Constructing an Economic Activity Indicator for Turkey

Aysu Çelgin
Elif Akbostancı

July 2021
Working Paper No: 21/14

TÜRKİYE CUMHURİYET
MERKEZ BANKASI

Address:

Central Bank of the Republic of Turkey

Head Office

Structural Economic Research Department

Hacı Bayram Mah. İstiklal Caddesi No: 10

Ulus, 06050 Ankara, Turkey

Phone:

+90 312 507 80 04

Facsimile:

+90 312 507 78 96

Constructing an Economic Activity Indicator for Turkey#

Aysu Çelgin*, Elif Akbostancı**

Abstract

In this paper, a monthly economic activity indicator is constructed for the Turkish economy for 1988-2020 period. Dynamic factor modelling framework is utilized in the estimation of the indicator. In the context of data selection, first of all, the variables are categorized into five types as: activity (hard data), activity (survey-based data or soft data), trade, employment and financial variables. After determining the candidate variables for each category, data selection is finalized by using the hard-thresholding method. The results indicate that monthly economic activity indicator is successful in detecting the past recessionary and contractionary periods of the Turkish economy and providing timely information about the course of the economic activity.

Keywords: Economic activity, Dynamic factor model, Hard-thresholding, Real time analysis

JEL Classification: C22, E32, E37

** Corresponding author. Central Bank of the Republic of Turkey, Research and Monetary Policy Department.*
*** Middle East Technical University, Department of Economics.*
 # We would like to thank Mahmut Günay, Çağlar Yüncüler and Çağrı Sarıkaya for their invaluable contributions and comments. The views expressed in this paper are those of the authors and do not reflect the official views of the Central Bank of the Republic of Turkey.

Non-Technical Summary

In this paper, a monthly economic activity indicator for the Turkish economy for 1988-2020 period is constructed. Dynamic factor modelling framework is utilized in the estimation of the indicator. This indicator can be used to assess the expansion/contraction phases of the economic activity.

In the variable selection part, we implement the hard-thresholding method by Bai and Ng (2008). We firstly categorize the variables into five types as: activity (hard data), activity (survey-based data or soft data), trade, employment and financial variables. After doing the categorization, candidate variables for each category are determined. Then by using the hard-thresholding method, the most parsimonious variables are obtained for estimation of the economic activity indicator from the available data set. Based on this methodology, we construct an economic activity indicator using GDP, industrial production index, electricity production, total vehicles production, volume of production over the past 3 months, real sector confidence index, import volume index, non-farm employment, credit stock and credit default swap (CDS).

Our monthly economic activity indicator detects October 1988-February 1989, April 1994-January 1995, October 1998-March 1999, August 1999-September 1999, February 2001-February 2002, October 2008-September 2009 and August 2018-January 2019 as recessionary/contractionary periods. A real-time application of the model confirms that using timelier variables provide timely information about the current state of the economy.

1. Introduction and Literature Review

Economic activity is one of the main indicators to evaluate how a country performs over time. Academicians, business people and decision makers give much importance to the detection of expansion/contraction phases and the real-time cyclical analysis of the economic activity as it is considered crucial for implementing efficient policies. To this end, accurate assessment of the economic activity has an important place in the economic literature.

Gross Domestic Product (GDP) is the most widely known indicator for making deductions about the overall performance of economic activity. However, it has certain drawbacks regarding its timing and content. First of all, it is published with a considerable time lag and is exposed to data revisions after the initial dissemination. Second, GDP itself is not enough to encompass all information about the overall economic activity (Aruoba and Sarikaya, 2013). Tracking the developments in markets other than goods market, e.g. labor market, financial markets, etc., necessitates different data sources and more information than GDP provides. Moreover, utilizing soft data (survey-based data) related with production, consumption, trade and employment may also be useful in providing timelier information and incorporating expectations (Aruoba, Diebold and Scotti, 2009). To sum up, a timelier indicator of economic activity, which encompasses different branches of the economy, would be preferable to GDP.

The literature on constructing economic activity indicators is well established, in particular for the US economy. It has progressed over time in terms of data type and estimation methodologies. The pioneering study of Stock and Watson (1989) presents three monthly economic activity indicators for the US economy by using different macroeconomic variables on monthly frequency with the help of dynamic factor modelling framework. Other examples for the US economy that prefer dynamic factor modelling as estimation framework are Mariano and Murasawa (2003), Proietti and Moauro (2006) and Auroba et al. (2009). These papers differ from Stock and Watson (1989) in selecting variables at different frequencies, such as quarterly, weekly and daily, to their data set. They criticize Stock and Watson (1989) in exclusion of quarterly indicators, especially GDP, since this prevents utilization of extra information in quarterly variables. They extend the work of Stock and Watson (1989) by incorporating GDP in their data set, as of being the most important measure of the overall state of the economy. In a later study, Evans (2005) contributes to the literature by estimating the state of the US economy in real-time on a daily basis. Furthermore, Aruoba et al. (2009) construct an indicator on a daily basis for the US economy. Proietti and Moauro (2006) extend their work by

constructing economic indicators for Euro Area. In a later paper, Matheson (2011) also extends the country coverage to 32 countries by utilizing dynamic factor modelling approach and monthly variables out of 6 different variable blocks in the construction of economic activity indicator. Darne and Ferrara (2011) construct indicators for both Euro Area and six main countries by using a Markov-Switching VAR model and Markov-Switching factor model. Additionally, Dua and Banerji (2000) and Simone (2001) construct economic activity indicators by using NBER methodology and general to specific approach for Indian economy and Argentina, respectively.

The literature on constructing economic activity indicator for Turkey is scarce. Among them, Aruoba and Sarikaya (2013) construct an economic activity indicator by using mixed frequency variables. Additionally, Çakmaklı and Altuğ (2014) construct a coincident real economic activity indicator for Turkey. Both studies use dynamic factor modelling, while the latter utilize Bayesian semiparametric estimation instead of Kalman filtering algorithm used by the former.

In this paper, we construct a monthly economic activity indicator to detect historical expansion/contraction periods and to evaluate the economic outlook of the Turkish economy so that we provide timely information about the near future of economic conditions in Turkey. Similar to most of the studies in the literature, dynamic factor modelling approach is preferred in constructing economic activity indicator because of being good at synthesizing macroeconomic variables into an indicator (Barhoumi, Darne and Ferrara, 2013). Based on this methodology, we construct an economic activity indicator using the industrial production index, electricity production, total vehicles production, volume of production over the past 3 months, real sector confidence index, import volume index, non-farm employment, credit stock and credit default swap (CDS) in the estimation. GDP is also added to the data set since it is the broadest measure of economic activity.

One of the main contributions of this study is that the variables are selected in an analytical and systematic way. First of all, the variables that are used in the analysis are grouped in five different categories which are activity (hard data), activity (survey-based data or soft data), trade, employment and financial variables. After doing the categorization, candidate variables for each category are determined. In the construction of our data set for the economic activity indicator, we implement the hard-thresholding method by Bai and Ng (2008). By this method, the most parsimonious variables are obtained for estimation of the economic activity indicator from the available data set.

Another contribution of this paper is that we use a timelier data set compared to other two papers about Turkey, i.e. Aruoba and Sarikaya (2013) and Çakmaklı and Altuğ (2014). Nearly all variables used in these two papers are released with a lag of 40 to 60 days. Although our data set also contains variables announced with lagged periods, six of the ten variables are released at the appertaining month or at the beginning of next month. In this respect, we can update our indicator earlier than the other two studies and get timelier signals about the course of economic activity.

The last contribution of our work is that our indicator is good at detecting the past recession and contraction periods. Aruoba and Sarikaya (2013) and Çakmaklı and Altuğ (2014) construct indicators for 1987-2011 and 1989-2014 periods respectively and they detect nearly the same periods, which are 1994, 2001 and 2008-2009, as recession periods for Turkish economy. The monthly economic activity indicator constructed in our paper covers the period starting from 1988 to February 2020. In our work, we implement the same approach with these two papers when determining the recessionary periods. We detect that October 1988-February 1989, April 1994-January 1995, October 1998-March 1999, August 1999-September 1999, February 2001-February 2002, October 2008-September 2009 and August 2018-January 2019 are recessionary and contractionary periods. This means that our indicator detected both the recessions indicated in these two papers and four more periods as recessions and contractions which are October 1988-February 1989, October 1998-March 1999, August 1999-September 1999 and August 2018-January 2019.

The results show that the economic activity indicator is good at detecting historical recession and contraction periods. To evaluate whether the indicator provide timely information about the current state of the economy or not and to show the importance of using timelier variables in the estimation, a real-time application is performed. In this regard, the model is estimated until a certain period and the parameters are fixed; then, the economic activity indicator is calculated at new data announcements for different data releases. It is concluded that with the timelier variables announced more promptly, we would get timely information about declines in economic activity. For this study, we are able to assess the decline in economic activity starting from April 2020, even in that month.

The paper proceeds as follows. Section 2 provides the model and methodology used in the estimation of the indicator. Section 3 introduces the data set and variable selection methodology in detail. Section 4 presents the economic activity indicator. Additionally, implied recession and contraction periods indicated for Turkish economy are compared with other

papers on Turkey and elaborated in detail, and also a real-time application for the Turkish economy is presented. Finally, Section 5 presents a brief summary of the findings and concludes the paper.

2. Model and Methodology

As for the use of dynamic factor modelling (DFM) framework in the construction of economic activity indicators, Barhoumi et al. (2013) state that it is a useful tool in summarizing the information in a large data set by forming a small number of common factors. In other words, DFM framework is generally opted for its success in utilizing the macroeconomic variables and producing reliable estimates.

In the construction of our economic activity indicator, we follow a similar approach to Aruoba and Sarikaya (2013). In this method, economic conditions are considered as unobserved variable and tried to be explained by different observed indicators. Furthermore, variables in different frequencies can be used simultaneously. Then, with the help of a linear and statistically optimal filter, the economic activity indicator is calculated.

2.1. Dynamic Factor Model at Monthly Frequency

Although economic conditions change at higher frequencies (hourly, daily, etc.), data releases have been less frequent. Most of the indicators are often monthly or quarterly. Therefore, we construct our indicator at monthly frequency. If the data has a higher frequency than monthly frequency, two different approaches are taken depending on the characteristics of the data. If it is a stock variable, end of the month value is taken as the monthly data. If it is a flow variable, then monthly average of the data is calculated.

As mentioned earlier, we adapt the methodology of Aruoba and Sarikaya (2013) while constructing the model. In this framework, the unobserved economic conditions at month t is denoted by y_t and it evolves according to the following transition equation

$$y_t = a_1 y_{t-1} + a_2 y_{t-2} + \ldots + a_k y_{t-k} + u_t \qquad (1)$$

Since we follow the model in Aruoba and Sarikaya (2013), we choose k equal to 3 and rewrite the transition equation as follows[1]

$$y_t = a_1 y_{t-1} + a_2 y_{t-2} + a_3 y_{t-3} + u_t \qquad (2)$$

where $u_t \sim$ N (0, σ_n^2).

Then, x_t^i denote the vector of observable variables, which are related to the unobserved factor y_t linearly. Here, i represents the variables. For i-th monthly variable, the measurement equation is written as follows:

$$x_t^i = c^i + d^i y_t + e_t^i \qquad (3)$$

In equation 3, c^i is a constant term, $d^i y_t$ is the common component and e_t^i is an idiosyncratic component which is expressed as

$$e_t^i = \beta_1^i e_{t-1}^i + \beta_2^i e_{t-2}^i + \beta_3^i e_{t-3}^i + v_t^i \qquad (4)$$

where $v_t^i \sim$ N (0, $\sigma_{v^i}^2$). The common component and the idiosyncratic component are assumed to be mutually orthogonal. The common component represents the covariation between the variables related with economic activity and the business conditions represented by the factor. The idiosyncratic component contains the shocks special to each variable. Both in equation 2 and equation 4, it is assumed that the residuals are normally distributed with zero mean and constant variance.

For the monthly variables in the estimation, we use equation 3. However, not all macroeconomic series are published on a monthly frequency. Thus, we rewrite the measurement equation for quarterly variables. For stock variables, quarterly data is the average of respective monthly data. Thus, the measurement equation for quarterly stock variables is revised as

[1] For the monthly variables, we checked for whether AR(3) process is significant or not and found that, except one variable, AR(3) process is significant. In this respect, we prefer to select k equal to 3 as in Aruoba and Sarikaya (2013).

$$x_t^i = \begin{cases} \sum_{j=0}^{2} x_{t-j}^i = c^i + \frac{1}{3} d^i \left(y_t + y_{t-1} + y_{t-2}\right) + \frac{1}{3}\left(e_t^i + e_{t-1}^i + e_{t-2}^i\right) & if\ x_t^i\ observed \\ NA & otherwise \end{cases} \quad (5)$$

For flow variables, quarterly data is approximately the sum of monthly data. Accordingly, our measurement equation for quarterly flow data becomes the sum of right-hand side of equation 3 and is expressed as

$$x_t^i = \begin{cases} \sum_{j=0}^{2} x_{t-j}^i = 3c^i + d^i \left(y_t + y_{t-1} + y_{t-2}\right) + \left(e_t^i + e_{t-1}^i + e_{t-2}^i\right) & if\ x_t^i\ observed \\ NA & otherwise \end{cases} \quad (6)$$

2.2. State-Space Representation and Estimation

The state-space representation of the model is in the following form:

$$\begin{aligned} z_{t+1} &= Tz_t + R\lambda_t \\ x_t &= c + \sigma z_t \end{aligned} \quad (7)$$

Here, z_t represents the state vector containing y_t, e_t and their lagged values. As stated in the first part, x_t represents the vector of observable variables and c is the vector of constant terms. λ_t is the vector of error terms including residuals u_t and v_t in equations 2 and 4, and it is distributed as λ_t~ (0, Q). Moreover, T, R, σ and Q are constant. The sample size is written as t= 1, 2,...., T, where T is the last observation.

After writing the model in state-space form, Kalman filter is utilized to estimate the model by maximum likelihood estimation and Kalman smoother is used to obtain an estimate of the factor. It should be highlighted that this approach is good at dealing with missing data problem since it puts no weight on the missing values while calculating common factors (Matheson, 2011). In order to put no weight on the missing observations, the variance of the idiosyncratic component is selected to be extremely large. Barhoumi et al. (2013) also state that in DFM framework, two-step estimation procedure by using Kalman filter and smoother solves the end-of-sample missing value problem (known as the ragged-edge data problem) significantly. More details about the Kalman filtering methodology and its application can be found in Solberger and Spånberg (2020).

3. Data

3.1. A Primer on Data Selection

Data selection is probably the most important step of constructing an economic activity indicator. For the best outcome, data would meet the following properties: i) It would be long enough to make a reliable econometric estimation, ii) It would be able to identify the expansion/contraction and crisis periods in the past, iii) It would be easily accessible by the public, iv) It would be released in a timelier manner in order to improve the real-time characteristic of the indicator.

Another important aspect in such analyses is to decide on the number of variables to include in the analysis. Whether inclusion of too many variables improves the model accuracy or not is an important aspect to evaluate the quality of the estimated economic activity indicator. Adding all relevant variables may sound to be the best option to have a more accurate result. However, Boivin and Ng (2006) conclude that if addition of new variables does not make contribution to the estimated factors, there cannot be any improvement in the forecasts made by a larger-sample data. Additionally, Barhoumi et al. (2013) claim that addition of a new variable is not preferred if it increases the idiosyncratic noise and does not make any contribution to the performance of the factor.

As a final remark, inclusion of too many variables from a specific sector may lead to biased results as it may increase the weight of that particular sector beyond its true size. In this regard, categorization of variables would improve the diversification among variables and the representation of different sectors in the economy. For example, Evans (2005) categorizes the variables into 6 types as real activity, consumption, investment, government, net exports, forward-looking. Further, he includes at least one variable from each category to the estimation. Matheson (2011) applies another categorization as hard data, survey-based data, trade, financial conditions, employment and income, prices and costs.

3.2. Variables

Before selecting the variables for the analysis, we categorize the candidate variables into five types: activity (hard data), activity (survey-based data or soft data), trade, employment and financial variables. Although our categorization is a mixture of Evans (2005) and Matheson (2011), it does not include some of the headings they consider and it is more similar to what Matheson (2011) does. The reasoning rests on the public availability of the variables and the

availability of historical series of the variables. Despite data limitations, we try to form the most extensive categorization for our estimation. Candidate variables for each category are listed as follows:

- **Activity (hard data) –** industrial production index and its components, i.e. intermediate goods, capital goods, durable consumer goods and non-durable consumer goods production indices; electricity production; production and sales of total vehicles and its sub-items, i.e. automobile and commercial vehicles.
- **Activity (survey-based data or soft data) –** Purchasing Managers' Index (PMI) and its components, i.e. PMI Output and PMI New Orders; capacity utilization rate; the volume of production over the past 3 months; real sector confidence index.
- **Trade –** import and export volume indices and their sub-items, i.e. intermediate goods, capital goods, durable consumer goods and non-durable consumer goods.
- **Employment –** total employment; non-farm employment; unemployment rate; non-farm unemployment rate.
- **Financial Variables –** credit stock; Credit Default Swap (CDS) and Chicago Board Options Exchange Volatility Index (VIX).

For each category, adding more variables could be an option but the availability of historical data becomes a limiting factor in the variable selection phase. In this respect, above-mentioned candidate variables for the estimation and their beginning periods are listed in Table 3.1. From these variables, we select industrial production index, electricity production, total vehicles production, the volume of production over the past 3 months, real sector confidence index, import volume index, non-farm employment, credit stock and Credit Default Swap (CDS) indicators in our analysis. Variable selection method and the rationale for selecting these variables are elaborated in Sections 3.3 and 3.4.

Table 3.1. Candidate Variables and Their Beginning Periods

Activity (Hard Data) Variables	Sample Begins	Activity (Soft Data) Variables	Sample Begins	Trade Variables	Sample Begins
Industrial Production Index (IPI)	1987M01	Purchasing Managers' Index (PMI)	2005M05	Export Volume Index (QX)	1987M01
IPI- Intermediate Goods	1997M01	PMI- Output	2005M05	QX- Intermediate Goods	1994M01
IPI- Capital Goods	1997M01	PMI- New Orders	2005M05	QX- Capital Goods	1994M01
IPI- Durable Consumer Goods	1997M01	Capacity Utilization Rate	1991M02	QX- Durable Consumer Goods	1994M01
IPI- Non-Durable Consumer Goods	1997M01	Volume of Production over the past 3 Months	1988M01	QX- Semi-Durable Consumer Goods	1994M01
Electricity Production	1987M01	Real Sector Confidence Index	1994M06	QX- Non-Durable Consumer Goods	1994M01
Total Vehicles Production	1987M01			Import Volume Index (QM)	1987M01
Commercial Vehicles Production	1987M01			QM- Intermediate Goods	1994M01
Automobile Production	1987M01			QM- Capital Goods	1994M01
Total Vehicles Sales	1993M01			QM- Durable Consumer Goods	1994M01
Commercial Vehicles Sales	1993M01			QM- Semi-Durable Consumer Goods	1994M01
Automobile Sales	1993M01			QM- Non-Durable Consumer Goods	1994M01
Employment Variables	**Sample Begins**	**Financial Variables**	**Sample Begins**		
Total Employment	1989Q01	Credit Stock	1987Q01		
Non-Farm Employment	1989Q01	Credit Default Swap (CDS)	2001M01		
Unemployment Rate	1989Q01	Chicago Board Options Exchange Volatility Index (VIX)	1990M01		
Non-Farm Unemployment Rate	1989Q01				

Note: M denotes month and Q denotes quarter.

Industrial production index, import volume index and non-farm employment data are published by Turkish Statistical Institute (TURKSTAT). Electricity production and total vehicles production data are taken from Turkish Electricity Transmission Corporation (TETC) and Automotive Manufacturers Association (AMA), respectively. The volume of production over the past 3 months data is a question[2] from Business Tendency Survey (BTS) Statistics conducted by the Central Bank of the Republic of Turkey (CBRT) to the manufacturing firms, so this data is taken from CBRT database. Real sector confidence index is also taken from the database of CBRT. Credit stock is taken from two different sources, which are Bank for International Settlements (BIS) and Banking Regulation and Supervision Agency (BRSA) for two different periods. The source of CDS data is Bloomberg database.

Estimation of the economic activity indicator starts at the beginning of 1988, but some of our variables do not have data dating back to 1988. Industrial production index, electricity

[2] The official question about the volume of production over the past 3 months asked to the manufacturing firms is that "How has your production developed over the past 3 months?". It is an important indicator about the production of manufacturing firms and positively related with economic activity.

production, total vehicles production and the volume of production over the past 3 months have values since January 1988 on a monthly basis. Even though, electricity production is announced on a daily basis, it is included in the analysis on a monthly frequency. However, real sector confidence index and CDS start at June 1994 and January 2001, respectively. For import volume index, the annual percentage changes of 2010-based data is available starting from January 2006. For January 1988-December 1989, annual percentage changes of 1982-based data; for January 1990-December 1997, annual percentage changes of 1989-based data; for January 1998-December 2004, annual percentage changes of 1994-based data; and, for January 2005-December 2005, annual percentage changes of 2003-based data are used. Non-farm employment data is available at three different frequencies. For the period of 1989-1999, it is announced semi-annually; for 2000-2004, it is announced on a quarterly frequency; and, since 2005, it is announced as monthly but calculated as three-months moving average[3]. In order to avoid conflict, it is used in the analysis on a quarterly frequency. Firstly, semi-annual data is transformed to the quarterly frequency by using seasonal factors as in Coşar and Yavuz (2019). Then quarterly annual percentage changes of variables are calculated for non-farm employment data starting from the first quarter of 1990. Credit stock is available on a weekly basis starting from January 2006 in BRSA database. In tracing credit stock back to 1987, we benefit from BIS credit to non-financial sector database. The caveat of BIS data is that it is available on quarterly basis, which forces us to use credit data in this frequency in model estimations.

In the estimation of the economic activity indicator, seasonally adjusted[4] levels of the volume of production over the past 3 months and real sector confidence index, and level of CDS are used. The remaining variables are added to the analysis in the form of annual percentage changes.

3.3. The Methodology of Variable Selection

One of the main contributions of this study is in the variable selection part. Although some of the previous papers about the construction of the economic activity indicators categorize candidate variables like in our work, most of them decide which ones to include in the analysis by expert judgement. In our work, after deciding on the variables from each category, the

[3] Three-months moving average means that February data represents January-February-March period and May data represents April-May-June period. Thus, variables announced at February, May, August and November represent each quarterly variable in that year, respectively.

[4] Seasonally adjusted data are taken from their official sources, CBRT database.

variables to include in the estimation are selected by the hard-thresholding method implemented in Bai and Ng (2008). In this method, the relation between the explained variable y_t and the explanatory variables X_{ti} is evaluated for every i-th variable by considering the t-statistics associated with every X_{ti}. The steps of this method are as follows:

1. For each i-th variable, perform a regression of y_t on X_t and derive the t-statistics from each regression for every X_t.
2. Take the absolute values of each t-statistics as $|t_1|$, $|t_2|$,…., $|t_i|$ and sort from the largest to the smallest one.
3. Decide a threshold value for t-statistics as t* and select the variables having larger t-statistics than t*.

As being the most common measure of economic activity, GDP is selected as the dependent variable y_t and the variables in the data set are treated as X_{ti}. Then, the annual percentage change of GDP is regressed on each variable sequentially. When comparing the statistical significance, t-statistics of the variables in the five categories are compared within their own groups in order to select at least one variable from each category. The significance level is chosen as 0.05 and the corresponding t-statistics value 1.96 is determined as the threshold value. After regressing GDP on the possible variables from each category, variables having larger t-statistics than the threshold value of 1.96 are listed as potential variables for the analysis. Then, the variables are eliminated with respect to their beginning periods and their representativeness of the economy. If a variable and its sub-items have higher t-statistics than the threshold value, we select the main variable because of starting earlier compared to sub-items and containing information about sub-items.

3.4. Variable Selection

The candidate variables that GDP is regressed on are listed in Table 3.1. For all of the survey-based activity variables and some of the financial variables such as CDS and VIX, the levels instead of quarterly changes are used in these regressions. The sample period for the regressions are 1988Q1-2019Q4. Since historical availability of the variables alters, variable selection is made in two different ways. Firstly, GDP is regressed on the variables available since 1988 and the selection is made by considering their t-statistics. Then, in order to evaluate variables

starting later than 1988, regression is done by separating the estimation period into 3 sub-periods and variable selection is repeated for each period[5,6].

As seen from Table 3.1 and Table 3.2, there are not many variables dating back to 1988. Even there is no variable in the employment category starting at 1988. Based on the t-statistics in Table 3.2, industrial production index, electricity production, total vehicles production, the volume of production over the past 3 months, import volume index and credit stock are selected for the estimation of the economic activity indicator. Although commercial vehicles production and automobile production have t-statistics higher than the threshold value, they are not included in the analysis because they are represented by total vehicles production.

Table 3.2. Variables used in the Whole Sample 1988-2019 and Their t-Statistics from Regression with GDP

Activity (Hard Data) Variables	t-statistics	Activity (Soft Data) Variables	t-statistics	Trade Variables	t-statistics
Industrial Production Index (IPI)	19.28	***Volume of Production over the past 3 Months***	13.63	Export Volume Index (QX)	0.32
Electricity Production	4.57			***Import Volume Index (QM)***	8.03
Total Vehicles Production	7.05				
Commercial Vehicles Production	5.79				
Automobile Production	5.81				
Financial Variables	**t-statistics**				
Credit Stock	4.70				

As stated above, in order to evaluate the variables having beginning period later than 1988, same regression is done by dividing the estimation period into three sub-periods as 1988-1997, 1998-2007 and 2008-2019. For the period of 1988-1997, variables are same as those selected for the whole sample and they are depicted in Table 3.3.

[5] For both of the variable selection exercises, t-statistics are listed in tables and the selected variables are written in ***bold*** and ***italic*** format.

[6] Whether variables selected for the estimation have strong relationship with GDP or not except crisis periods, such as 2001 and 2009, is an important question to evaluate. In order to answer this, variable selection exercise is repeated by taking values of the variables for the period of 2006-2019, excluding 2001 crisis from the sample, and for the period of 2010-2019, excluding 2009 crisis from the sample. It is concluded that same variables are selected for the estimation for these periods. Details can be shared upon request.

Table 3.3. Variables used in Period 1988-1997 and Their t-Statistics from Regression with GDP

Activity (Hard Data) Variables	t-statistics	Activity (Soft Data) Variables	t-statistics	Trade Variables	t-statistics
Industrial Production Index (IPI)	14.17	***Volume of Production over the past 3 Months***	11.57	Export Volume Index (QX)	1.44
Electricity Production	4.76			***Import Volume Index (QM)***	6.92
Total Vehicles Production	6.60				
Commercial Vehicles Production	4.30				
Automobile Production	3.87				
Financial Variables	**t-statistics**				
Credit Stock	3.30				

Compared to the 1988-1997 period, the data set is enlarged for 1998-2007 period. The variables used in the regression for this period and their t-statistics are listed in Table 3.4. Selected variables for the estimation of the economic activity indicator are same as those selected for the whole sample and for the 1988-1997 period, and additionally real sector confidence index and non-farm employment are also selected. Because of having lower t-statistics than the industrial production index, its sub-items are not included in the analysis. Although sales of total vehicles and its sub-items have t-statistics larger than the threshold value, they are not included in the analysis because production values, which start earlier than them, of these variables are included. For the survey-based variables, capacity utilization rate might be selected but its monthly data starts later than data of the volume of production over the past 3 months so this variable is not replaced with capacity utilization rate data. Real sector confidence index is added to the analysis in order to have at least one variable from confidence indexes. Although some sub-items of import volume index have larger t-statistics, import volume index is kept in the analysis because of being the main item and starting earlier than its sub-items. For the employment variables category, non-farm employment data is selected because it has the largest significant t-statistics in its category. For the financial variables category, VIX is not selected because its t-statistics is nearly equal to the threshold value.

Table 3.4. Variables used in Period 1998-2007 and Their t-Statistics from Regression with GDP

Activity (Hard Data) Variables	t-statistics	Activity (Soft Data) Variables	t-statistics	Trade Variables	t-statistics
Industrial Production Index (IPI)	19.39	Capacity Utilization Rate	6.55	Export Volume Index (QX)	0.08
IPI- Intermediate Goods	10.60	***Volume of Production over the past 3 Months***	5.85	QX- Intermediate Goods	0.32
IPI- Capital Goods	8.54	***Real Sector Confidence Index***	5.32	QX- Capital Goods	0.08
IPI- Durable Consumer Goods	0.92			QX- Durable Consumer Goods	0.80
IPI- Non-Durable Consumer Goods	3.79			QX- Semi-Durable Consumer Goods	0.10
Electricity Production	4.05			QX- Non-Durable Consumer Goods	2.08
Total Vehicles Production	4.90			***Import Volume Index (QM)***	5.31
Commercial Vehicles Production	3.93			QM- Intermediate Goods	3.86
Automobile Production	4.46			QM- Capital Goods	6.51
Total Vehicles Sales	2.91			QM- Durable Consumer Goods	7.20
Commercial Vehicles Sales	3.62			QM- Semi-Durable Consumer Goods	2.94
Automobile Sales	2.60			QM- Non-Durable Consumer Goods	1.86
Employment Variables	**t-statistics**	**Financial Variables**	**t-statistics**		
Total Employment	0.61	***Credit Stock***	2.69		
Non-Farm Employment	2.50	Chicago Board Options Exchange Volatility Index (VIX)	1.97		
Unemployment Rate	1.64				
Non-Farm Unemployment Rate	0.28				

For the third period containing 2008-2019, there are again additions to the data set. The t-statistics from the regression of GDP with all variables are listed in Table 3.5 for 2008-2019 period. Eight variables selected in the previous period are preserved in data set and additionally CDS are selected for the estimation of economic activity indicator. Among PMI and BTS variables, the volume of production over the past 3 months data from BTS has the highest t-statistics so it is kept in the analysis. Although intermediate goods imports have the largest t-statistics in its category, import volume index is kept in the analysis since its t-statistics is approximately the same with its sub-item, intermediate goods. For the financial variables category, credit supply is kept and CDS is added to the analysis.

Table 3.5. Variables used in Period 2008-2019 and Their t-Statistics from Regression with GDP

Activity (Hard Data) Variables	t-statistics	Activity (Soft Data) Variables	t-statistics	Trade Variables	t-statistics
Industrial Production Index (IPI)	18.14	Purchasing Managers' Index (PMI)	12.61	Export Volume Index (QX)	1.78
IPI- Intermediate Goods	8.86	PMI- Output	8.27	QX- Intermediate Goods	0.58
IPI- Capital Goods	11.34	PMI- New Orders	9.04	QX- Capital Goods	4.45
IPI- Durable Consumer Goods	4.58	Capacity Utilization Rate	3.51	QX- Durable Consumer Goods	1.67
IPI- Non-Durable Consumer Goods	7.52	***Volume of Production over the past 3 Months***	15.45	QX- Semi-Durable Consumer Goods	1.68
Electricity Production	3.08	***Real Sector Confidence Index***	7.54	QX- Non-Durable Consumer Goods	1.53
Total Vehicles Production	2.74			***Import Volume Index (QM)***	5.75
Commercial Vehicles Production	2.26			QM- Intermediate Goods	5.88
Automobile Production	2.47			QM- Capital Goods	3.80
Total Vehicles Sales	4.29			QM- Durable Consumer Goods	2.51
Commercial Vehicles Sales	3.34			QM- Semi-Durable Consumer Goods	3.72
Automobile Sales	4.15			QM- Non-Durable Consumer Goods	3.06
Employment Variables	**t-statistics**	**Financial Variables**	**t-statistics**		
Total Employment	4.45	***Credit Stock***	4.62		
Non-Farm Employment	4.47	***Credit Default Swap (CDS)***	4.97		
Unemployment Rate	3.53	Chicago Board Options Exchange Volatility Index (VIX)	2.42		
Non-Farm Unemployment Rate	3.61				

At Table 3.6, the correlation of GDP with the selected nine variables are shared to show how strongly they are related with GDP. It is concluded that variables related with production have higher correlation than employment and financial variables.

Table 3.6. Correlation of GDP with Variables used in the Estimation of Economic Activity Indicator

Variables	Correlation	Variables	Correlation
Industrial Production Index (IPI)	0.91	Import Volume Index (QM)	0.76
Electricity Production	0.56	Non-Farm Employment	0.36
Total Vehicles Production	0.72	Credit Stock	0.45
Volume of Production over the past 3 Months	0.79	Credit Default Swap (CDS)	-0.34
Real Sector Confidence Index	0.76		

To sum up, variables selected for the estimation of economic activity indicator have significant t-statistics derived from the regression of GDP on each variable and have high correlations with GDP.

4. Estimation Results

4.1. Monthly Economic Activity Indicator

The monthly economic activity indicator constructed with the aforementioned nine variables in Section 3 and GDP is illustrated in Figure 4.1. The black line shows the economic activity indicator and the red dotted-lines show its upper and lower bands (95 percent confidence intervals). The values below/above zero imply that the economy is in contraction/expansion period. Furthermore, absolute values of the indicator in the related periods show the rate of contraction/expansion. In this regard, we should consider the duration of the indicator being below/above zero in deciding the course of economic activity. The grey shaded areas shown in Figure 4.1 point out the periods when both the indicator and its upper bands are lower than zero. Accordingly, there are seven detected recession and contraction periods: October 1988-February 1989, April 1994-January 1995, October 1998-March 1999, August 1999-September 1999, February 2001-February 2002, October 2008-September 2009 and August 2018-January 2019. When determining the recessions and contractions, we implement the same methodology with Aruoba and Sarikaya (2013) and Çakmaklı and Altuğ (2014) which also use Turkish data, and we select the periods that the indicator has negative values longer than one-month length and both the upper band of the indicator and itself have values lower than zero. Simple correlations of the variables with the indicator are demonstrated in Table 4.1. It can be concluded that industrial production index has the highest correlation with the estimated factor (indicator). Import volume index, GDP and electricity production are also highly correlated with the indicator. Among all variables, credit stock and CDS have the lowest correlations with the estimated factor and make limited contributions to it.

[Figure 4.1 near here]

Table 4.1. Correlation of the Economic Activity Indicator with Variables used in the Estimation

Variables	Correlation	Variables	Correlation
Industrial Production Index (IPI)	0.95	Import Volume Index (QM)	0.86
Electricity Production	0.75	Non-Farm Employment	0.52
Total Vehicles Production	0.62	Credit Stock	0.27
Volume of Production over the past 3 Months	0.72	Credit Default Swap (CDS)	-0.26
Real Sector Confidence Index	0.65	Gross Domestic Product (GDP)	0.80

After calculating the indicator, its simple average is calculated to convert it to quarterly basis and compared with the annual percentage change of GDP in Figure 4.2. The indicator is usually successful in tracking the growth rate of national income, especially in terms of its direction. Compared to the expansion periods, the relationship between the indicator and GDP strengthens in the recessions. In Table 4.2, annual percentage changes of GDP for 1988Q1-2019Q4 are listed and the quarters when both GDP has negative annual growth rates and recessions indicated by the indicator are shaded grey. It seems that almost in all quarters when GDP has contracted largely, the indicator signals them as recession periods.

[Figure 4.2 near here]

Table 4.2. GDP Growth Rates

1988Q1-1991Q4	1992Q1-1995Q4	1996Q1-1999Q4	2000Q1-2003Q4	2004Q1-2007Q4	2008Q1-2011Q4	2012Q1-2015Q4	2016Q1-2019Q4
9.6	8.2	8.7	4.0	10.8	7.2	6.8	4.8
3.8	5.7	8.1	6.9	11.6	2.3	5.0	4.9
2.7	5.4	5.3	8.2	8.3	1.0	3.6	-0.8
-5.0	5.5	7.0	7.0	8.5	-5.9	4.2	4.2
-2.4	4.9	6.9	2.4	9.6	-14.4	8.5	5.3
-1.7	11.3	8.5	-7.2	7.9	-6.7	9.8	5.3
0.6	7.4	7.0	-7.3	8.1	-1.5	8.9	11.6
3.5	8.4	7.8	-10.0	10.5	3.1	6.9	7.3
10.8	5.2	9.2	-1.1	6.7	7.0	8.7	7.4
13.3	-10.7	3.3	7.9	9.6	8.1	2.9	5.6
6.2	-7.8	2.7	7.1	6.1	8.7	3.7	2.3
8.7	-5.5	-1.2	11.2	6.3	9.7	5.9	-2.8
-0.4	-1.5	-6.1	6.6	8.3	11.7	3.6	-2.3
-0.5	13.5	-2.2	3.4	3.2	11.5	7.2	-1.6
3.9	9.0	-4.3	5.8	3.6	11.6	5.8	1.0
-0.7	6.6	-1.2	6.6	5.5	9.9	7.5	6.0

Note: Shaded periods show recessions indicated by the economic activity indicator.

We calculate the average and standard deviation of the GDP growth rate for different interval values of our economic activity indicator in order to make inferences about the power of growth. By considering Table 4.3, it can be said that if the indicator exceeds 0.5, it indicates that the growth rate can be quite strong. Moreover, if the indicator is lower than -0.5, considering the standard deviation, it is very likely to see negative annual growth rate.

Table 4.3. Average and Standard Deviation of GDP Growth Rate for Different Interval Values of Economic Activity Indicator

Interval of Economic Activity Indicator	Average of GDP Growth Rate	Standard Deviation of GDP Growth Rate	Number of Observations
> 1.0	12.3	0.9	3
[0.5 , 1.0]	8.5	2.3	20
[-0.5 , 0.5]	5.6	3.2	84
[-1.0 , -0.5]	-2.1	2.1	12
< -1.0	-8.5	2.6	9

4.2. Comparison of the Economic Activity Indicator with Other Indicators for Turkey

In Section 1, we introduce two different papers, Aruoba and Sarikaya (2013) and Çakmaklı and Altuğ (2014), which construct economic activity indicators for Turkey. Here, the recession and contraction periods detected by our indicator with the ones detected by these two works are compared. The estimation periods for these two studies are 1987-2011 and 1989-2014, respectively.

Aruoba and Sarikaya (2013) estimate an economic activity indicator with GDP, industrial production index, imports of intermediate goods, non-farm employment and electricity production. While determining the recessionary periods, they consider both the indicator and its upper bands being below zero more than one-month length. In this respect, they identify 1994, 2001 and 2008-2009 as recession periods. These three recession periods are same with the ones we detect by considering our economic activity indicator with some differences in their lengths. Additionally, our indicator detects four more periods as recession/contraction: October 1988-February 1989, October 1998-March 1999, August 1999-September 1999 and August 2018-January 2019.

Çakmaklı and Altuğ (2014) calculate coincident economic indicators based on GDP and industrial production index by using GDP, industrial production index, total employment less agricultural employment, trade and services turnover index, retail sales volume index, final consumption, total export quantity index and total import quantity index. Like our work as well as Aruoba and Sarikaya (2013), they select the crisis periods by considering both the indicators and their upper bands are lower than zero at the same time. Although there are several months when their indicators imply negative growth rates, the recession periods detected are 1994-1995, 2000-2001 and 2008-2009. Like in the case of Aruoba and Sarikaya (2013), our indicator detects more recessions compared to Çakmaklı and Altuğ (2014).

4.3. Historical Evaluation of Recession Periods

The recession and contraction periods indicated by our monthly economic activity indicator are shown closely in Figure 4.3-4.8. Three periods which are April 1994-January 1995, February 2001-February 2002 and October 2008-September 2009 last longer than the other three periods.

By considering the values of the indicator in October 1988-February 1989 contraction period, we can say that the indicator falls below zero two months before the contraction period. However, it does not jump above zero so quickly after the end of contraction (Figure 4.3).

[Figure 4.3 near here]

In April 1994-January 1995 period, economic activity indicator falls below zero starting one or two months before the detected recession periods (Figure 4.4). This is one of the financial crises that Turkish economy went through. In this crisis, government used the Central Bank reserves to finance public debt instead of foreign borrowing and this caused both huge reserve and foreign exchange losses. As a result, the exchange rate (value of Turkish Lira against US dollar) plummeted and the overnight interest rate ascended to historically peak levels. Additionally, the inflation rate rose to three-digit levels. Although a stand-by agreement with IMF was signed in April 1994, the terms of the agreement were not implemented properly.

[Figure 4.4 near here]

The economic activity indicator gradually worsens starting earlier than the beginning of October 1998-March 1999 recession but it jumps above zero very quickly. However, for August 1999-September 1999 period, the indicator and the upper bands again fall below zero indicating a contraction period (Figure 4.5). The first recession period overlap with the Russian crisis. Although the crisis hit Russia on July 1998 and continued for shorter period, it had serious contagion effects for its many neighbouring countries including Turkey. It seriously caused the foreign investors to lose their confidence and affected the capital inflows to countries including Turkey. Loss in capital inflows affected the economic activity negatively by slowing it down. The second contraction period of August 1999-September 1999 can be attributed to the aftermath of the devastating earthquake that hit one of the most industrial regions of Turkey in August 17, 1999.

[Figure 4.5 near here]

February 2001-February 2002 is another example to the country-specific financial crises (Figure 4.6). 2001 crisis is a banking sector crisis that Turkish economy experienced. It corresponds to a typical emerging market twin crisis in which interest rates reached the peak values and the prices of the treasury bills crashed simultaneously with the currency crisis

causing the deterioration in banks' balance sheets. Furthermore, in this period, foreign investors withdraw their fundings from Turkey. In order to keep the devaluation of Turkish Lira under control, Central Bank lost considerable amount of its reserves. To cure the devastating effects of the crisis, different reforms were implemented together with IMF assistance.

[Figure 4.6 near here]

October 2008-September 2009 is a part of the global financial crisis period started in the US economy (Figure 4.7). It is considered as the worst one after the Great Depression in 1929. Although it emerged in the US economy, its effects spread to all countries rapidly. Turkish economy was also affected seriously from the global crisis. Firstly, financial flows came to a standstill causing the amount of foreign exchange available to decline. Moreover, the exports of Turkey declined sharply especially to European countries which are the major trading partners of Turkey. Decline in exports further aggravated the foreign exchange supply which caused the imports of Turkey to decline. The deficiency of imported intermediate goods and the private sector indebtedness led to disruption in production chain and economic activity.

[Figure 4.7 near here]

August 2018-January 2019 is a recession period in which the economic activity indicator and its upper band suddenly fall below zero together but they do not jump above zero simultaneously. The indicator recovers very slowly until the end of 2019 even its upper bands turn back to positive earlier (Figure 4.8). Following the exchange rate shock hitting the Turkish economy at August 2018, Central Bank implemented a tight monetary policy by raising the interest rate. In this period, inflation rate reached high levels. Domestic demand led contraction in economic activity because of the volatile financial conditions and the descending credit demand. Although monetary tightening of advanced economies led to declines in financial flows to Turkey, depreciation of exchange rate and strong tourism revenues backed up net exports.

[Figure 4.8 near here]

The recession and contraction periods detected by our economic activity indicator with their durations and the corresponding crisis to these periods are listed in Table 4.4. To sum up, our economic activity indicator, calculated by using different macroeconomic variables and GDP, is good at detecting historical recession/contraction periods, better than other papers about Turkey, and giving signals about very near-term realizations.

Table 4.4. Recession/Contraction Periods Detected by Economic Activity Indicator with Their Durations

Recession/Contraction Periods	Duration of Recessions/Contractions	Corresponding Crisis
October 1988-February 1989	5 Months	…
April 1994-January 1995	10 Months	1994 Financial Crisis
October 1998-March 1999	6 Months	1998 Russian Financial Crisis
August 1999-September 1999	2 Months	August, 17 Earthquake
February 2001-February 2002	13 Months	2001 Banking Crisis
October 2008-September 2009	12 Months	Global Financial Crisis
August 2018-January 2019	6 Months	Exchange Rate Shock in August 2018

4.4. Real Time Application

Like historical performance of the economic activity indicator in detecting past well-known recession periods, timely information of it about the current state of the economy is crucial for policy makers. With new data arrivals, estimation of the indicator may change because of both new observations and revisions to previous observations. Therefore, the real-time characteristics of the variables are given great importance in constructing the economic activity indicators.

In the first part, we estimate the indicator for the period of 1988M01-2020M02 because the data of the latest announced variables are available for February 2020. However, nearly half of the variables used in the indicator have data available for later months, especially for March and April 2020, when that estimation is done. Thus, variables used in the estimation are announced at different times during a month and the most recent observations of them can be different. Aruoba and Sarikaya (2013) estimate the model until a certain period and get fixed parameters; then, calculate their economic activity indicator with these fixed parameters at each new data announcements to make a real-time evaluation of the economic activity. Similar to their real-time analysis, we estimate the model for the period of 1988M01-2019M03 and take the fixed parameters. Then, we conduct a pseudo real-time analysis by calculating the indicator up to June, September and December 2019 with available variables. After that, as a real-time analysis, we calculate our economic activity indicator up to February 2020 and April 2020 with available variables when the first estimation is done (at the end of April 2020). Then, with new data arrivals, the indicator is recalculated at May 22, 2020 up to May 2020.

Figure 4.9 demonstrates the economic activity indicators estimated up to March, June, September and December 2019 for pseudo real-time analysis and indicators estimated at the end of April until February and April 2020, and at 22nd of May until May 2020 due to the

disclosure of data at different times. The indicator named as "Economic Activity Indicator_2019M03" belongs to the estimation that is done for the period of 1988M01-2019M03 to get fixed parameters. Other indicators named as "Economic Activity Indicator_2019M06", "Economic Activity Indicator_2019M09" and "Economic Activity Indicator_2019M12" represent the indicators estimated until June, September and December 2019. Lastly, the indicators named as "Economic Activity Indicator_2020M02", "Economic Activity Indicator_2020M04" and "Economic Activity Indicator_2020M05_May22" show the indicators estimated until February, April and May 2020, respectively. The red-dotted lines are the confidence bands of the indicator calculated on 22nd of May, 2020.

[Figure 4.9 near here]

When the model estimation is first made at the end of April, half of the variables contain information about the activity in April. The economic activity indicator and its upper bands fall below zero at April 2020 indicating that month as a starting of a recession period. If we do not have these timely variables and the most recent variable could have been available for February, we would not have timely information on the decline in economic activity in April or we would get informed about it with two months lagged. In the analysis made on 22nd of May, again we have data for April for six of the all ten variables and for May for three of the all ten variables, so we can obtain information about the course of economic activity. As given in Table 4.2, GDP contracted by 2.8 percent in the last quarter of 2018. Figure 4.9 demonstrates that the indicator estimated on 22nd of May takes the value nearly -0,9 on averages of October-November-December 2018 corresponding to the last quarter of 2018. When considering the nearly -3,6 value of the indicator on averages of April-May 2020, it can be inferred that the GDP may contract nearly 11 percent in annual terms in the second quarter of 2020.[7] However, because of having limited variables for April and May, it is better to make prudent inferences.

In sum, having timely variables are important for providing real-time information about the economic activity. However, lags in data announcements and revisions in recently announced variables obstruct evaluation of the economic activity in real-time.

5. Conclusion

In this paper, an economic activity indicator for the Turkish economy for 1988-2020 period is constructed. Dynamic factor modelling framework is utilized in the estimation of the indicator.

[7] The actual contraction in the second quarter of 2020 was realized as 10.3 percent.

After writing the model in state-space form, we use Kalman filter to estimate the model and Kalman smother to obtain the factor, i.e. economic activity indicator.

We select industrial production index, electricity production, total vehicles production, the volume of production over the past 3 months, real sector confidence index, import volume index, non-farm employment, credit stock and CDS for the estimation of the economic activity indicator. As being the broadest measure of economic activity, GDP is also added to the data set. Data selection is done with the help of the hard-thresholding method. In this context, first of all, the variables are categorized into five types as: activity (hard data), activity (survey-based data or soft data), trade, employment and financial variables. For each category, the candidate variables that date back to earlier periods are preferred to be selected. Then by using the hard-thresholding method, variable selection is finalized.

The results indicate that our monthly economic activity indicator is successful in detecting the past recessionary and contractionary periods of the Turkish economy. The recessions/contractions detected by our economic activity indicator are October 1988-February 1989, April 1994-January 1995, October 1998-March 1999, August 1999-September 1999, February 2001-February 2002, October 2008-September 2009 and August 2018-January 2019. Almost all of these periods correspond to the crisis periods that are commonly accepted in the literature. While determining the recessionary periods, we implement the same methodology with Aruoba and Sarikaya (2013) and Çakmaklı and Altuğ (2014) which also use Turkish data. Comparing with these two papers considering the same time period, our indicator detects recessions better than their indicators.

By using timely variables, our indicator provides real-time information about the current state of the economy. Data sets in the other two studies for Turkey consist of variables announced with a lag of 40 to 60 days. Whereas six of the ten variables in our data set are released at the appertaining month or at the beginning of next month. In this respect, our indicator can be updated earlier than the indicators estimated in these two studies. Additionally, for the purpose of showing the importance of timelier variables, a real-time application is performed. We estimate the model until a certain period and fixed the model parameters. Then, we calculate our economic activity indicator at new data announcements for different data releases. With the help of the timelier variables, we can get information about the decline in economic activity which enables to implement timelier and stronger policies.

All in all, our economic activity indicator is good at detecting historical recession/contraction periods and providing timelier information about the course of economic activity.

References

Aruoba, B. S., Diebold, F. X., & Scotti, C. (2009). Real-Time Measurement of Business Conditions. *Journal of Business and Economic Statistics*, 27, 417-427.

Aruoba, B. S., & Sarikaya, Ç. (2013). A Real Economic Activity Indicator for Turkey. *Central Bank Review*, 13(1), 15-29.

Bai, J., & Ng, S. (2008). Forecasting Economic Time Series Using Targeted Predictors. *Journal of Econometrics*, 146, 304-317.

Barhoumi, K., Darne, O., & Ferrara, L. (2013). Dynamic Factor Models: A Review of the Literature. *OECD Journal: Journal of Business Cycle Measurement and Analysis*, 73-107.

Boivin, J., & Ng, S. (2006). Are More Data Always Better for Factor Analysis. *Journal of Econometrics*, 132(1), 169-194.

Coşar, E. E. & Yavuz, A. A. (2019). Is There Asymmetry Between GDP and Labor Market Variables in Turkey under Okun's Law?. *CBRT Working Paper*, 19(27).

Çakmaklı, C., & Altuğ, S. (2014). Constructing Coincident Economic Indicators for Emerging Economies. *Policy Analysis in the Post Great Recession Era Conference.* İstanbul.

Darne, O., & Ferrara, L. (2011). Identification of Slowdowns and Accelerations for the Euro Area Economy. *Oxford Bulletin of Economics and Statistics*, 73(3), 335-364.

Dua, P., & Banerji, A. (2000). An Index of Coincident Economic Indicators for the Indian Economy. *Centre For Development Economics, Delhi School of Economics Working Paper*, 73.

Evans M. D. D. (2005). Where Are We Now: Real-Time Estimates of the Macro Economy. *The İnternational Journal of Central Banking*, 127-175.

Mariano, R. S., & Murasawa, Y. (2003). A New Coincident Index of Business Cycles Based on Monthly and Quarterly Series. *Journal of Applied Econometrics*, 18(4), 427-443.

Matheson T. (2011). New Indicators for Tracking Growth in Real Time. *IMF Working Paper*, 11(43).

Proietti, T., & Moauro, F. (2006). Dynamic Factor Analysis with Non Linear Temporal Aggregation Constraints. *Applied Statistics*, 55(2), 281-300.

Simone, A. (2001). In Search of Coincident and Leading Indicators of Economic Activity in Argentina. *IMF Working Paper*. 01(30).

Solberger, M. & Spånberg, E. (2020). Estimating a Dynamic Factor Model in EViews Using the Kalman Filter and Smoother. Computational Economics, 55, 875–900.

Stock, J. H., & Watson, M. W. (1989). New Indexes of Coincident and Leading Economic Indicators. *NBER Macro Annual (Vol. 4). Cambridge: MIT Press*, 351-409.

Figures

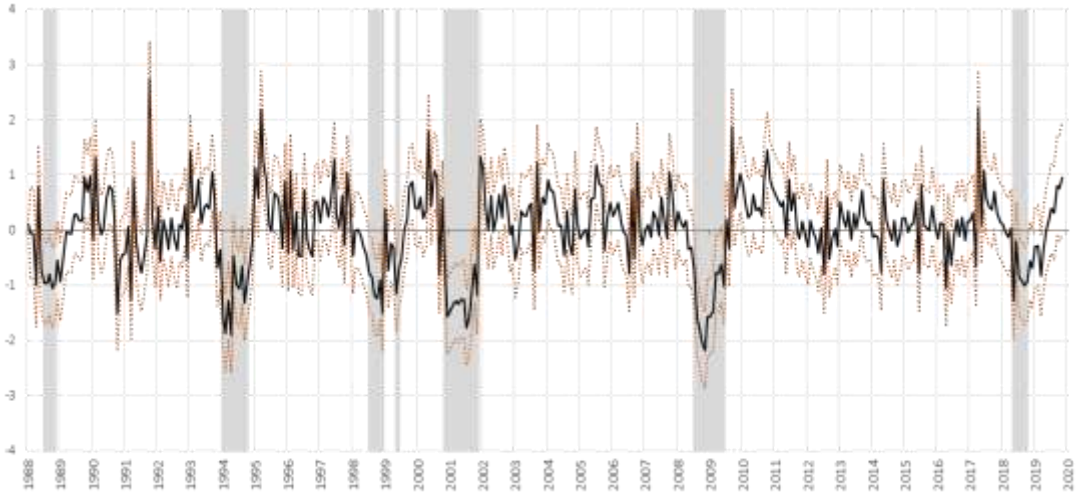

Figure 4.1. Economic Activity Indicator for Turkey

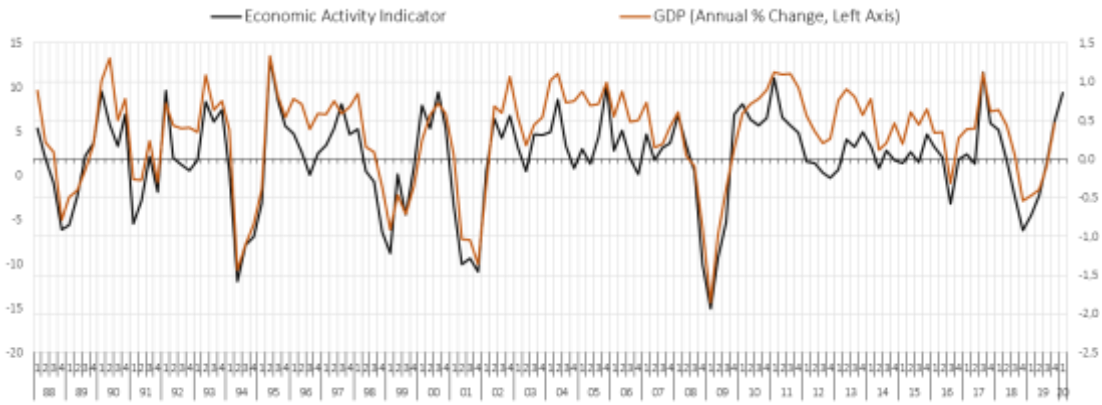

Figure 4.2. Economic Activity Indicator for Turkey and GDP (Annual % Change)

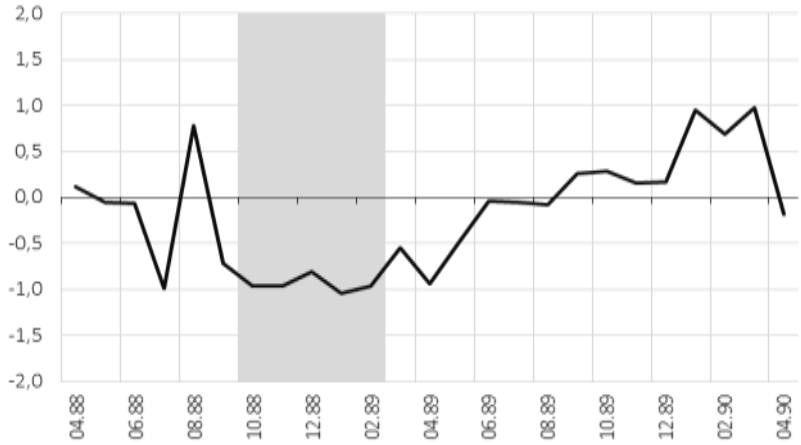

Figure 4.3. October 1988-February 1989 Contraction

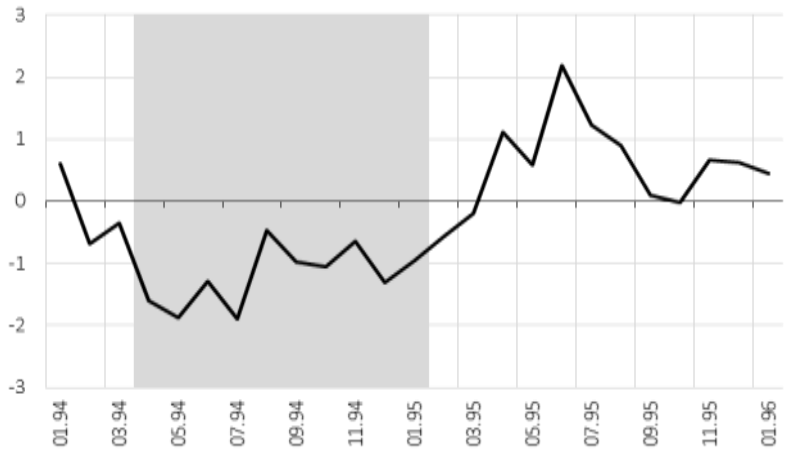

Figure 4.4. April 1994-January 1995 Recession

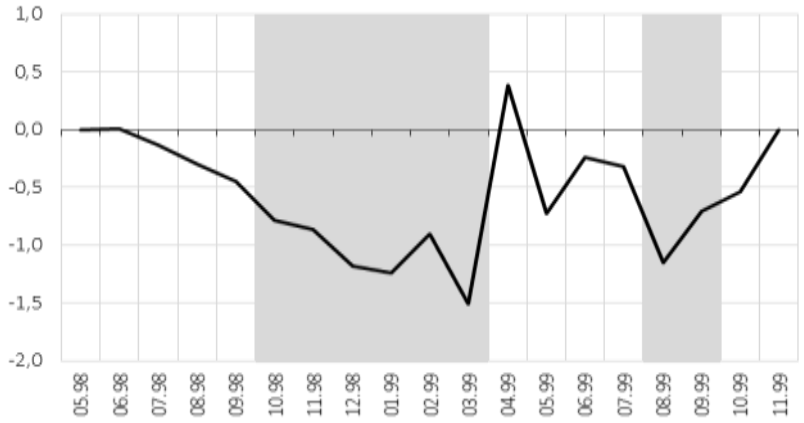

Figure 4.5. October 1998-March 1999 Recession and August 1999-September 1999 Contraction

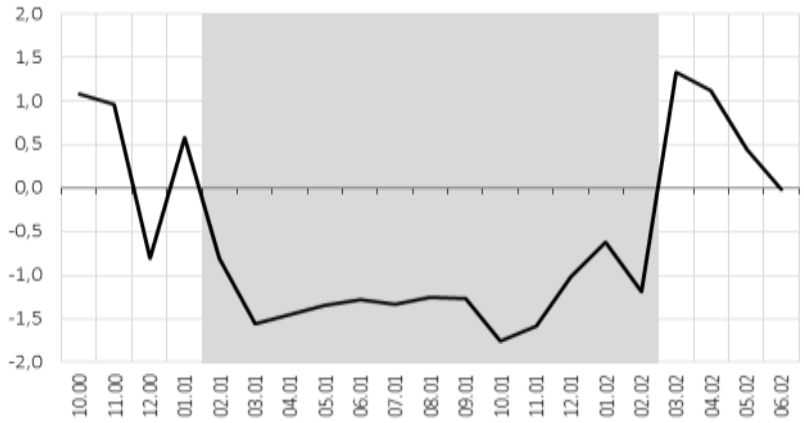

Figure 4.6. February 2001-February 2002 Recession

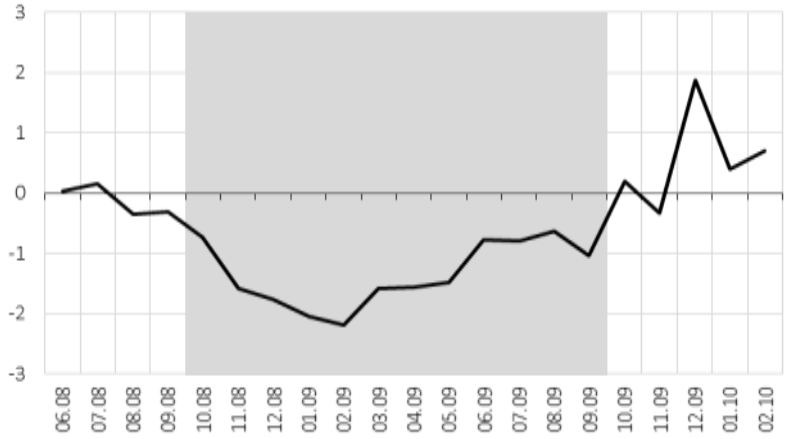

Figure 4.7. October 2008-September 2009 Recession

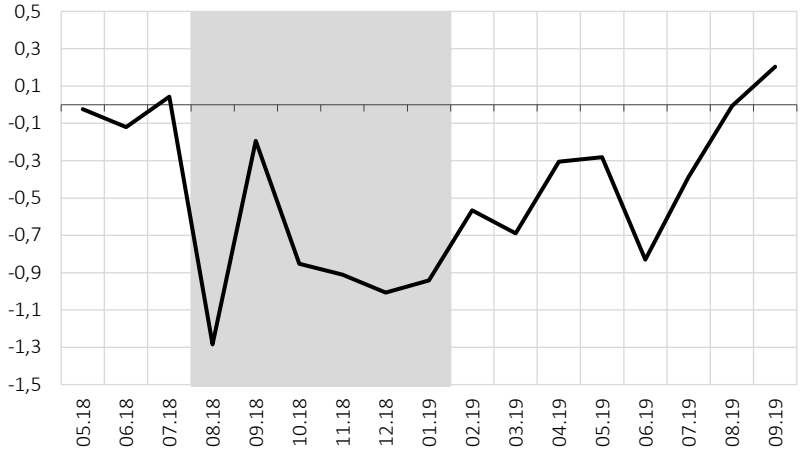

Figure 4.8. August 2018-January 2019 Recession

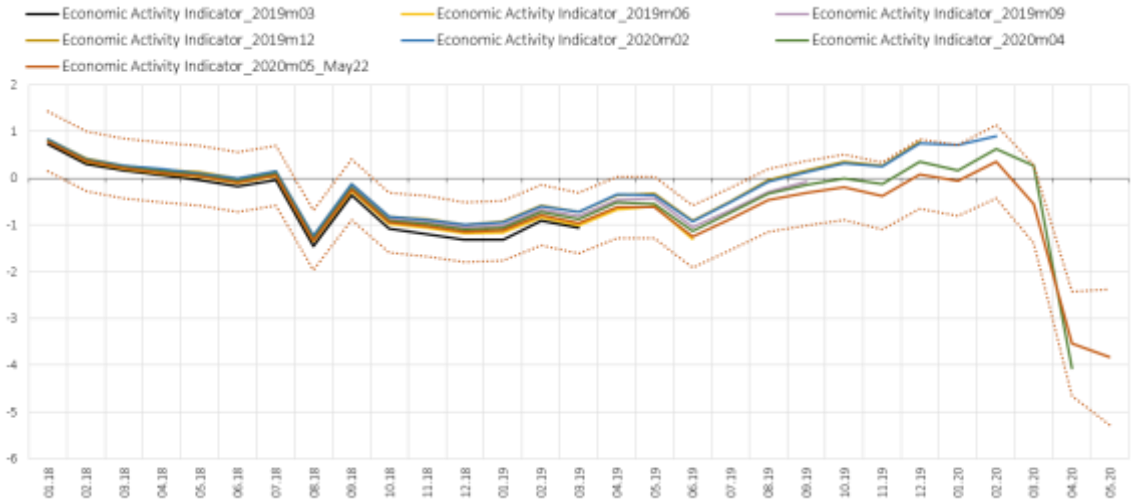

Figure 4.9. Real-Time Application to the Economic Activity Indicator

Central Bank of the Republic of Turkey

Recent Working Papers

The complete list of Working Paper series can be found at Bank's website

(**http://www.tcmb.gov.tr**)

Tariff Changes by Turkey During the Covid-19 Pandemic: Impact on Import Value and Import Prices
(Yusuf Kenan Bağır Working Paper No. 21/13 July 2021)

Does Stock Market Listing Boost or Impede Corporate Investment?
(İbrahim Yarba, Ahmet Duhan Yassa Working Paper No. 21/12, July 2021)

Nowcasting and Short-term Forecasting Turkish GDP: Factor-MIDAS Approach
(Selçuk Gül, Abdullah Kazdal Working Paper No. 21/11, July 2021)

Firm-Level Impact of Credit Guarantees: Evidence from Turkish Credit Guarantee Fund
(Ufuk Akçiğit, Ünal Seven, İbrahim Yarba, Fatih Yılmaz Working Paper No. 21/10, April 2021)

The Importance of External Shocks and Global Monetary Conditions for A Small-Open Economy
(Gülnihal Tüzün Working Paper No. 21/09, April 2021)

Okun's Law under the Demographic Dynamics of the Turkish Labor Market
(Evren Erdoğan Coşar, Ayşe Arzu Yavuz Working Paper No. 21/08, March 2021)

Potential Growth in Turkey: Sources and Trends
(Orhun Sevinç, Ufuk Demiroğlu, Emre Çakır, E. Meltem Baştan Working Paper No. 21/07, March 2021)

Cost of Credit and House Prices
(Yusuf Emre Akgündüz, H. Özlem Dursun-de Neef, Yavuz Selim Hacıhasanoğlu, Fatih Yılmaz Working Paper No. 21/06, March 2021)

External Vulnerabilities and Exchange Rate Pass-Through: The Case of Emerging Markets
(Abdullah Kazdal, Muhammed Hasan Yılmaz Working Paper No. 21/05, February 2021)

The Impact of Oil Price Shocks on Turkish Sovereign Yield Curve
(Oğuzhan Çepni, Selçuk Gül, Muhammed Hasan Yılmaz, Brian Lucey Working Paper No. 21/04, February 2021)

Decomposition of Bank Loans and Economic Activity in Turkey
(Hande Küçük Yeşil, Pınar Özlü, Çağlar Yüncüler Working Paper No. 21/03, February 2021)

The Role of Expectations in the Inflation Process in Turkey: Have the Dynamics Changed Recently?
(Ümit Koç, Fethi Öğünç, Mustafa Utku Özmen Working Paper No. 21/02, February 2021)

Consequences of a Massive Refugee Influx on Firm Performance and Market Structure
(Yusuf Emre Akgündüz, Yusuf Kenan Bağır, Seyit Mümin Cılasun, Murat Günay Kırdar Working Paper No. 21/01, January 2021)

Do Household Consumption and Saving Preferences Vary Between Birth-Year Cohorts in Turkey?
(Evren Ceritoğlu Working Paper No. 20/15, October 2020)

Credit Decomposition and Economic Activity in Turkey: A Wavelet-Based Approach
(Oğuzhan Çepni, Yavuz Selim Hacıhasanoğlu, Muhammed Hasan Yılmaz Working Paper No. 20/14, October 2020)

Do Investment Incentives Promote Regional Growth and Income Convergence in Turkey?
(Hülya Saygılı Working Paper No. 20/13, October 2020)