

TÜSİAD-KOÇ UNIVERSITY ECONOMIC RESEARCH FORUM
WORKING PAPER SERIES

CAN TURKISH RECESSIONS BE PREDICTED?

Adrian Pagan

Working Paper 1027
October 2010

TÜSİAD-KOÇ UNIVERSITY ECONOMIC RESEARCH FORUM
Rumeli Feneri Yolu 34450 Sarıyer/Istanbul

Can Turkish Recessions Be Predicted?

Adrian Pagan

October 10, 2010

Contents

1	Introduction	1
2	Recognizing a Recession	3
3	Predicting a Recession with GDP Growth Data	7
4	Predicting Recessions: Using a Small Structural VAR to Predict GDP Growth	10
5	Can Non-linear Models of GDP Growth Help?	14
6	Predicting Recessions: Indicators of Future Growth	17
7	Conclusion	18
8	References	18

1 Introduction

There is much scepticism about the ability to predict recessions. Harding and Pagan (2010b) have argued that this is because the definition of a recession involves the signs of future growth rates of economic activity and there is little predictability of these from the past. Turkey represents an interesting case study since growth in Turkish GDP features quite high serial correlation, suggesting that growth itself is predictable. Thus I want to examine whether

it is possible to predict recessions in Turkey. As there seems only a small published literature on this it will be necessary to indicate what definition of recession is to be used and what information might be available to make a prediction of such an event.

In section 2 a definition of a recession is given that revolves around isolating peaks and troughs in a series that represents economic activity. Although the presentation will concentrate upon quarterly data it can be extended to monthly series, although there is little to be gained from doing so for an understanding of the prediction issues. Section 3 then uses that definition to examine whether there is some predictability for recessions in Turkey using various sets of information. These sets are constructed in a number of ways. Firstly, in order to establish the basic themes of the paper, only information on the growth rates in activity is used. This turns out to provide little that can be exploited for recession prediction. Secondly, a small linear dynamic model of the Turkish economy is constructed and used to make recession predictions. Although the latter improves the prediction record when compared to the situation when only growth information is used, it is only marginally better, except for the last recession. Finally, we ask whether a non-linear dynamic model - a Markov Switching model of Turkish growth - might be more efficacious, but find in the negative.

It might have been anticipated that neither the linear nor non-linear models would prove particularly useful for the predictive task, since they only utilize information on past events, and any major improvement in predictive efficacy is likely to require the application of series capturing the future shocks affecting the economy. In the US and Euro area there are quite a few series that have been suggested for this purpose e.g. the term structure of interest rates, indices such as the Business Conditions Index published by the Federal Reserve Bank of Philadelphia - Aruoba et al (2009) - and the Euro-Sting model indicators set out in Camacho and Perez-Quiros (2010). Such data does not seem to be readily available in Turkey. We experiment with the US and Euro-Area indicators to see if they might provide some useful information about recessions in the Turkish economy, in the event that these are connected with a global downturn. We also canvass the use of an index of capacity utilization which has appeared in regressions explaining Turkish GDP growth. There may be other series that could be used for this purpose but they do not seem to be readily available. It would probably be useful if whatever indicators are available were gathered and made accessible for macroeconomic research on business cycles.

2 Recognizing a Recession

Figure 1 shows the log of seasonally adjusted Turkish quarterly real GDP, y_t , over the period 1987:4 to 2010:1.¹The six recessions and the point they are at in the graph are 1988:4-1989:2 (5), 1991:1-1991:2 (14), 1994:2-1995:1 (27), 1998:4-1999:4 (45), 2000:1-2001:4 (54) and 2008:4-2009:3 (85). For graphical purposes the data has been mean corrected and .4 added on so as to keep the series between zero and unity. There are six obvious recessions. The one between 1990:4 and 1991:2 is the least striking. Figure 2 shows it was a shallow recession and one in which there was not a smooth rise from the trough in 1991:2.

Now, rather than look at the pictures to decide where the turning points are, we can automate the process of selecting them. A *peak* marks the end of an expansion and a trough the end of a recession. A program that we use to date quarterly series like this is the BBQ program.² BBQ derives from the principles set out in Bry and Boschan (1983) and underlies much of the NBER business cycle dating philosophy. It is a WYSIWYG program, as evidenced by putting the turning points identified by BBQ on the graph of the log of Turkish GDP - see Figure 1 where the grey areas are BBQ-defined recession periods. Note that the shallow recession we have just mentioned was identified by BBQ. Indeed, following our standard strategy, BBQ was run on this data first and then the outcomes identified by the program were visually verified. So the first point to make is that BBQ isolates turning points in a series representing economic activity. It is worth noting that we could have just used the original GDP data rather than the log of it to locate the turning points. They are the same in both series due to log being a monotonic transformation. It is more instructive to work with the log of GDP, as the changes in that series are approximately growth rates. Given the fact that BBQ reliably finds turning points we can think more formally about how one detects a recession by looking at the rules that are written into BBQ.

The basic rules that BBQ uses to locate a set of turning points are as follows.

¹With y_t being the log of GDP the data used in our analysis is the average $(y_t + y_{t-1} + y_{t-2} + y_{t-3})/4$, which is known to eliminate an evolving seasonal pattern. Other methods of seasonal adjustment such as X11-ARIMA might be employed but this method is simple and isolates the business cycle quite well.

²Available at <http://www.ncer.edu.au/data/>

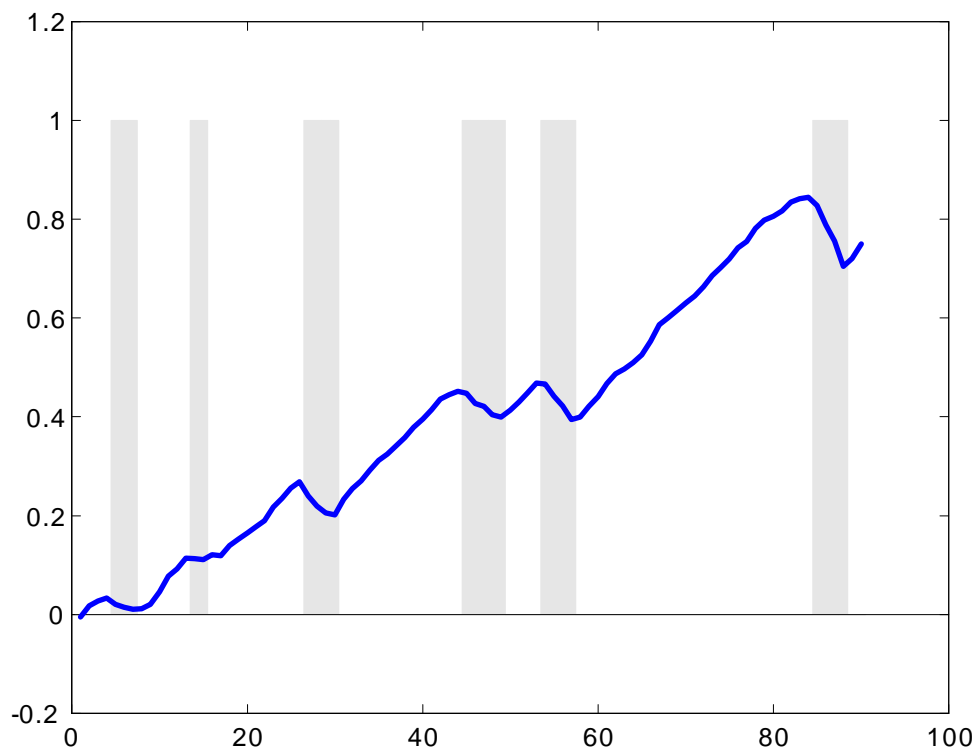


Figure 1: S.A. log GDP and Recession Periods for Turkey, 1987:4-2010:1

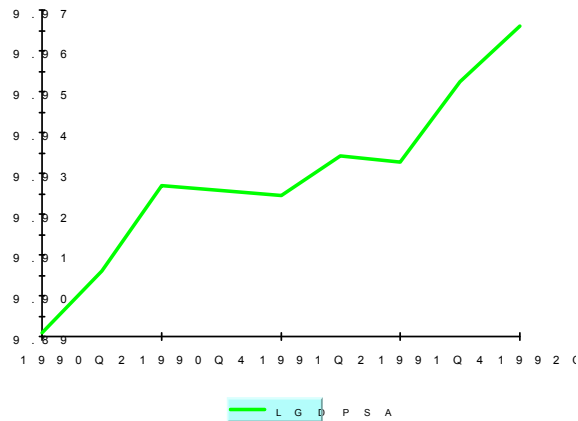


Figure 2: The Early 1990s Recession and Expansion

1. A *peak* occurs at time t if y_t is greater than $\{y_{t-1}, y_{t-2}, y_{t+1}, y_{t+2}\}$. Thus 2000:4 is a peak since the values in $\{y_{2000:2}, y_{2000:3}, y_{2000:4}, y_{2001:1}, y_{2001:2}\}$ are $\{10.2432, 10.2621, 10.2826, 10.2801, 10.2543\}$. Why choose two quarters on either side of the potential peak? The reason is the feeling that a recession (time between peak and a trough) should last for some minimal time, otherwise recessions will be called too often. By convention this has become 2 quarters (or five months if one uses monthly data).³ This could be changed if one wished. For Turkey it would matter only a little if one moved to one quarter as the minimum length of a recession, since there is just one period of negative growth in what one would most likely think of as an expansion phase (1991:4, see Figure 2). In countries such as the US and Australia it would matter a lot, as these often have a single quarter of negative growth in expansions. The point is that a recession is an unusual event, and so some convention needs to be established about how such behaviour in GDP is to be recognized. One might also apply some quantitative rules e.g. the decline in GDP has to be larger than some specified value. This might be used to eliminate the recession of 1990:4-1991:2 in Turkey but, although this is sometimes done informally, it is not common. It should be noted that the BBQ rule does not coincide with that often used in the press that a recession is

³The NBER Dating Committee uses the five monthly rule when finding the turning points in the US economy.

two consecutive periods of negative growth. Nor does it replicate rules that sometimes appear in the academic literature e.g. Fair (1993) has a recession occurring in time t if there are two consecutive negative growth rates in GDP in the five quarters that begin in t .

2. There are other constraints that BBQ uses such as a minimal length for a complete cycle i.e. the period from a peak to the next peak, but these are of smaller importance and won't detain us here.

3. Once the turning points have been isolated it is possible to determine where recessions and expansions occurred. It is convenient to summarize this information by constructing a series S_t that takes the value unity when we are in an expansion and zero when we are in recession. Thus, when we are concerned with predicting a recession at time $t + 1$ we will be asking what the chance is that $S_{t+1} = 0$. It will also be convenient to define $R_t = 1 - S_t$ as then $R_t = 1$ indicates a recession.

4. The condition for a peak can be expressed in terms of growth rates in economic activity. When that is done a peak at t occurs when $\{\Delta y_t > 0, \Delta_2 y_t > 0, \Delta y_{t+1} < 0, \Delta_2 y_{t+2} < 0\}$, where $\Delta_2 y_t = y_t - y_{t-2} = \Delta y_t + \Delta y_{t-1}$ is six-monthly growth. Another way of expressing this is to adopt the conventional definition that a recession starts the period after a peak while an expansion begins the period after a trough - see Estrella and Trubin (2006). Using that perspective we can alternatively express a turning point as a change in state viz. $S_t = 1 \rightarrow S_{t+1} = 0$ if there is a peak at t . Thus, if $\{\Delta y_t > 0, \Delta_2 y_t > 0, \Delta y_{t+1} < 0, \Delta_2 y_{t+2} < 0\}$, then there is a change from expansion to recession. If these conditions are not satisfied then we remain in the current state i.e. $S_t = 1 \rightarrow S_{t+1} = 1$. Thus to know if there has been a change in state we will need to know future outcomes and these are dependent on whether the events $\{\Delta y_{t+1} < 0, \Delta_2 y_{t+2} < 0\}$ occur.

As Harding and Pagan (2010b) observe the states S_t are governed by a recursive relation

$$\begin{aligned}
 S_{t+1} &= S_t S_{t-1} [1 - \mathbf{1}(\Delta y_{t+1} \leq 0) \mathbf{1}(\Delta y_{t+1} + \Delta y_{t+2} \leq 0)] \\
 &\quad + S_t (1 - S_{t-1}) \\
 &\quad + (1 - S_t) (1 - S_{t-1}) \mathbf{1}(\Delta y_{t+1} > 0) \mathbf{1}(\Delta y_{t+1} + \Delta y_{t+2} > 0),
 \end{aligned} \tag{1}$$

where $\mathbf{1}(\mathcal{A}) = 1$ if \mathcal{A} is true and zero otherwise.⁴ We wish to predict S_{t+1}

⁴There is a small complication caused by completed cycles having a minimum duration of five quarters. Only occasionally does this constraint bite.

using the information available at t (designated by F_t). Then (1) points to the fact that any prediction of S_{t+1} requires some values to be assigned to $\{S_t, S_{t-1}\}$, as well as the future signs of Δy_{t+1} and $\{\Delta y_{t+1} + \Delta y_{t+2}\}$. As the latter depend upon the nature of the process generating Δy_t , it will be necessary to consider various candidates for this in the following sections. Notice however that it is the sign of Δy_t that must be predicted rather than Δy_t itself.

3 Predicting a Recession with GDP Growth Data

We are then interested in whether a recession can be predicted at time $t + 1$ using information available at t i.e. in predicting whether $S_{t+1} = 0$ (or $R_{t+1} = 1$). To make this concrete position ourselves at 2000:4 and ask whether there will be a recession in 2001:1. To perfectly predict $S_{2001:1}$ we need to know the sign of the GDP growth rates in 2001:1 and 2001:2. If the growth rates were independent then knowing these past values will be of no use in predicting the future growth rates *per se*. Now in many countries there is very little persistence in growth rates of GDP e.g. the UK and Australia. But in Turkey there is quite strong first order serial correlation in growth rates of the order of .7. *Prima facie* this might look advantageous but we will see later that it is not.

Suppose we know that $S_t = 1$ and $S_{t-1} = 1$. From (1) the probability of a recession given that we are in an expansion at t and some information F_t will be

$$\begin{aligned} \Pr(R_{t+1} = 0|F_t) &= E\{\mathbf{1}(\Delta y_{t+1} \leq 0) \mathbf{1}(\Delta y_{t+1} + \Delta y_{t+2} \leq 0) | F_t\} \\ &= g(F_t). \end{aligned}$$

The functional relation $g(\cdot)$ will generally be non-linear for two reasons. One is that the conditional expectations will be non-linear in F_t as they must lie between zero and unity, but it also may be that Δy_{t+j} ($j = 1, 2$) depends in a non-linear way upon F_t . In most instances $g(\cdot)$ will not be analytically derivable. If the number of elements in F_t is limited then one can use non-parametric methods to estimate $g(\cdot)$ as in Harding and Pagan (2010a). Unlike that paper it is important to make the $g(\cdot)$ function monotonic, given that it is a probability, and Harding (2010) shows how one can adjust the non-parametric estimates to impose monotonicity in a reasonably simple way.

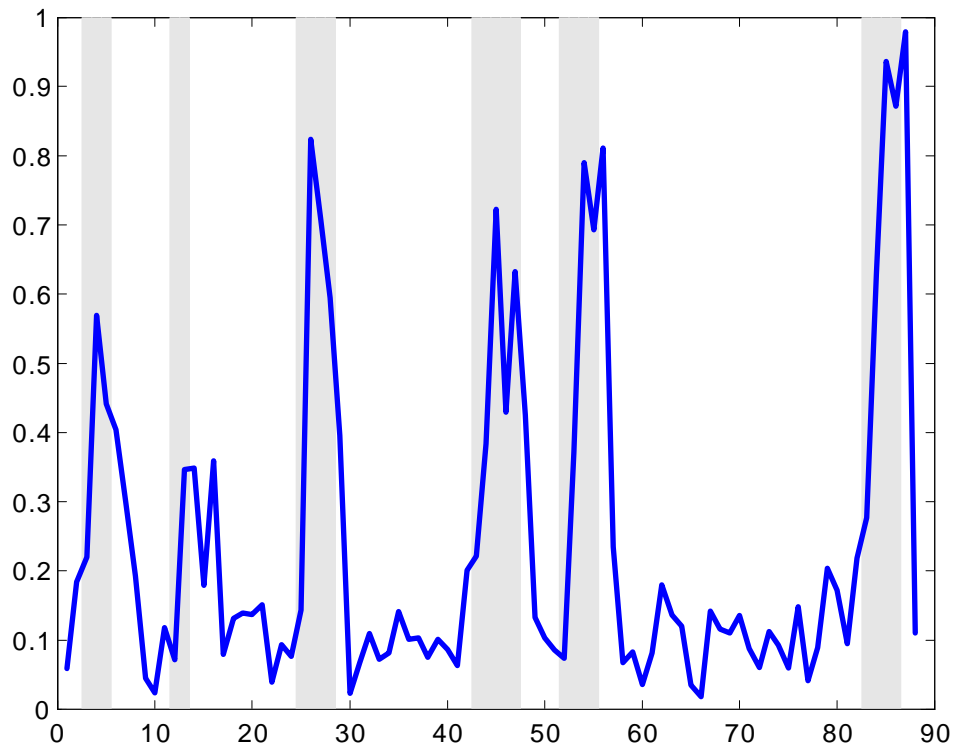


Figure 3: Probability of Recession Conditioned on GDP Growth in Previous Quarter

Figure 3 shows $\Pr(R_{t+1}|\Delta y_t)$ from 1987:4 to 2010:1 i.e. $F_t = \Delta y_t$, while Table 1 focuses upon these predicted probabilities during the 2001 recession.⁵

⁵Although we will write $\Delta y_t, S_{t-1}$ etc. as the available information we will mean all the past values of these quantities.

Prediction At t /For $t + 1$	$\Pr(R_{t+1} = 1 \Delta y_t)$	R_{t+1}
2000:4/2001:1	.06	1
2001:1/2001:2	.55	1
2001:2/2001:3	.94	1
2001:3/2001:3	.82	1
2001:4/2002:1	.94	0

This is a typical pattern - the first period of the recession is predicted with very low probability, but it then rises as the recession gets underway. Thus at the time the recession emerges i.e. $S_{t+1} = 0$, we would have prediction probabilities for the various Turkish recessions of .22 (1988:4), .07 (1991:1), .14 (1994:2), .22 (1998:4), .07 (2001:1) and .28 (2008:4). If we think that a critical value here is .5 (a fairly common choice) then none of the six recessions would have been predicted using current GDP growth.⁶ To put these numbers into context, since 24% of the time was spent in recession over 1987-2010, if you just allocated a value of .24 every period you would almost always do better than trying to exploit the information available on growth rates - the single exception being for the last recession.

As mentioned before an important element in recession prediction is the ability to predict negative growth i.e. a high value of $\Pr(\Delta y_{t+1} \leq 0|F_t)$ is desirable. Now, if $F_t = \Delta y_t$, the fact that there is strong positive serial correlation in GDP growth in Turkey militates against successfully predicting $\Delta y_{t+1} < 0$, since a positive growth in the previous period points towards it being positive again. Indeed, the correlation of $\psi_t = 1(\Delta y_{t+1} < 0)$ with ψ_{t-1} is .59.⁷ Hence it is very difficult to predict negative growth coming out of an expansion. Only after the recession has arrived will the strong dependence in Δy_t make the probability of $\Delta y_{t+1} < 0$ substantial. A non-parametric estimate of the $\Pr(\Delta y_{t+1} < 0|\Delta y_t)$ shows that for small positive growth rates in GDP the probability is around .4, and so less than the critical value of .5.⁸

⁶The issue of deciding on a threshold is a difficult one. The choice raises similar issues to balancing Type 1 and Type 2 errors in hypothesis testing.

⁷Under a normality assumption for Δy_t Kedom(1980) gave an expression for the serial correlation coefficients of $1(\Delta y_{t+1} > 0)$ in terms of the serial correlation coefficients of Δy_t .

⁸The probability is identical to $E(1(\Delta y_{t+1} < 0)|\Delta y_t)$ given the binary nature of the event $1(\Delta y_{t+1} < 0)$ so we can estimate the probability with a non-parametric estimate of

Thus, even if there is close to zero growth at t , we would still not attach a high probability to negative growth in the next period.

In practice it is unlikely that the information available to predict recessions would be current period GDP growth (Δy_t) due to the lags in assembling national income data. In Australia the most we could hope for is Δy_{t-1} . Even then this quantity can be subject to substantial revision, and even a possible sign change. This has two consequences. One is that it will no longer be the case that we would know S_t i.e. whether we are in an expansion or a recession when the prediction needs to be made. If it was the case that S_{t-1} was known to be unity, then a positive Δy_t would mean that $S_t = 1$, since the peak in y_t would not be at $t - 1$. But if we don't know Δy_t then it might be negative. Since a negative growth can occur in an expansion, S_t could be either 0 or 1, and so we will need to predict this, as well as Δy_{t+j} ($j = 1, 2$). This problem of trying to come up with the latest GDP growth outcome is often referred to as "now-casting".

4 Predicting Recessions: Using a Small Structural VAR to Predict GDP Growth

In an attempt to expand the information set used to perform the predictions we need to build models for Δy_t . To this end a small structural Vector Autoregression (SVAR) model was fitted to Turkish data from 1990:3 until 2010:1.⁹ The length of sample was determined by the availability of a short run interest rate (i_t). The variables fitted were the logs of exports (x_t), GDP (y_t), Gross National Expenditure (n_t) - "absorption" in international economic models - CPI inflation (π_t) and the real exchange rate (q_t). The model is a smaller version of that used by Dungey and Pagan (2000) for Australia, and has close connections with that used in Catão and Pagan(2010) when modelling Brazil and Chile. In the latter paper a model based on a typical New Keynesian model for an open economy was augmented with extra variables if the data supported such additions. Here we do not have the forward looking expectations in equations that appeared in Catão and Pagan (2010). For our purpose this did not seem necessary as the expectations are always

the conditional mean of $1(\Delta y_{t+1} < 0)$.

⁹Sometimes the sample started at 1990:4 and ended at 2009:4, depending on the lags and data availability.

replaced with observable variables and so would show up as extra regressors if required. The equations can then essentially be solved to determine a data generating process for Δy_t .

A few comments on the SVAR equations in (2)-(8) are in order. First, variables with a tilde are deviations from a fitted deterministic trend and so can be regarded as "gaps". The trends are much the same for GDP and GNE but that for exports is almost twice as large. Exports typically grow faster than GDP for many countries and this is handled in the trade literature using gravity models. Some of this disparate behaviour comes about due to the removal of trade barriers. As these are largely exogenous to the economic outcomes of the country being examined, we simply allow the trend growth in exports to be higher than GDP. A second order SVAR was taken to be the reference point, reflecting the fact that many New Keynesian models imply a VAR(2) as their solved solution. The data strongly supports this for some equations. If the second lags of variables were not significant they were deleted.

Both exports and GNE seemed to have a seasonal pattern, and thus these series were smoothed by a fourth order moving average, just as for GDP. After this seasonal adjustment, the exports, GNE and GDP data were converted to percent deviations. Data for interest rates and inflation have been converted to annual percentages and the log of the real exchange rate was multiplied by 400 to be consistent with these units.

Because the model is recursive OLS was applied to estimate the coefficients. Equations (2)-(8) provide the estimated coefficients with the absolute values of the t ratios below the coefficients. The ε_t^j have standard deviation of unity and so the scalar multiplying them is the standard deviation of the shock. The shocks were generally uncorrelated, the exception being those associated with the real exchange rate and GNE equations. Hence one cannot separately interpret those shocks.

$$\tilde{x}_t = 1.55\tilde{x}_{t-1} - .56\tilde{x}_{t-2} - .007q_{t-1} + 1.86\varepsilon_t^x \quad (2)$$

(15.8) (5.5) (2.2)

$$\tilde{n}_t = 1.67\tilde{n}_{t-1} - .78\tilde{n}_{t-2} - .013rr_{t-1} + 1.98\varepsilon_t^n \quad (3)$$

(21.1) (9.5) (.9)

$$\tilde{y}_t = .86\tilde{y}_{t-1} - .07\tilde{y}_{t-2} + .53\tilde{n}_t - .41\tilde{n}_{t-1} - .001q_{t-1} + .022\tilde{x}_t + .46\varepsilon_t^y \quad (4)$$

(11.9) (1.6) (22.0) (10) (1.5) (3.7)

$$\pi_t = 1.33\tilde{y}_t - .27q_{t-1} + 16.4\varepsilon_t^\pi \quad (5)$$

(3.5) (11.3)

$$i_t = .77i_{t-1} + .14\pi_t + .09\tilde{y}_t - .03q_{t-1} + 7.1\varepsilon_t^i \quad (6)$$

(12.4) (2.7) (.6) (1.5)

$$q_t = .81q_{t-1} + .44(rr_t - rr_t^*) - .46\pi_{t-1} + 27.7\varepsilon_t^q \quad (7)$$

(12.3) (2.4) (2.4)

$$rr_t = i_t - \pi_t \quad (8)$$

Exports are viewed as being affected by the real exchange rate but also growing with some exogenous world trade variable that is not specified. Thus the export shock can be interpreted as the deviation of world trade from a constant growth path. The absorption equation is motivated by the conventional Euler equation for consumption, where the real rate of interest affects expenditure decisions, but it is entered with a lag to reflect institutional realities. The GDP equation reflects the split up of expenditure into domestic and external components. The shock here could be regarded as a preference shock between foreign and domestic goods. Inflation responds to the output gap and the exchange rate. The latter is highly significant and parallels what was found for Chile and Brazil in Catão and Pagan (2010). An interest rate rule is used and it exhibits a dependence on the output gap, inflation and the real exchange rate. The last variable was used by Alp and Elekdag (2010) in their work, although here the evidence for it is much weaker. Finally the real exchange rate responds to the real interest rate differential (the real interest rate based on three month Treasury Bills for the US was taken to be the foreign real rate) but there also seemed to be a negative effect from lagged inflation. We note that the coefficient on the real interest differential is just half of what one might expect from uncovered interest parity, although one cannot make such a simple comparison without having some measure of

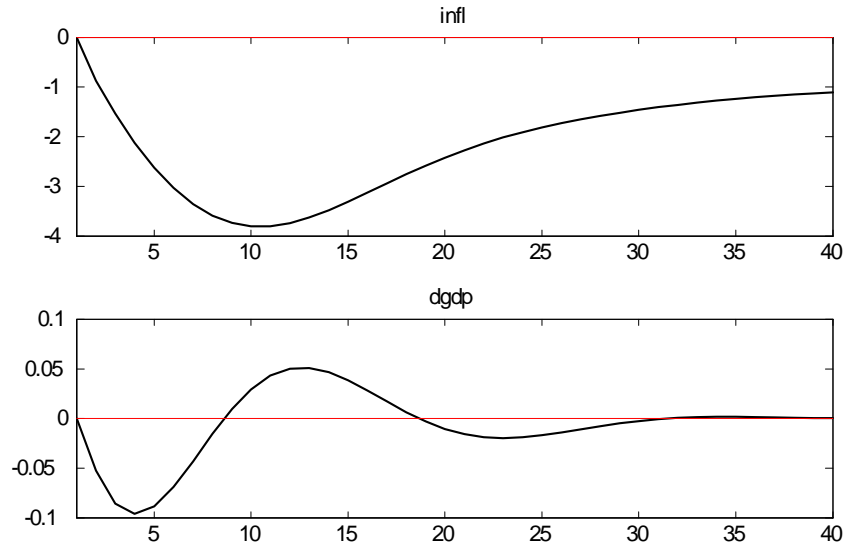


Figure 4: Monetary Impulses for Annual Inflation and Quarterly GDP Growth for the Turkish SVAR

exchange rate expectations.

Figure 4 shows the impulse responses of annual inflation (*infl*) and quarterly GDP growth (*dgdgdp*) to a one standard deviation interest rate shock. One standard deviation is quite large, around 700 basis points. It is therefore apparent that monetary policy does not have strong effects upon GDP growth but it does have strong effects on inflation, and these come through the exchange rate. This is similar to what was found by Catão and Pagan for Brazil and Chile. Simulating the SVAR model results in an average duration of recessions and expansions of 4.6 and 10.7 quarters respectively. For the period since 1987 the averages in the data for the six complete cycles were 3.7 and 11.3, so the match is reasonable.

Now there are quite a few variables in the SVAR that could be used as F_t . It seems efficient that one utilize $E(\Delta y_{t+1}|F_t)$ from the SVAR model as an explanatory variable in the Probit model for R_t . Given the estimated parameters of the SVAR above we find that¹⁰

¹⁰Ideally one would evaluate $\Pr(R_{t+1}|F_t)$ using the formula (1). This can be done by simulating the SVAR model and computing the required expectations non-parametrically.

$$E_t(\Delta y_{t+1}|F_t) = .034\tilde{x}_t - .14\tilde{y}_t + .475\tilde{n}_t - .0069rr_t - .0012q_t \\ - .012\tilde{x}_{t-1} - .07\tilde{y}_{t-1} - .413\tilde{n}_{t-1}.$$

Using this for F_t the probabilities of a recession from the Probit model are given in Figure 5. As a simple summary it is once again useful to look at the first period probability of a recession and these are $\{.07, .26, .39, .03, .65\}$, which are superior to those which used growth in GDP viz $\{.07, .14, .22, .07, .28\}$.¹¹ So the SVAR model does provide a set of variables that improve on the predictive power, particularly for the last recession. Nevertheless, one should be careful about this apparent success, as it is unlikely that variables such as \tilde{n}_t and \tilde{y}_t would be available to make a prediction, just as Δy_t was not, although variables such as rr_t and q_t might well be. Indeed, if we assume that only lagged information is available, the prediction probabilities decline. So the .39 for the 1998/9 recession becomes .29 and the last recession becomes .42. Again this implies that a good now-cast of absorption, GDP and exports is needed.

5 Can Non-linear Models of GDP Growth Help?

The previous section drew attention to studying $\Pr(\Delta y_{t+1} < 0|F_t)$ as a first test of the ability to predict a recession. So far we have assumed that there is effectively a linear model connecting Δy_t and past values of GDP growth as well as other variables (in the SVAR case). One might allow Δy_t to also depend upon the state of the economy at $t-j, S_{t-j}$, as this is often mentioned as a possibility. Of course, since S_{t-j} depends on growth rates in GDP, one could assert that all that is needed is observable growth rates. But this ignores the fact that S_t is a parsimonious summary of these, and that it also introduces some non-linear structure through the fact that S_t depends on the sign of the growth rate and not the magnitude. Fitting a Probit model to $1(\Delta y_{t+1} < 0)$, with explanatory variables Δy_t and S_t suggests that there is little separate influence of S_t .

An alternative modification is to allow growth in economic activity to be a non-linear function of past growth. Many non-linear models for Δy_t

¹¹The 1988:4-1989:2 recession is not included as there was no data on rr_t .

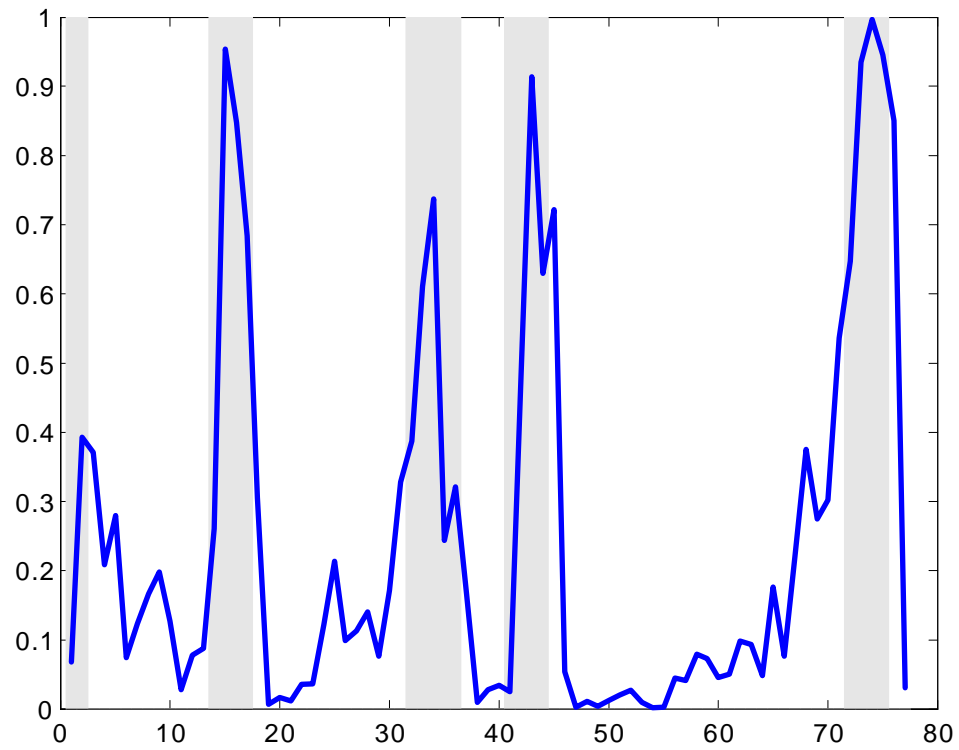


Figure 5: Probability of Recession Conditioned upon Expected Value of Growth from SVAR Model

have been proposed, and often one sees comments that these produce better forecasts of GDP growth than linear models. A popular one that is used in a lot of the business cycle literature is that of a Hidden Layer Markov Chain, introduced into econometrics by Hamilton (1979). This is often given the shortened descriptor of a Markov Switching (MS) model, with the simplest variant having the form,

$$\Delta y_t = \mu_t + \beta \Delta y_{t-1} + \sigma \varepsilon_t \quad (9)$$

$$\mu_t = \mu_1 \xi_t + (1 - \xi_t) \mu_0 \quad (10)$$

$$p_{ij} = \Pr(\xi_t = i | \xi_{t-1} = j), \quad (11)$$

where ξ_t is a binary random variable that follows a first order Markov process with transition probabilities p_{ij} and ε_t is *n.i.d*(0, 1). More complicated models are available but we doubt that these improve the recession predictions - see for example the discussion in Engel et al (2005). The MS model in (9) – (11) was estimated for Turkey using data from 1988:1-2008:4, producing the results in Table 2.¹²

	est	t
β	.275	2.5
μ_1	1.215	4.2
μ_0	-1.013	-2.4
p_{11}	.92	5.1
p_{01}	.26	2.0
p_{10}	.08	2.0
p_{00}	.74	1.8
σ^2	.625	5.4

The probability of getting $\Delta y_{t+1} < 0$ given Δy_t from this model was found by simulation to be .36 for small positive values of Δy_t . Thus there is actually a smaller probability of getting a negative growth rate at $t + 1$ than what would have been found from a model in which growth just depended linearly on past growth. It may be that the MS model gives a better fit to the data but it produces a worse record at predicting recessions.

¹²The package used for estimation was Perlin (2009).

6 Predicting Recessions: Indicators of Future Growth

So far we have looked at whether one can predict recessions with the past history of macroeconomic variables and found that this is not likely. The fact that we are looking for the shocks that cause movements in future growth suggests that greater success might be had by concentrating upon variables that contain some forward-looking information. A number of these have been suggested for the US and the Euro Area. In Harding and Pagan (2010b) the best predictor for U.S. recessions seemed to be the Business Conditions Index constructed by Aruoba et al (2009) (ADS) and maintained by the Federal Reserve Bank of Philadelphia. This is introduced into a Probit model for Turkish recessions along with the SVAR model predictions constructed earlier. The t ratio for the ADS variable was around unity, so there was not much extra benefit to its use. Of course this index is available with shorter lags than most of the variables entering the SVAR. Still, even when only lagged information is used to construct the SVAR predictions, the ADS series fails to become significant.

The situation is better for two of the forward indicators of Euro Area growth - the Euro-Area Economic Sentiment Indicator (ESI) and the Germany IFO Business Climate Indicator (IFO). In this case, when added on to a Probit model featuring the SVAR predictions, one gets t ratios of 1.93 and 2.3 respectively. These t ratios rise to 2.5 and 2.1 if one recognizes that the SVAR predictor needs to be based on some lagged variables. Because the data we have available on the Euro Area indicators is limited it is difficult to effect a good comparison. The main difference to what the SVAR model would indicate is a higher probability of predicting the 1998/9 recession. This is somewhat odd as there was quite strong growth in the Euro Area at that time. Consequently, it might have been hard to explain any recession prediction that was based on the two forward indicators of Euro Area growth.

It would be ideal if one had some sentiment indicators for Turkey. I have not been able to find any with a substantial history. For Turkey Aysoy and Kipici (2005) give a GDP equation of the form¹³

$$\Delta y_t = a_1 \Delta y_{t-1} + a_2 r_t + a_3 \Delta_4 cps_{t-1} + a_4 \Delta_4 pcu_t,$$

¹³They actually use $y_t^u - y_{t-4}^u$, where y_t^u is seasonally unadjusted data, but, since we have $y_t = y_t^u + y_{t-1}^u + y_{t-2}^u + y_{t-3}^u$, it follows that $\Delta y_t = \Delta_4 y_t^u$.

where r_t is the real Treasury Bill rate, cps_t is total credit in real terms extended to the private sector, and pcu_t is the private sector's capacity utilization rate. This suggests that one might use capacity utilization as an indicator. Again using the SVAR predictors as the benchmark, it was found that there is no advantage in adding on either the level of utilization or its growth rate. If one used the SVAR indicator constructed from lagged information then there was an improved prediction. Since it is likely that one would use the indicator information in now-casting GDP growth, it might be that this is a better interpretation of the increased predictive success.

7 Conclusion

We found that using information from past macroeconomic variables would result in only limited success in predicting Turkish recessions. Of course it may be that the SVAR model that we used could be improved by building in features that reflect financial factors and wealth effects, as in Alp and Elekdag (2010). It would be interesting to repeat our exercises with their model. Fundamentally however, the prediction of a recession requires some projection of future shocks, and for these one needs some forward-looking indicators. Finding these is difficult as there seems no readily available collection of them. Future research on Turkish macro-economic outcomes should attempt to build such indicators.

8 References

Alp, H and S. Elekdag (2010), "The Role of Monetary Policy During the Global Financial Crisis: The Turkish Experience", Central Bank of Turkey Discussion Paper

Aruoba, S.B., Diebold, F.X. and Scotti, C. (2009), "Real-Time Measurement of Business Conditions," *Journal of Business and Economic Statistics* 27:4 (October 2009), pp. 417-27.

Aysoy, C. and A.N. Kipici (2005), " A Quarterly Macroeconometric Model of the Turkish Economy", *Turkey Central Bank Review*, 39-71

Bry, G., Boschan, C., (1971), *Cyclical Analysis of Time Series: Selected Procedures and Computer Programs*, New York, NBER.

Camacho, M and G. Perez-Quiros (2010), "Introducing the Euro-Sting:

Short-Term Indicator of Euro Area Growth", *Journal of Applied Econometrics*, 25, 663-694.

Catão, L. and A. R. Pagan (2010), "The Credit Channel and Monetary Transmission in Brazil and Chile: A Structured VAR Approach" in L.F. Céspedes, R. Chang and D. Savaria (eds) *Monetary Policy Under Financial Turbulence* (Bank of Chile, Santiago, Chile)

Dungey, M and A. R. Pagan (2000), "A Structural VAR Model of the Australian Economy", *Economic Record*, 76, 321-342.

Engel, J., D. Haugh and A. Pagan (2005) " Some Methods for Assessing the Need for Non-Linear Models in Business Cycles", *International Journal of Forecasting* 21, 651-662.

Estrella, A., and Trubin, M.R. (2006), The Yield Curve as a Leading Indicator: Some Practical Issues," *Federal Reserve Bank of New York, Current Issues in Economics and Finance* 12.

Fair, R. C. (1993), "Estimating Event Probabilities from Macroeconometric Models Using Stochastic Simulation" in J.H. Stock and M.W. Watson (eds) *Business Cycles, Indicators and Forecasting*, NBER, University of Chicago Press, 157-178

Hamilton, J.D., (1989), "A New Approach to the Economic Analysis of Non-Stationary Time Series and the Business Cycle", *Econometrica*, 57, 357-84.

Harding, D and A.R. Pagan (2010a), "An Econometric Analysis of Some Models of Constructed Binary Random Variables", *Journal of Business and Economic Statistics*, (forthcoming)

Harding, D. and A.R. Pagan (2010b), "Can We Predict Recessions?", *paper given to the 6th Eurostat Colloquium on Modern Tools for Business Cycle Analysis*

Harding, D. (2010), "Imposing and Testing Monotonicity in Generalized Dynamic Categorical Models of the Business Cycle", presented at the 15th Australasian Macroeconomics Workshop, Wellington, New Zealand.

Kedem, B., (1980), *Binary Time Series*, Marcel Dekker, New York

Perlin, M. (2009), "MS_Regress - A package for Markov Regime Switching Models in Matlab", MATLAB Central: file exchange available at

<http://www.mathworks.com/matlabcentral/fileexchange/authors/21596>