i) The *LR*-statistic is calculated by using the original data set; (ii) an artificial data set is created by random draws with replacement from the original data set; (iii) the

Table 2
Comparison of TVP and Markov-Switching TVP

	TVP	Markov-Switching TVP
Log-likelihood	−345.086	−284.128
AIC	1752.173	1644.255
SIC	6256.908	6208.375
HQ	2449.540	2350.816
LR- test	121.917	
LR-test 5% critical value	14.067	
Bootstrap *LR*-test	0.0667	

Notes: Following Vazquez (2004), the Akaike, Schwarz and Hannan–Quinn model selection criteria are computed as $AIC=-2L+2n$, $SIC=-2L+2n\log(T)$ and $HQ=-2L+2n\log(\log(T))$, respectively where L is the maximum value of the Gaussian log-likelihood function, n is the number of estimated parameters and $T=189$ is the number of observations.

Table 3
Estimates of the business cycle model

Parameters	Estimates	Standard Errors
p_{00}	0.803251**	0.114280
p_{01}	0.089345	0.089783
p_{10}	0.290212**	0.128436
p_{11}	0.152326	0.150604
p_{20}	0.000165**	0.000001
p_{21}	0.843354**	0.156975
ϕ_1	0.046386	0.116455
ϕ_2	0.206613**	0.071582
σ_0^2	0.001562**	0.000441
σ_1^2	0.000084*	0.000061
σ_2^2	0.000041*	0.000022
μ_0	−0.008823	0.009237
μ_1	0.030872**	0.003350
μ_2	0.006474*	0.003408
Log-likelihood	−136.715405	

Notes: ** and * indicate significance at the 5% and 10% levels, respectively. Estimation is by maximum likelihood. Heteroskedastic-consistent standard errors according to White (1982) are shown. The sample size is 64. The initial parameter values are all set to 0.5. The Akaike, Schwarz and Hannan–Quinn model selection criteria are computed as in Table 1.

LR^*-statistic is calculated for the artificial data set; (iv) repeat the process 100 times. At the end of this process, p-value of the bootstrap analysis is calculated as finding the fraction of the LR^*-statistic calculated from the artificial data set higher than the LR-statistic calculated from the original data set. The results are given in the last row of Table 2. As is evident, the p-value is calculated as 0.0667, which supports our initial findings of rejecting the null of TVP model.

4. Business cycle analysis

In this section, we develop a model to capture the business cycles experienced by Turkish economy. We start by introducing our model. Then, we introduce our data, and finally we depict the results.

4.1. The model

For the business cycle analysis of Turkey, we employ a three-state Markov-switching model following the idea of Garcia and Perron (1996). Saltoglu et al. (2003) uses a similar model to analyze the Turkish business cycle. However, having employed a two-state model they distinguish only the recessionary and non-recessionary states of the Turkish economy. By using a three-state model we take one step forward and obtain a convenient framework to decompose the non-recessionary state into high-growth and low-growth states. In particular, we consider the following model with three-state Markov-switching mean and variance:

$$\left(y_t - \mu_{S_t}\right) = \phi_1\left(y_{t-1} - \mu_{S_{t-1}}\right) + \phi_2\left(y_{t-2} - \mu_{S_{t-2}}\right) + e_t \tag{10}$$

$$e_t \sim N\left(0, \sigma_{S_t}^2\right) \tag{11}$$

where y_t is the percentage change (growth) in output; μ_{S_i} and $\sigma_{S_i}^2$ are the state-dependent mean and variance, respectively. In particular, we have:

$$\mu_{S_t} = \mu_0 S_{0t} + \mu_1 S_{1t} + \mu_2 S_{2t} \tag{12}$$

and

$$\sigma_{S_t}^2 = \sigma_0^2 S_{0t} + \sigma_1^2 S_{1t} + \sigma_2^2 S_{2t} \tag{13}$$

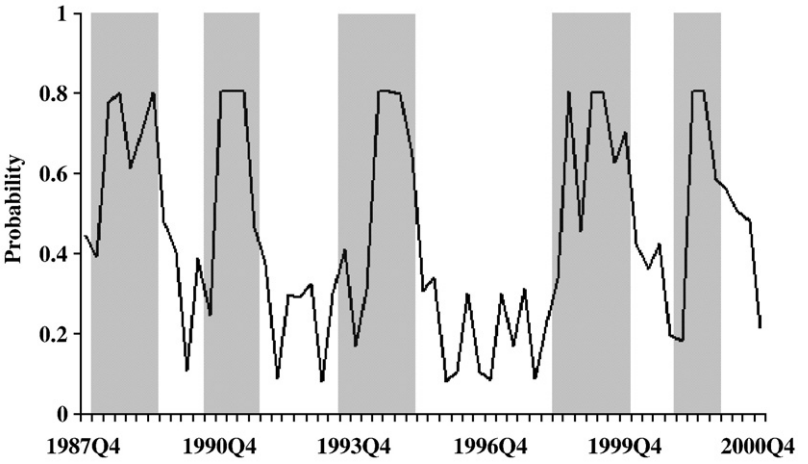

Fig. 5. Filtered probability of a recession. Notes: The shaded areas show the recessionary periods calculated by the OECD.

where $S_{jt} \in \{0,1\}$ is the unobserved three-state Markov-switching variable such that $S_{jt}=1$ if $S_{jt}=j$, and $S_{jt}=0$ otherwise, for $j=0,1,2$. S_t evolves according to the transition probabilities given below:

$$p = \begin{pmatrix} p_{00} & p_{01} & p_{02} \\ p_{10} & p_{11} & p_{12} \\ p_{20} & p_{21} & p_{22} \end{pmatrix} \tag{14}$$

where $p_{ij} = \Pr[S_t = j | S_{t-1} = i]$ and $\sum_{j=0}^{2} p_{ij} = 1$, for $j=0,1,2$, and for all i.

4.2. Data and methodology

We estimate the model given by Eqs. (10)–(14).[8] In our analysis, we use quarterly data covering the period 1987: Q1-2002:Q4. For the percentage change in output, y_t, we first seasonally adjust the real GDP data published at the website of CBRT and then take the first (log) difference.

4.3. Estimation results

The estimation results are given in Table 3. Table 3 represents the three different states of growth regimes in the Turkish economy: The *high growth regime* corresponds to a quarterly growth rate of 3.09%; the *low growth regime* corresponds to a quarterly growth rate of 0.65%; and finally, *a recession period* corresponds to a quarterly growth rate of −0.88%. It is also worth noting that, the variance of the percentage change in output takes its highest value in the recession periods.

Fig. 5 shows the filtered probability of a recessionary period where the shaded areas show the recessionary periods determined by the OECD.[9] According to Fig. 5, our analysis captures all of the recessionary periods determined by the OECD. These are: the 1988–89 stagnation that signaled the shortcomings of the export-led growth strategy adopted during 1980s, the 1990–91 recession caused by the Gulf War, the 1994 recession that followed the financial crisis in the same year, the 1998–1999 recession triggered by the Russian Crisis and deepened by the 1999 earthquake, and finally, the 2001 recession that followed the financial and currency crises that took place in November 2000 and February 2001.

Similarly, Fig. 6 shows the filtered probabilities of high-growth and low-growth regimes. Since we have three states in our model, a decrease in the probability of a recession implies an increase in the probability of a high-level and/or a

[8] For the estimation, we have modified the GAUSS codes of Kim and Nelson (1999).

[9] http://www.oecd.org/document/29/0,2340,en_2649_34349_35725597_1_1_1_1,00.html is the webpage of the OECD that publishes the OECD Composite Leading Indicators: Reference Turning Points and Component Series.

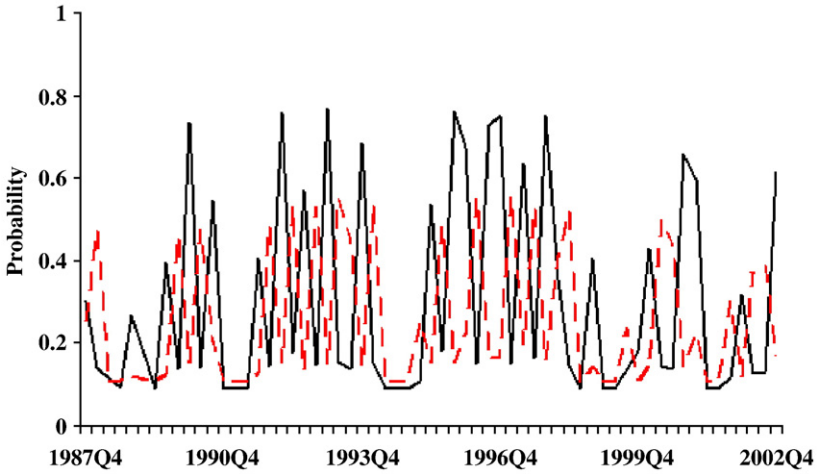

Fig. 6. Filtered probabilities of regimes with high-growth and low-growth. Notes: The solid line represents the probability of a high-growth regime, and the dashed line represents the probability of a low-growth regimes.

low-level growth. As is evident by Fig. 6, ignoring all the recessionary periods, we observe that, high- and low-growth regimes do not move in a parallel fashion but follow each other. This justifies our choice of a three-state model that enables us to decompose the non-recessionary periods.

As before, by using Eq. (8), we can calculate the expected durations of state 1, state 2, and state 3 as follows:

$$E(D_0) = \frac{1}{1-p_{00}} \approx 5.1 \tag{15}$$

$$E(D_1) = \frac{1}{1-p_{11}} \approx 1.1 \tag{16}$$

$$E(D_2) = \frac{1}{1-p_{22}} \approx 1.4 \tag{17}$$

Note that, for Eqs. (15) and (16), we used the values of p_{00} and p_{11} obtained from Table 3 and, for Eq. (17), we calculated p_{22} by using Table 3 and Eq. (14). Eq. (15) says that the expected duration of a recession is around 5 quarters, Eq. (16) says that the expected duration of a high-growth regime is around 1 quarter, and finally, Eq. (17) says that the expected duration of a low-growth regime is again around 1 quarter. Since high- and low-growth regimes follow each other according to Fig. 6, these low duration values of high- and low-growth regimes are not surprising.

In order to justify the usage of Markov-switching approach for the business crisis analysis, we compare the performance of AR(2) model and Markov-switching AR(2) model in Table 4. According to our model selection

Table 4
Comparison of AR(2) and Markov-switching AR(2)

	AR(2)	Markov-Switching AR(2)
Log-likelihood	−155.691	−136.715
AIC	317.383	301.431
SIC	336.336	389.880
HQ	319.934	313.338
LR-linearity-test	37.952	
LR-test 5% critical value	16.919	
Bootstrap *LR*-test	0.0916	

Notes: Following Vazquez (2004), the Akaike, Schwarz and Hannan–Quinn model selection criteria are computed as $AIC = -2L + 2n$, $SIC = -2L + 2n\log(T)$ and $HQ = -2 + 2n\log(\log(T))$, respectively where L is the maximum value of the Gaussian log-likelihood function, n is the number of estimated parameters and $T = 64$ is the number of observations.

criteria, Markov-switching AR(2) model is chosen. Moreover, log-likelihood ratio (LR) test rejects the null hypothesis of AR(2) model. Finally, the bootstrap *LR*-test supports our results.

5. Conclusions

We used a time-varying dynamic factor model with regime switching to construct and estimate the leading indicators of the currency crises for Turkey. We found that the model is successful in capturing all the currency crises in the sample period and that the deterioration of net international reserves and domestic credits perform well as leading indicators.

After that, we analyzed the business cycles of the Turkish economy, by using a three-state univariate Markov-switching model. The model captures all the recessionary periods the Turkish economy went through in the sample period. Furthermore, the three-state nature of the model enables us to decompose the non-recessionary state into two sub states.

A combined look at the results of the two models has important policy implications in the sense that most of the recessionary periods of the Turkish economy during the sample periods can be attributed in great part to currency crises.

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