THE TALE OF TWO EPISODES: ESTIMATING TIME-VARYING POTENTIAL OUTPUT AND NAIRU USING A MULTIVARIATE FILTER FOR TURKEY

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submitted by **MERT GÖKCÜ** in partial fulfillment of the requirements for the degree of **Master of Science in Economics, the Graduate School of Social Sciences of Middle East Technical University** by,

Prof. Dr. Yaşar KONDAKÇI
Dean
Graduate School of Social Sciences _____

Prof. Dr. Meltem DAYIOĞLU TAYFUR
Head of Department
Department of Economics _____

Assist. Prof. Dr. Dilem YILDIRIM KASAP
Supervisor
Department of Economics _____

Examining Committee Members:

Prof. Dr. Elif AKBOSTANCI (Head of the Examining Committee)
Middle East Technical University
Department of Economics _____

Assist. Prof. Dr. Dilem YILDIRIM KASAP (Supervisor)
Middle East Technical University
Department of Economics _____

Assoc. Prof. Dr. Ayşegül ÇORAKÇI
Çankaya University
Department of Economics _____

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last Name: Mert GÖKCÜ

Signature:

ABSTRACT

THE TALE OF TWO EPISODES: ESTIMATING TIME-VARYING POTENTIAL OUTPUT AND NAIRU USING A MULTIVARIATE FILTER FOR TURKEY

GÖKCÜ, Mert
M.S., The Department of Economics
Supervisor: Assist. Prof. Dr. Dilem YILDIRIM KASAP

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In the aftermath of the 2001 crisis, a steady growth pattern was sustained, inflation rates were reduced to single-digit levels and a remarkable improvement in interest rates was realized in Turkey. Despite these positive developments, the Turkish economy has experienced two cyclical downturns in this period. The first one was due to the global financial crisis, which spans the period 2008-Q2 and 2009-Q1, while the second one took place between 2018-Q3 and 2018-Q4 when strong and abruptly depreciation in Turkish Lira and high country's risk premium existed. Although the depth and duration of the latter downturn were shorter than the former, both periods had major repercussions on the labor market. In this thesis, we examine the business cycle conditions and estimate the non-accelerating inflation rate of unemployment (NAIRU) in both episodes by using univariate and multivariate detrending methods. Although univariate filters give confusing results, multivariate filter results are fairly reasonable. Though estimate of the slack in the output is smaller in the recent period, the unemployment rate and NAIRU increase sharply and reach the highest levels historically in both periods. Due to weaker foreign demand and composition of industrial sector products, slack in capacity utilization rate is higher in the global financial crisis. As a result, the labor market has been the most affected by these turmoil negatively.

Keywords: Potential Output, Output Gap, NAIRU, Multivariate Filter, Bayesian Estimation

ÖZ

İKİ DÖNEMİN HİKÂYESİ: ÇOK DEĞİŞKENLİ BİR FİLTRE KULLANARAK TÜRKİYE İÇİN ZAMAN İÇİNDE DEĞİŞEN POTANSİYEL BÜYÜME VE ENFLASYONU HIZLANDIRMAYAN İŞSİZLİK ORANININ TAHMİN EDİLMESİ

GÖKCÜ, Mert
Yüksek Lisans, İktisat Bölümü
Tez Yöneticisi: Assist. Prof. Dr. Dilem YILDIRIM KASAP

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Türkiye ekonomisinde 2001 krizi sonrasında istikrarlı bir büyüme patikası görülürken, enflasyon oranları tek haneli seviyelere indirilmiş ve faiz oranlarında kayda değer bir iyileşme gerçekleşmiştir. Bu olumlu gelişmelere rağmen, Türkiye ekonomisi bu dönemde iki dönemsel gerileme yaşamıştır. Bunlardan ilki küresel finansal krizin etkisiyle 2008-2 ve 2009-1 döneminde yaşanırken, ikincisi ise Türk Lirasında güçlü ve ani bir değer kaybının yaşandığı ve ülke risk priminin yüksek olduğu 2018-3 ile 2018-4 arasında gerçekleşmiştir. Her ne kadar son dönemdeki gerilemenin derinliği ve süresi öncekinden daha kısa olsa da, her iki dönemde de işgücü piyasasında olumsuzluklar görülmüştür. Bu tezde, her iki dönem için konjonktürel dalgalanmaları ve enflasyon oranını hızlandırmayan işsizlik oranını (NAIRU) tek ve çok değişkenli filtreleme yöntemleri kullanarak tahmin ediyoruz. Tek değişkenli filtreler özellikle örneklemin son noktası için muğlak sonuçlar verse de, çok değişkenli filtre sonuçları oldukça makul görünmektedir. Gelirdeki durgunluk son dönemde daha az olmasına rağmen, işsizlik oranı ve NAIRU keskin bir şekilde artmakta ve her iki dönemde de tarihsel olarak en yüksek seviyelere ulaşmaktadır. Zayıf seyreden dış talep ve sanayi sektörü ürünlerinin bileşimi nedeniyle küresel finansal krizde kapasite kullanım oranındaki daralma daha yüksektir. Sonuç

olarak, işgücü piyasası bu çalkantılardan en fazla etkilenen makroekonomik değişken olmuştur.

Anahtar Kelimeler: Potansiyel Büyüme, Çıktı Açığı, Enflasyonu Hızlandırmayan İşsizlik Oranı, Çok Değişkenli Filtre, Bayesçi Tahmin

To My Family

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CHAPTER 1

INTRODUCTION

In the aftermath of the 2001 crisis, the Turkish economy displayed a strong performance thanks to structural reforms (Kara, 2006)[1]. A steady growth pattern was sustained, inflation rates were reduced to single-digit levels, and a remarkable improvement in interest rates was realized. Despite these positive developments, the Turkish economy has experienced two cyclical downturns since 2001. The first one was due to the global financial crisis, which spans the period 2008-Q2 and 2009-Q1, while the second one took place between 2018-Q3 and 2018-Q4[2] when strong and abruptly depreciation in Turkish Lira and high country's risk premium existed. Although the depth and duration of the latter downturn are shorter than the former, both periods had major repercussions on the labor market, as unemployment rates rose to historically high levels (13.8% and 16.8% in 2009-Q2 and 14.0% and 16.4% in 2019-Q3 for the total unemployment rate and non-farm unemployment rate respectively), due to employment losses as a result of a slowdown in economic activity and rising uncertainty. While most of the employment losses occurred in the industrial sector during the global financial crisis, employment losses spread across sectors in the 2018 downturn. Against this background, we aim to examine the business cycle conditions and estimate the non-accelerating inflation rate of unemployment (NAIRU)

[1] Independence of the Central Bank of the Republic of Turkey (CBRT) was strengthened by the Central Bank law, which was amended in April 2001 after the 2001 crisis. CBRT adopted implicit inflation targeting regime in 2002-2005 and it gradually switched to full-fledged inflation targeting. Adoption of the crawling peg exchange rate regime was given up and CBRT let the Turkish Lira to float. CBRT could no longer purchase debt instruments issued by Treasury in the primary bond market to ensure fiscal discipline and sustainability. Moreover, banking system has restructured.

[2] Although the quarterly growth figures adjusted for seasonally and calendar effects started to increase as of the date, the direct and indirect effects of macroeconomic events during the related period continued to reflect especially on the economic activity, labor market and price developments within the next year.

in both episodes by using univariate and multivariate detrending methods. While the extent of the fall in the output gap and the rise in NAIRU will be compared, the implications of these developments on the macroeconomic outlook will be investigated.

Potential output and the output gap are valuable to both monetary policymakers and non-monetary policymakers such as fiscal authority. The precision of the estimation of the output gap has important policy implications for the current and future dynamics of economies. A reliable output gap estimation enables central bankers to assess the appropriateness of their monetary policy stance. If the level of output gap implies upward (downward) pressure on the inflation, central banks whose primary objective is to maintain low and stable inflation can tighten (ease) its policy stance. Therefore, incorrect estimation of the output gap could result in monetary policies that lead to inflation or low growth rates. From the fiscal authorities' perspective, governments would like to know whether the budget deficit is sustainable or not to calibrate fiscal policy. To do this, cyclically-adjusted budget balance[3] whose calculation needs the output gap must be correctly estimated. Over-optimism and overestimation of the economy's potential capacity could lead to a substantial deterioration in budget deficits and public debt. Kangur et al. (2019) clarify that there exists a positive correlation between upward revisions to real-time output gaps with public debt levels and public debt. Therefore, identifying the state of the economy precisely is crucial to ensure macroeconomic stability. Burns and Mitchell (1943)[4] and Lucas (1977)[5] put forward

[3] For further details on the cyclically-adjusted budget balance calculations, see Van den Noord (2000) and Girouard and André (2005).

[4] Burns and Mitchell (1943): "*Business cycles are a type of fluctuations found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar characters with amplitudes approximating their own*."

[5] Lucas (1977): "*Movements about trend in gross national product in any country can be well described by stochastically disturbed difference equation of very low order. These movements do not exhibit uniformity of either period or amplitude, which is to say, they do not resemble the deterministic wave motions which sometimes arise in the natural sciences. Those regularities which are observed are in the co-movements among different aggregative time series. There is, as far as I know, no need to qualify these observations by restricting them to particular countries or time periods: they appear to be regularities common to all decentralized market economies. Though there is absolutely no theoretical*

two different notions related to business cycles. While the classical view by Burns and Mitchell (1943) considers level data, the latter is interested in detrended data, i.e. growth cycles. Since it is thought to be more relevant to inflation and financial cycles, considering the growth cycle to construct the business cycle models has been more common recently among the policymakers, central bankers, and academicians. The growth cycle or output gap can be described as the percentage deviation of the actual output from the potential[6]. The mystery on the output gap emerges from the definition since it includes potential output term, which is unobservable. Okun (1962) describes potential output as the maximum amount of output that can be produced without giving rise to inflation.

NAIRU is another key ingredient to evaluate inflationary pressure, which makes central banks to monitor NAIRU developments closely as well. Moreover, it is considered as the labour market slack and utilized to measure the capacity pressure. NAIRU, unveiled by Modigliani and Papademos (1975), is the improvement over the natural rate of unemployment, the level of unemployment consistent with the equilibrium of the real wages, introduced by Phelps (1967) and Friedman (1968). Ball and Mankiw (2002) declare that there must be some level of unemployment, NAIRU, which is consistent with a stable inflation. Natural rate and NAIRU are two different concepts although NAIRU converges to the natural rate of unemployment in the long-run when shocks fade. While the former is affected by structural and institutional changes so it is accepted constant and time-invariant, the latter is a time-varying variable due to its derivation exploiting the trade-off between inflation and unemployment in the short-run. Therefore, central banks could affect the NAIRU but not the natural rate.

There are numerous approaches ranging from univariate decompositions, which utilize simple statistical techniques, to multivariate decompositions containing structural

reason to anticipate it, one is led by the facts to conclude that, with respect to the qualitative behaviour of co-movements among series, business cycles are all alike."

[6] Different output gap definitions are also available. The difference between actual output and a long term, steady state output path and deviation of actual output from the hypothetical level of output achieved when nominal rigidities in the economy are absent are some of the numerous descriptions of the output gap (Melolinna and Tóth, 2016).

economic relationships and models as well as micro-founded work for estimating the potential output, output gap and NAIRU. In the univariate methods, the deterministic polynomial trend (DPT) method is the simplest one. It assumes that the trend component of the series is the deterministic function of time. Similarly, first-order difference (FOD) method is easily conducted to decompose any time series. Hodrick-Prescott (HP) filter (1981, 1997) is arguably the most commonly used method to decompose a series into trend and cycle in the academic research, central banks for establishing policies, and private-sector economists. Since the filter utilizes both future and past realizations to extract the cycle, it is called as a two-sided (symmetric) filter. Unlike the previous approach, the one-sided HP filter is self-explanatory. Hamilton (2017) brought a lot of criticisms on the use of the one/two-sided HP filter and proposed an alternative detrending method, Hamilton's regression filter. It uses local projection to extract cycles. Moreover, Baxter and King (BK) and Christiano-Fitzgerald (CF) filter are the band pass filters allowing to decompose time series into different components based on the different frequency ranges. Although univariate filters are easy and fast to implement, they are purely statistical methods and do not require economic structure. Besides, the results derived by univariate methods may not be consistent with other macroeconomic variables. Furthermore, as shown in the Blagrave et al. (2015) and Hamilton (2017), univariate filters suffer from the end-point problem, which might be characterized by the exaggerated impact of the terminal point. It may cause several wrong implications. To capture typically economic relationships and get rid of the end-point problem, a multivariate filtering approach has been developed (Benes et al. (2010); Blagrave et al. (2015); Alichi et al. (2015, 2019)). The filter incorporates relevant empirical relationships between several macroeconomic indicators within the framework of a New Keynesian small open macroeconomic model. Following the previous approach, we construct a model including data on inflation, unemployment and capacity utilization rate for 2005-Q1 and 2019-Q4[7] to identify the cyclicality of output and unemployment rate during the downturn periods. Our model differs from other studies done for Turkey in several ways. It estimates domestic and foreign demand gaps along with the output gap since Alp et al. (2012) indicate that assessing the output gap individually may result in

[7] Recession periods earlier than 2005 have not been examined due to data shortages.

monetary policy error. Moreover, the relationship of the output gap with the capacity gap is an extension showing the richness of the model. Our empirical findings reveal that estimate of the output gap is smaller in the 2018 downturn than the estimate observed during the global financial crisis since foreign demand is more supportive for the latter due to competitive exchange rate and strengthening market diversification flexibility in exports. Potential growth decreased in both periods. NAIRU moves in tandem with the actual unemployment rate which has been above trend for a long time during both downturns. Though the estimate of the slack in the output is smaller in the recent period, the unemployment rate and NAIRU increase sharply and reach the highest levels historically in both periods. While the employment losses in the labor market were predominant in the industrial sector during the global financial crisis, sectorial diffusion in the employment losses have occurred in the 2018 downturn. Due to weaker foreign demand and composition of industrial sector products, slack in capacity utilization rate is higher in the 2008 downturn. As a result, the labor market has been the most affected by these turmoil negatively.

It is believed that our results serve useful implications on the fiscal and monetary policies. The most popular and proposed filters are used to derive the output gap, unemployment gap, and capacity utilization gap as well as potential output and NAIRU developments of the Turkey economy. Following Orphanides (2003) and Orphanides and van Norden (2005), who give notice of policy errors and lower predictability of inflation led by real-time biases in the output gap, we utilize a battery of filters and models. The thesis is the first study for Turkey in terms of including such a comprehensive analysis. First of all, our work enriches the relevant literature for Turkey in several ways. Secondly, we differentiate from other studies on the Turkish economy by integrating the capacity utilization gap block into our model. Thanks to this extension, we can compare the course of the cyclicality of the output, capacity utilization, and unemployment rate in the downturn periods of Turkey. Our study tries to find out which macro variables are labile in the downturn periods. In addition to comparing macroeconomic variables, we can also collate multivariate filtering estimations with a wide range of univariate filtering estimations by considering their pros and cons. We use various detrending methods to identify cyclicality of output and unemployment rate during the downturn periods.

The organization of the paper is as follows: Chapter 2 provides background information on Turkey's macroeconomic outlook by exploiting some stylized facts about the two largest cyclical downturn periods. The literature review on the estimation of the potential output, output gap, and NAIRU is given in Chapter 3. Chapter 4 introduces the model and data and also includes small comparisons on the filters. Chapter 5 discusses the results by comparing two periods in terms of different filters. Finally, Chapter 6 concludes.

CHAPTER 2

BACKGROUND ON MACROECONOMIC OUTLOOK IN TURKEY

A new economic program was implemented in the early 2000s to mitigate the adverse effects of the macroeconomic instability resulted from defects in economics basics, high debt dynamics, and problems of financial sectors in Turkey. There existed a significant budget deficit, very short borrowing terms, high real interest rates, accumulated domestic and foreign debt and high current account deficit. The program could not fix these disorders and the crisis in which foreign exchange rate and interest rates rose considerably broke out in February 2001. During the crisis, economic activity contracted sharply, unemployment rates rose to high levels, inflation rates elevated and financial indicators deteriorated (Table 1).

Table 1.

Macroeconomic Indicators

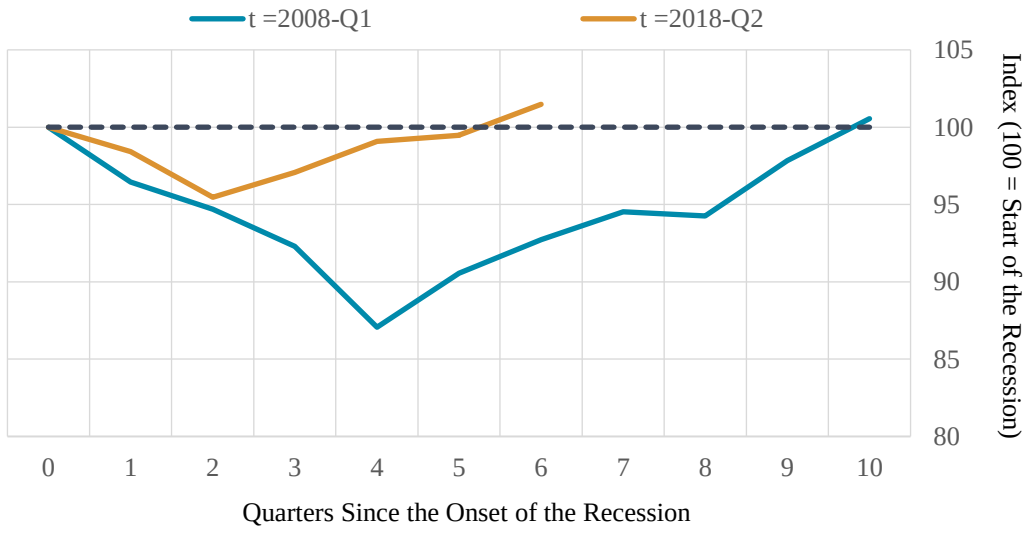
Indicators	1998	1999	2000	2001	2008	2009	2018	2019
Real GDP Growth (Annual percentage change)	3.1	-3.3	6.9	-5.8	0.8	-4.8	3.0	0.9
Inflation Rate, end of the year consumer prices (Annual percentage change)	69.6	68.8	39.0	68.5	10.1	6.5	20.3	11.8
Unemployment Rate (Percent)	6.4	7.2	6.0	7.8	10.0	13.1	11.0	13.7
Current Account Balance (Percent of GDP)	0.7	-0.4	-3.6	1.9	-5.0	-1.7	-2.6	1.2
General Government Net Debt (Percent of GDP)	43.7	61.2	46.8	64.8	26.8	30.9	13.6	16.2
Borrowing Requirement (Percent of GDP)	7.0	11.4	8.7	11.8	1.5	4.8	2.4	3.2
Treasury Auction Interest Rates (Percent, average)	115.5	105.6	36.2	99.6	18.6	12.6	16.6	16.1
US Dollar/TL (Annual percentage change)	71.6	61.0	48.5	96.5	6.6	13.4	37.5	12.2
CPI Based Real Effective Exchange Rate (2003=100, level)	94.9	101.6	115.6	89.6	119.3	111.9	81.8	76.1

Source: Turkstat, CBRT, MTF, IMF.

In the aftermath of the crisis, thanks to a great number of structural reforms adopted to ensure macroeconomic stability, the Turkish economy experienced favorable developments. Beginning from the first quarter of 2002, consecutive quarterly growth rates, rapid decline in the inflation rate, improvement in the labor markets and public budget have been realized. Although high growth rates continue, the Turkish economy has experienced two large cyclical downturns since 2001: the first one began in the second quarter of 2008 and lasted for four quarters due to the repercussions of the global financial crisis in 2008, while the second one took place in the second half of the 2018. Comparing the two episodes will allow us to identify similarities and differences between both periods, which helps to understand the effects of macroeconomic shocks on macro variables. Such a comparison will make easier to understand the results. The main points of the comparison are listed as follows:

- **The recovery to pre-crisis economic activity level was shorter in the 2018 downturn.** It took 10 and 6 quarters for GDP to return to its former level in the first and second cyclical downturn, respectively.

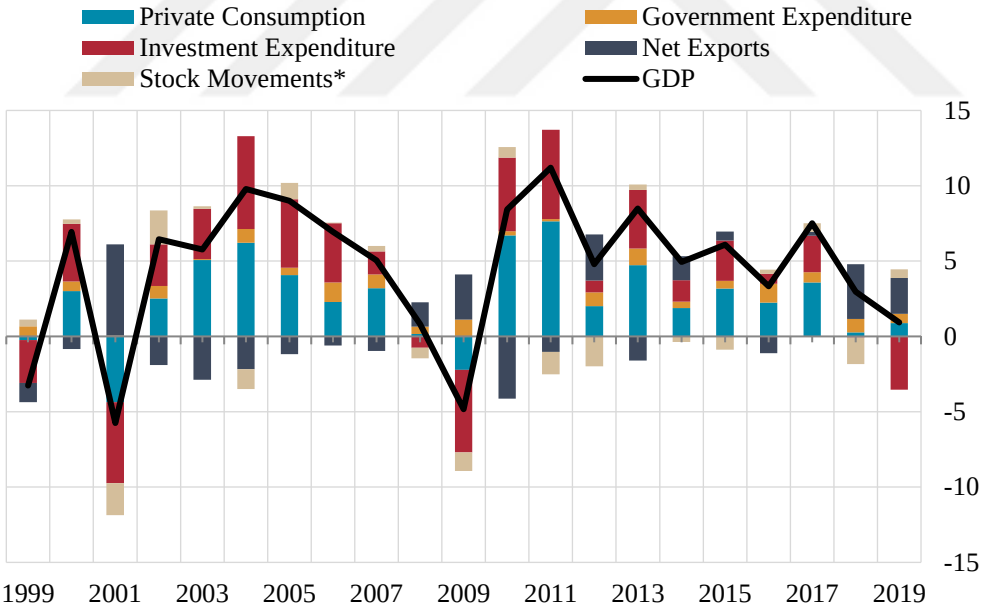
- **The level of contraction was deeper in the 2008 downturn.** The loss in output from peak to trough was around 13 percent in the former, and around 5 percent in the latter (Figure 1).



Source: Turkstat, author's own calculations.

Figure 1: Real GDP Dynamics during the Two Cyclical Downturns

- **While foreign demand contracted sharply in the 2008 downturn, domestic demand was deteriorated in the 2018 downturn**. Although the first downturn started in 2008-2 and ended in 2009-1, its effect was felt more in 2009. While annual GDP increased by 0.8 percent in 2008, the economy contracted at a very high rate throughout 2009 when the annual GDP decreased by 4.8 percent. Annual limited positive growth in 2008 was driven mainly by net exports and public consumption. The rather sharp contraction in private consumption and investments resulted in a strong negative contraction in 2009. As for the second one, although low growth rates are observed annually, there is no annual contraction in the economy due to positive growth in the first half of the 2018 and carry-over effect of the high growth in 2017. While the annual GDP increased by 3.0 percent in 2018, it increased by 0.9 percent in 2019. As in 2009, investment expenditures had a negative contribution to annual growth in 2019 due to high risk premium and financial constraints. As can be seen, it was the worst affected growth components in both periods (Figure 2).



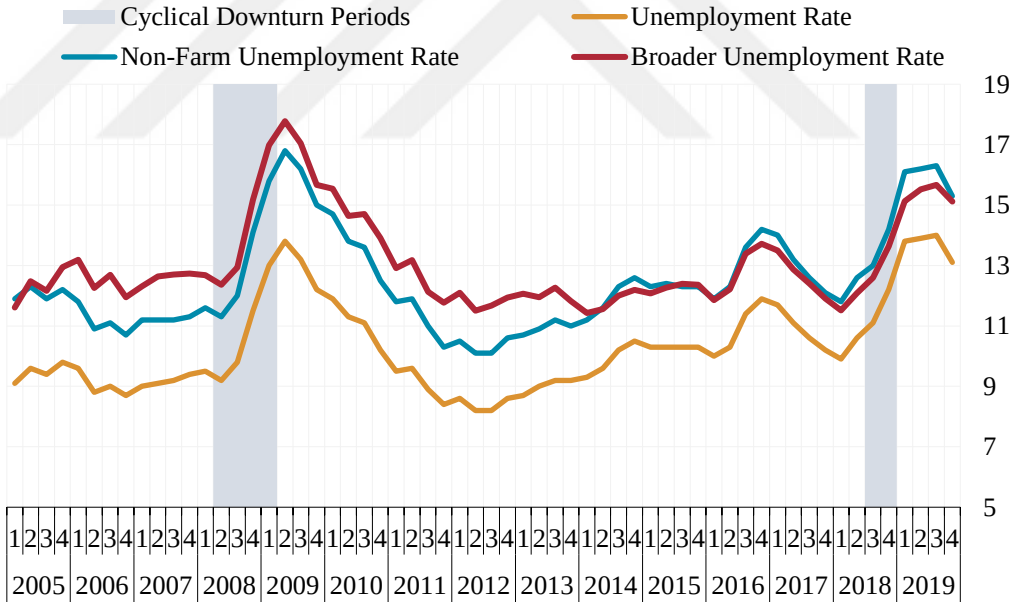
Source: Turkstat, author's own calculations.

*Contains residuals.

Figure 2: Annual Growth and Contributions (% Points)

- **Although the contraction width and duration of both periods are different from each other, the labor market was affected severely in both periods**.

Unemployment rates continued to increase for a while even after downturn periods which means that the effects of the downturns on the labor market are delayed. We see this more clearly in the 2018 downturn. Although unemployment rates started to decrease as soon as growth rates return to positive in the 2008 downturn, unemployment rates began to reduce after three quarters in the 2018 downturn due to the composition of the growth, ongoing uncertainties and level of tightness in financial conditions. In addition to these, there was stronger use of credit channel to get rid of downturn in 2018 but tax incentives were given to revive in 2008. While seasonally adjusted unemployment rate[8] peaked at 13.8 percent in the first one, it elevated at historically the highest level (14.0 percent) in 2019-3 due to slowdown in economic activity starting from 2018-3. Moreover, non-farm unemployment rates and broader unemployment rates considerably increased in both periods (Figure 3).



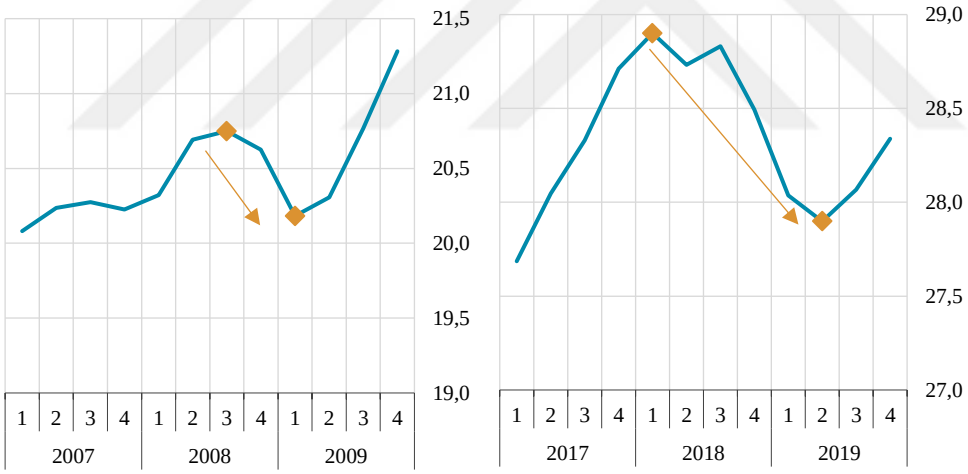
Source: Turkstat, author's own calculations.

Figure 3: Unemployment Rates (Seasonally adjusted, percent)[9]

[8] It took three years longer to return to the pre-downturn level.

[9] Broader unemployment rate is equal to (unemployed+discouraged workers)/(labour force+discouraged workers).

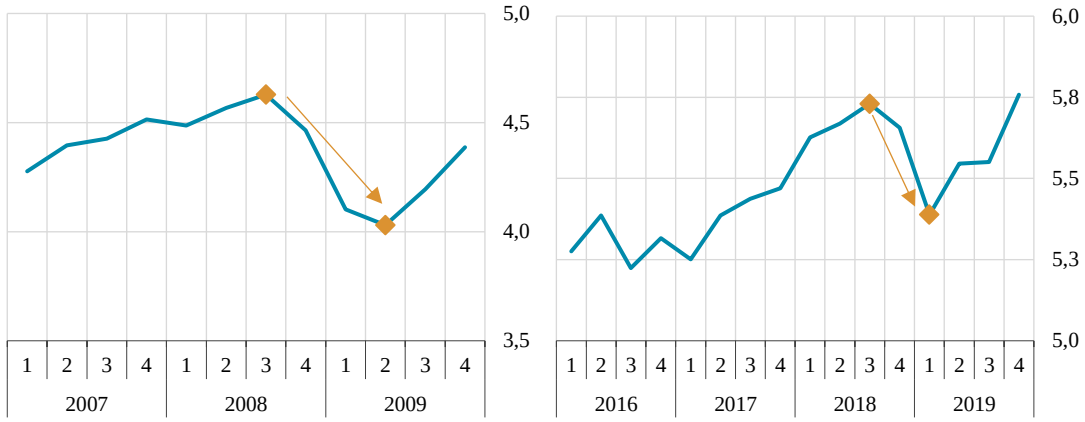
- **Employment losses are observed intensely in both periods due to the slowdown in economic activity** (Figure 4). For the first period, employment losses are mainly driven by employment losses in manufacturing sector especially export-oriented sectors (Figure 5, left panel) due to shock in the foreign demand; however, it is observed that the deterioration in the labor market has spread across sectors for the 2018 downturn period which means that employment losses were observed in all industry, manufacturing, service and construction sectors (Figure 5-6-7, right panels). Especially, considerable losses in construction employment attracted attention (Figure 7, right panel). In comparison to first one, public employment growth was stronger (Figure 8). Furthermore, while the unemployment duration period did not increase during the downturn periods, it showed an upward trend after the periods[10]. (Figure 9). Upward trend in unemployment duration may result in erosion of skills and weaker labor attachment thus it explains why discouraged workers increased during and/or after recessions (Figure 10).



Source: Turkstat.

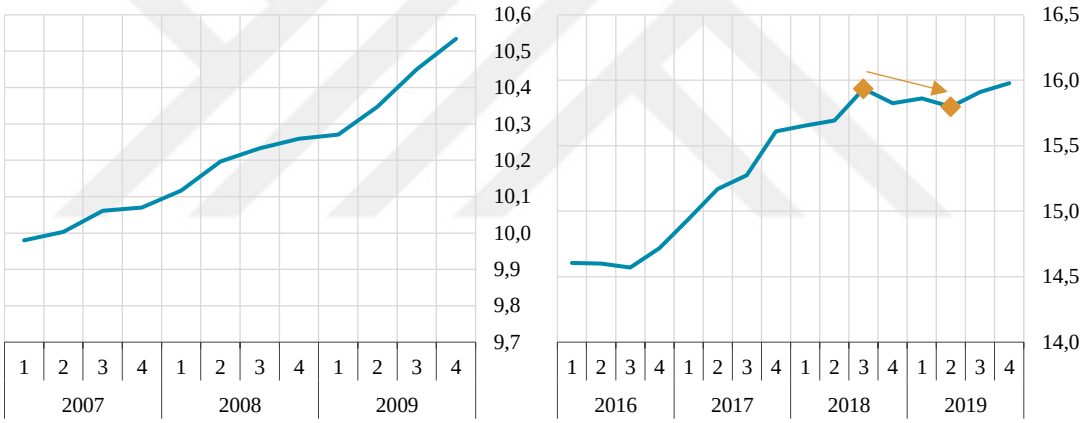
Figure 4: Total Employment (Seasonally adjusted, millions of persons)

[10] This situation remains valid even when long-term unemployed are excluded (Figure 9).



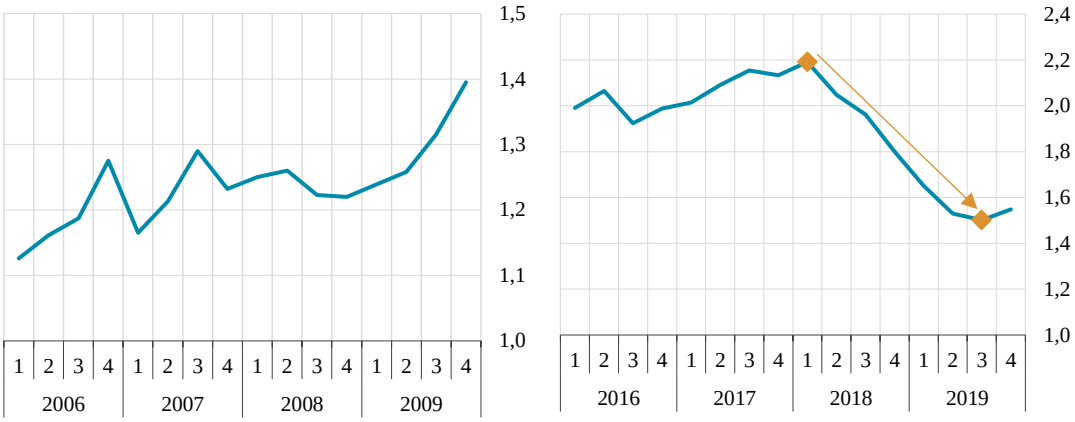
Source: Turkstat.

Figure 5: Manufacturing Sector Employment (Seasonally adjusted, millions of persons)



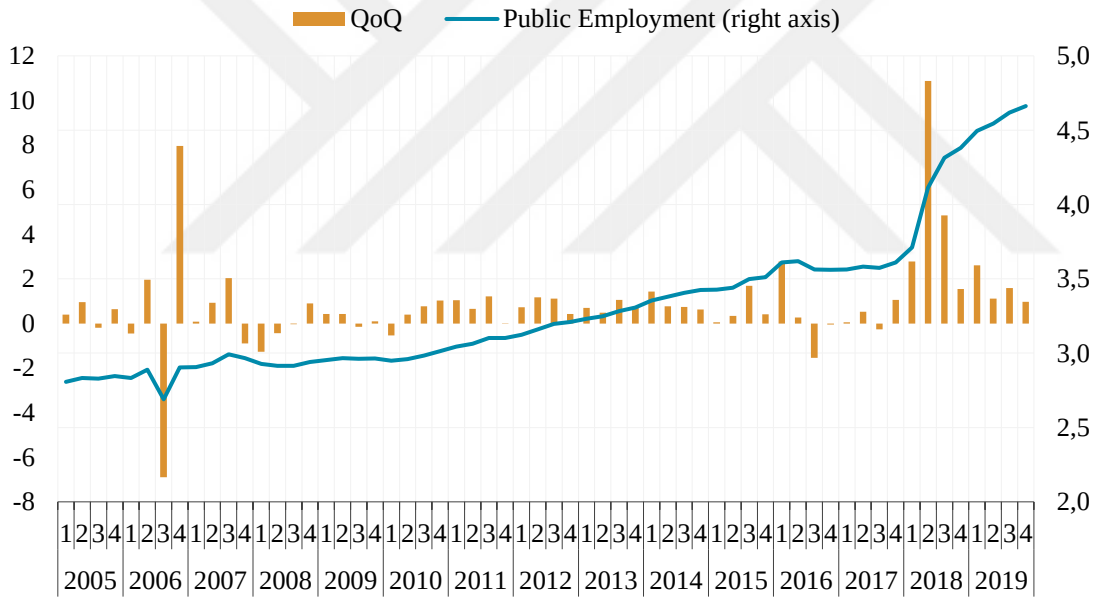
Source: Turkstat.

Figure 6: Services Sector Employment (Seasonally adjusted, millions of persons)



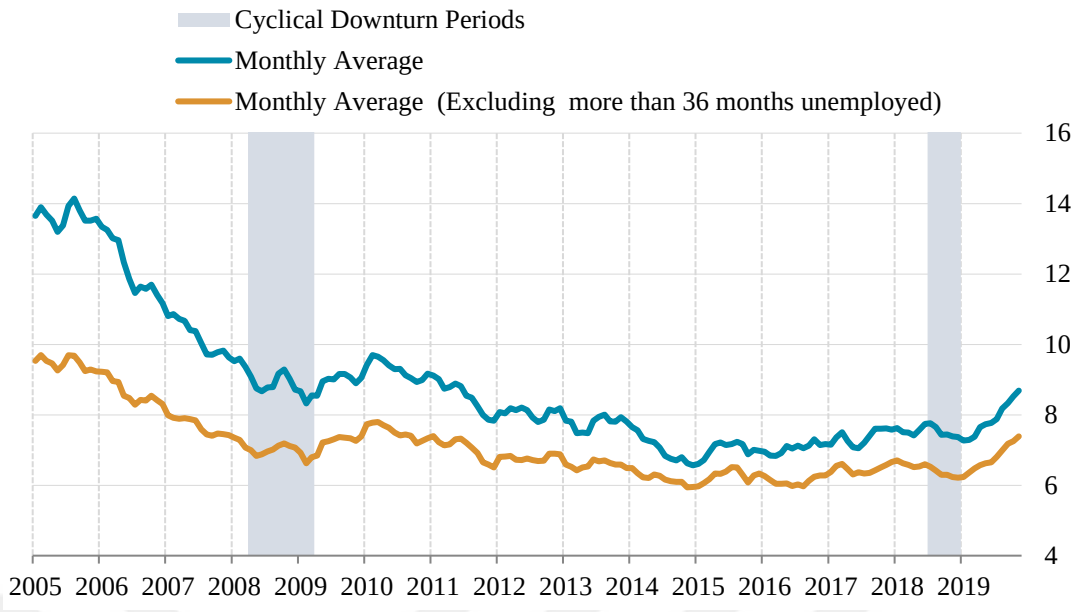
Source: Turkstat.

Figure 7: Construction Sector Employment (Seasonally adjusted, millions of persons)



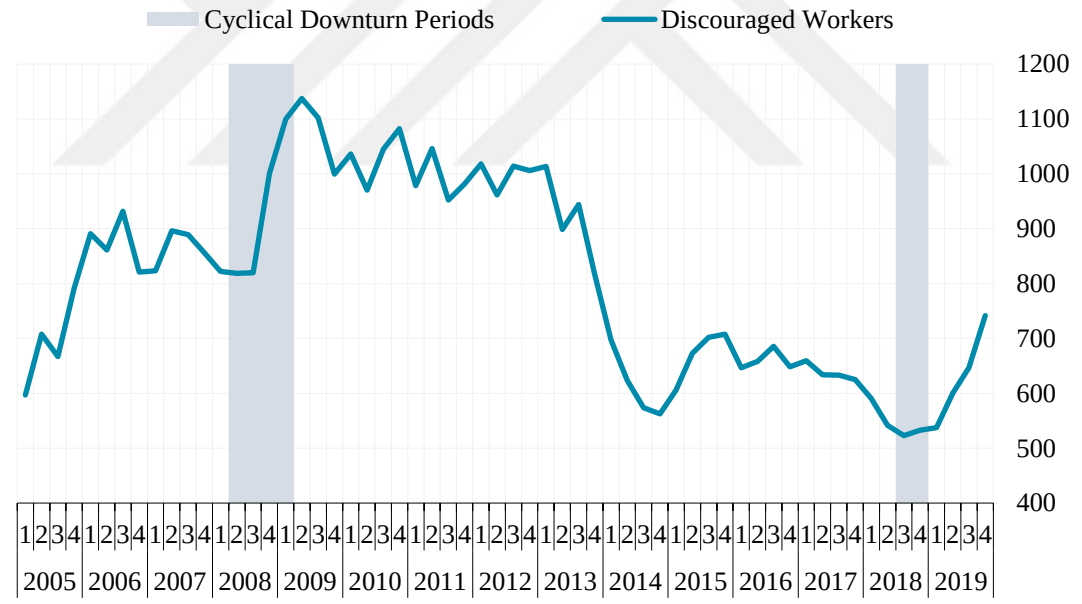
Source: Turkstat.

Figure 8: Public Employment (Seasonally adjusted, thousands of persons)



Source: Turkstat, author's own calculations.

Figure 9: Unemployment Duration (Average)

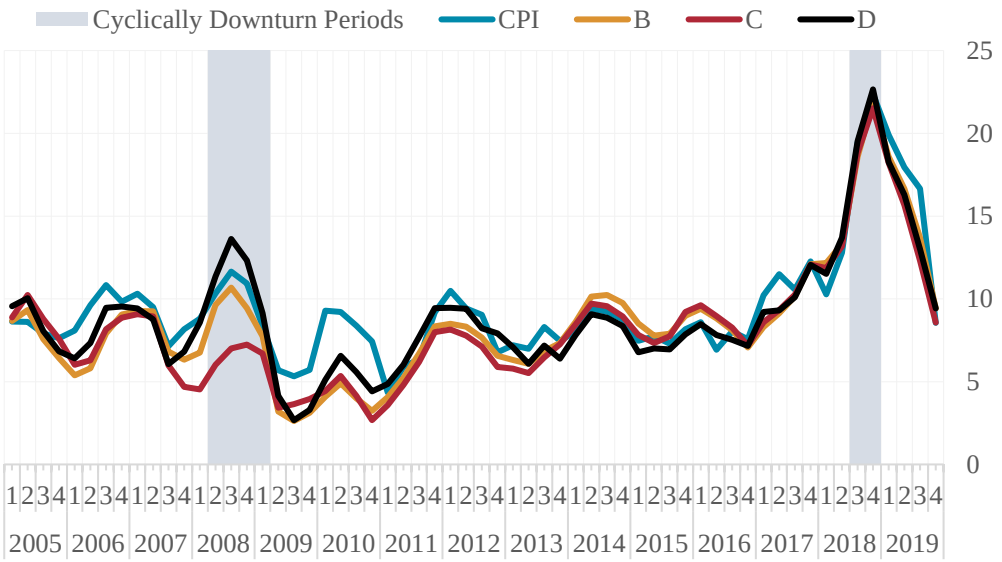


Source: Turkstat.

Figure 10: Discouraged Workers (Seasonally adjusted, thousands of persons)

- **Cost-induced factors for the increase in inflation became more significant in the 2018 downturn.** Although the contraction in economic activity and the high course of unemployment rates decreased demand-side pressures on inflation, cost-induced factors resulted in inflation to rise significantly during

recession periods. While headline inflation, the consumer price index (CPI), peaked at 12.06 percent in the first recession, it increased by almost 12 percent and reached 25.24 percent in the 2018 downturn. Indicators for the CPIs having specified coverages[11] accompanied to this increase and deterioration in core inflation indicators are quite evident (Figure 11). There are several reasons why the inflation rate has increased to such a high level in the 2018 downturn. The first one is that strong and abruptly depreciation in Turkish Lira was the main determinant to subsequently deterioration in pricing behavior of the price-makers, becoming higher and faster than historical averages pass-through to prices[12]. The second one is that the price of commodities fell very much in 2008 and it mitigated negative effects of the exchange rates on inflation. Moreover, differentiation in inflation expectations became a matter. These show that cost-induced factors play a decisive role in formation of inflation alongside the demand pressure in Turkey.



Source: Turkstat.

Figure 11: Inflation Rates (Annualized Quarterly Percentage Change)

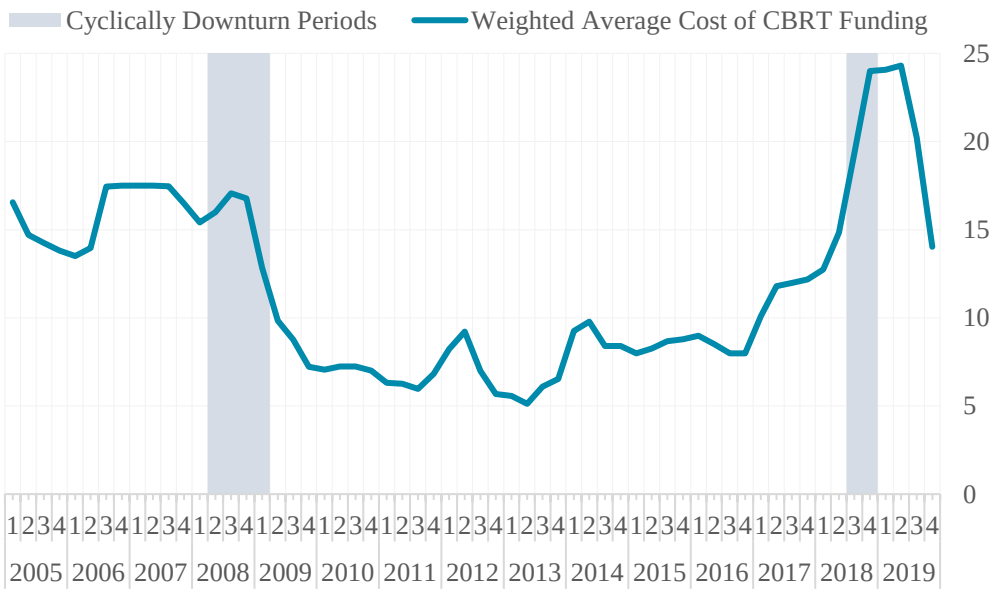
[11] B index is equal to CPI excluding CPI unprocessed food, energy and alcoholic beverages, tobacco products and gold.

C index equals to CPI excluding energy, food and non-alcoholic beverages, alcoholic beverages and tobacco products and gold.

D index means that CPI excluding unprocessed food, alcoholic beverages and tobacco products.

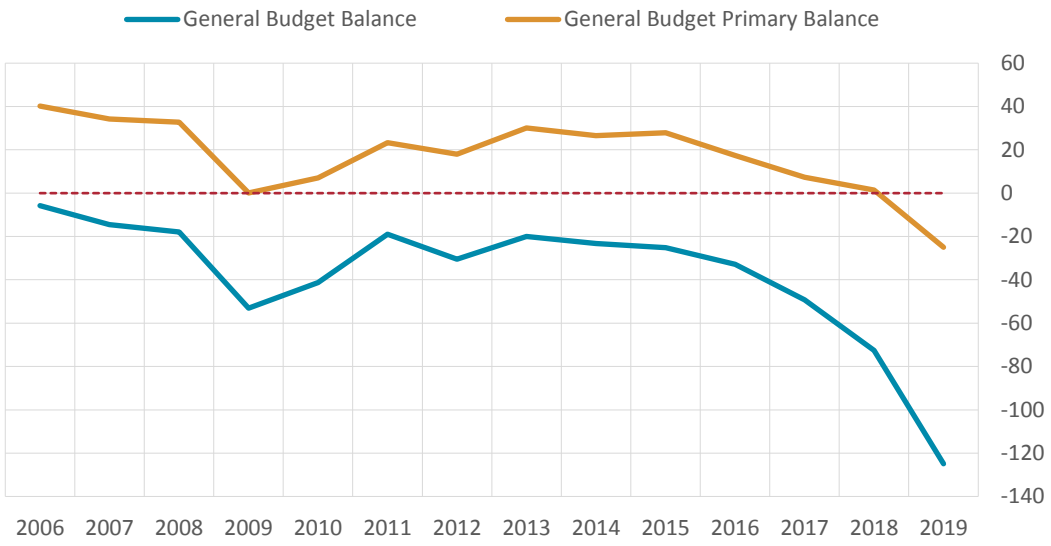
[12] For further details, see CBRT Inflation Report in 2019-2.

- **In both periods, monetary policy tightened to take the exchange rate under control and alleviate the inflationary impact of the exchange rate**. In the first period, a significant decrease in interest rates was observed with the decrease in inflation, even they are well below their pre-crisis levels. The reason for this might be that interest rates in developed countries are very low and the effects of the crisis are tried to be removed for a while. For the 2018 downturn, the sharp rise in inflation rates also led to a rapid rise in interest rates. With the decline in inflation rates, the central bank started to cut interest rates (Figure 12). On the fiscal policy side, it is observed that fiscal policy had a tendency to eliminate the effects of the crisis in both periods and eased the budget; however general budget deficit rose considerably more during the latter (Figure 13).



Source: CBRT.

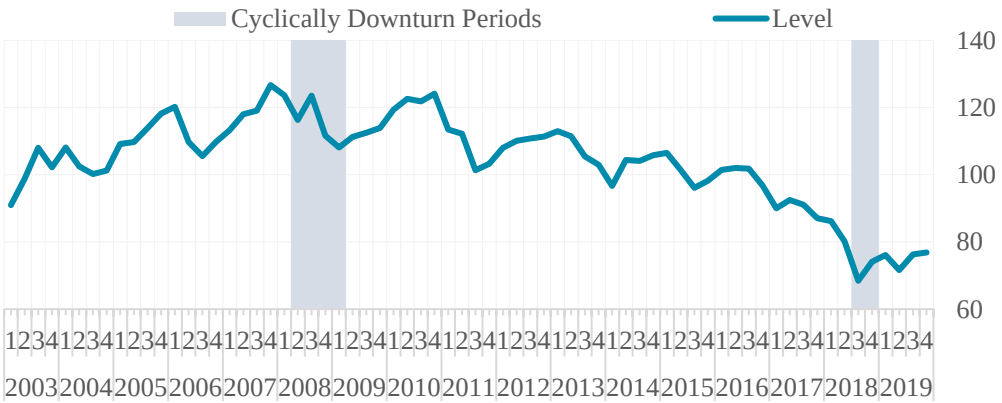
Figure 12: Weighted Average Cost of CBRT Funding (Percent)



Source: MTF.

Figure 13: General Budget Balance (Billion TL)

- **There is a great loss in the real effective exchange rate in both periods**. While the highest quarterly depreciation for the first period is obtained in the last quarter of 2008, the highest depreciation in the history of the series is observed in the third quarter of 2018 when the real exchange rate fell to own the lowest value (68.4) in its history. It is clearly seen from the graph that there is a downward trend in real exchange rate since the last quarter of 2010[13].



Source: CBRT.

Figure 14: Real Effective Exchange Rate (CPI-Based, 2003=100)

[13] One of the most important reasons for this situation may be that the central bank has switched to a new monetary policy mix. With this policy choice, the central bank started to give importance to financial stability without compromising price stability (Başçı and Kara (2011) and Kara (2013)).

CHAPTER 3

LITERATURE REVIEW

There exist numerous studies on the potential output, output gap, and NAIRU estimation due to their substantial implications for policymakers. Moreover, the selection of the relevant variables and constructing of a model are complex and difficult. In the vast literature, different approaches have been developed to obtain estimations.

Beveridge and Nelson (BN) (1981) developed a filter based on an unconstrained Autoregressive Integrated Moving Average (ARIMA) model. It assumes that much of the variation in series is determined by variation in the trend, whereas the variation in its cycle component is stationary and relatively small. Therefore, trend component accounts for non-stationary behavior of the series. Unlike the BN filter, Hodrick-Prescott (HP) filter (1981, 1997) implies a very smooth trend, which results in the cycle to include much of the variation in the series. It smooths series to estimate its trend component which is obtained by the first orders conditions and the cycle is extracted as the difference between the actual series and the estimated trend i.e. the filter behaves cycle component as a residual. Similar to the HP filter, the unobserved components (UC) model introduced by Harvey (1985) and Clark (1987) is another widely-used method to extract a trend function. Its key assumption is that the secular component follows a random walk drift and the cyclical component is a stationary finite order Autoregressive (AR) process. The band pass filter allows to decompose time series into different components based on different frequency ranges and relies on the theory of spectral analysis of time series data. It is defined as the combination of high pass and low pass moving average filters. It determines the components with periodicities larger than business cycle as trend and the components with shorter periodicities than business cycle as noise. BK (1995) and CF filter (2003) are widely-

used methods as band filters in the literature. As a more recent study, Hamilton (2017) proposes an alternative approach to decompose the series into trend and cycle. His approach is based on using local projection to extract cycles.

Each univariate filtering procedure has its pros and cons. For instance, the HP filter has been widely adopted among economists and academicians in a short while to decompose an observed variable into trend and cycle. The filter is utilized in a large number of studies as Baxter and Stockman (1989), Kydland and Prescott (1990), Stock and Watson (1990), Backus and Kehoe (1992), Canova (1998) as well as other recent studies. It has the flexibility to accommodate analysists' needs (Kydland and Prescott, 1990). Unlike the pure statistical filters, the HP filter incorporates economic justification (Canova, 2007). Also, the algorithm of the filter is quite easy. Moreover, zero correlation among the unobserved components and small trend variations are the main assumptions of the filter (Morley (2003), Zivot (2005)). On the other hand, Hamilton (2017) suggests that the HP filter should never be used due to its drawbacks. For instance, he argues that the HP filter could produce series that might have inconsistency with the original series and it suffers from the end-point problem as well as the concerns on selecting the correct smoothing parameter value. He emphasizes that his filter is superior to the HP filter since it can be applied to seasonally non-adjusted data with any frequency and it is free for model and assumption. For the UC model, the filter generates a very smooth trend like the HP filter but unlike BN filter[14].

[14] Under normal conditions, it reckons as no correlation between the shocks of the trend and cycle but BN filter assumes a perfect negative correlation between two unobserved variables. Therefore, both filters gives the different decomposed series although they have not any exogenous assumptions. Morley et al. (2003) find that both decomposition methods yield similar results when the restriction imposed as trend and cycle innovations are uncorrelated in the state-space model of UC decompositions is relaxed. Following Morley et al. (2003) and inspired by the Okun's law (1962), Sinclair (2009) develops a bivariate correlated unobserved components model comprising of the relationships between the permanent and transitory movements in the United States (U.S.) output and the unemployment rate. Perron and Wada (2009) state that different approaches as UC model, BN filter and HP filter yield different results since they neglect the change in the slope of the secular component of the real GDP. When they pay regard to change in the trend function of the real GDP of the U.S. resulted from the oil crisis in 1973, the series found by them more accords with the National Bureau Economic Research (NBER) chronology relative to the series derived by using the BN, UC and HP decompositions. Furthermore, the correlation between secular and cycle components implied by Morley et al. (2003) is no longer a problem when the slope of the trend function of the real GDP is allowed to change.

In general, univariate filters are appealing as they have simple ease of use and do not require any assumptions and any structural economic model. However, they are considered as purely statistical techniques and do not include economic relationships as Okun's law and Philips curve. Further, they have problems with end-point estimations. Against this background, numerous multivariate filters[15] have been developed to capture the economic interpretation of the output gap and NAIRU. The multivariate filter estimates potential output and NAIRU simultaneously under systems of equations. Laxton and Tetlow (1992), Kuttner (1994) and Butler (1996) are the earlier studies to construct a multivariate filter estimating potential output and NAIRU jointly. Later, Benes et al. (2010) develop a model containing data on inflation, unemployment, and capacity utilization for measuring potential output and NAIRU for 10 countries besides the U.S. and Euro area in order to produce the results consistent with economic theory. Regularized maximum likelihood (Ljung, 1999) in the Bayesian methodology is used to keep the parameters out of nonsensical regions and measure them. The main aim of the study is to incorporate relevant empirical relationships between potential GDP, labor market slack, core inflation and capacity utilization. Since the revisions of the current estimates of the output gap estimated by multivariate filter are dramatically smaller than HP, they conclude that multivariate filter has comparative advantage over random walk and HP filter. Following Benes et al. (2010), Blagrave et al. (2015) show that additional information as consensus forecasts for GDP and inflation can improve estimates at the end of the sample period which is probably the most interested in policymakers. Unlike Benes et al. (2010), they use annual data to estimate the potential output and NAIRU for 16 countries. Following previous studies, Alichi et al. (2018) extend the basic multivariate filter methodology by including structural economic relationships such as the Philips curve, Okun's law and a monetary policy block to improve the robustness and reliability of

[15] In addition to univariate and multivariate filters, structural model-based approaches using production function or Dynamic Stochastic General Equilibrium (DSGE) models exist for estimating potential output. The former is a supply side approach and employs labor, capital and total factor productivity (TFP) as factors of production. Obtaining the data on employment and capital, TFP is identified. There are two distinct approaches with regard to the type of TFP. It may either be a time varying variable as in Klump et al. (2007) or be a residual as in Musso and Westermann (2005). The production function allows decomposing drivers of the growth; however, end-point problem still prevails as univariate filters also ignores relationship between the labor market and inflation in addition to the difficulty in finding reliable capital stock. The latter includes more structural economic interpretation and deep parameters are also sensitive to the specifications of the model, which makes the implementation difficult.

the filter. Another extension on the structural multivariate filter methodology is given by Hansen et al. (2019). They use a broader labor market slack and take discouraged workers into account in the model. The rationale is that the traditional labor market slack does not reflect the precise relationship between the unemployment rate and inflation for the Korean economy. They find that their proposed filter yields more negative output gap estimates compared to the one using traditional labor market slack, which implies that different filters may lead to different policy implications. Blanchard and Summers (1986) and Ball (2009) state that temporary shocks could create persistent output losses when shocks have hysteresis effects, since long and deep recessions result in deterioration in the skills and weakening in labor market attachment. These feed the loss of the potential output gradually. Following this idea, Alichi et al. (2019) extend the multivariate filter approach for estimating potential output for U.S. developed by Alichi et al. (2018) with labor market hysteresis by comparing two episodes: the Volcker's recession period of the early 1980s and Great Recession that began in 2009. They express that hysteresis created much larger movements in the NAIRU and output gap. In addition to the inflation rate, the unemployment rate and capacity utilization rate, financial variables could be included in the model identifying potential output since potential output may not be sustainable when financial imbalances exist even if low inflation rate holds (Borio et al., 2013). They employ credit growth, real interest rates and housing prices as financial variables to obtain more reliable estimates on the output gap. The result of the study is that financial factors play a key role in deriving potential output and the multivariate filter incorporating them and yield more robust estimates in real time. Following Borio et al. (2013), Melolinna and Tóth (2016) develop a model including macroeconomic relationships as well as financial indicators for estimating the potential output of the United Kingdom by using Bayesian methods. With regard to real-time performance and forecasting ability, a model augmented with financial indicators having strong relative to a basic model. In addition to financial indicators, trade balance could be important for identifying the potential output since tradeable and nontradeable sectors could differentiate in terms of creating excess demand on the inflation and unemployment via the Philips curve. The effect of the excess demand of the tradeable sectors could be absorbed by trade balance; however, excess demand of the nontradeables may put more upward pressure on the inflation. Therefore, Darvas and

Simon (2015) extend global variables augmented Philips curve by adding the current account block to the basic model. They estimate a model for 45 countries by using maximum likelihood estimation technique within the framework of unobserved components models. They find that the current account equation is more significant than the Philips curve in obtaining the potential output. Therefore, the multivariate filtering approach for estimating potential output and NAIRU is very flexible since any macroeconomic relationship could be included in the model.

Thanks to the accumulation of data, similar studies have been initiated since the early 2000s in Turkey. Sarıkaya et al. (2005) estimate the output gap for Turkey by utilizing an extended Kalman filter technique to allow the parameter to change over time in a multivariate setting. They find that their filter has superiority over univariate filters like HP filter to capture boom-bust cycles for Turkey. As a similar study, Öğünç and Ece (2006) conclude that utilizing the supply side in the model reduces the parameter uncertainty and improves the output gap estimation for Turkey. Kara et al. (2007) use inflation and output gap dynamics within the nonlinear time series framework to estimate the output gap of Turkey. They allow parameters to be time-varying through the extended Kalman filter approach. Further studies have employed more diversified methods to estimate the output gap. As an example, Öğünç and Sarıkaya (2011) estimate the output gap for the 2002-2010 period using Bayesian techniques within the framework of the New Keynesian model. The study indicates that the long recession period put downward pressure on the inflation during this period. Also, they highlight that monetary policy should consider domestic and external dynamics of the aggregate demand when assessing the business cycle of the economy. In addition, they find that tendency of the backward indexing on the inflation is high, global growth is the key variable to output gap and appreciation of the real exchange rate brings down the growth in the long run for the 2002-2010 period. Following this study, Alp et al. (2012) jointly estimate output gap components, domestic and external, for Turkey within a stylized New Keynesian small open economy for the period 2002q1-2011q3 by utilizing Bayesian methodology. Their findings show that components of the aggregate demand differentiated in which export component remained low for a while but domestic side converged to its potential in a shorter time due to some stimulus

given to the economy to alleviate negative effects of the global crisis. Therefore, they propose that monetary policy should take these differentiations into consideration.

Next two studies differ from previous ones in terms of the data source. They use survey indicators to estimate the business cycle to eliminate the end-point problem and to yield timelier results. The first one, Coşar et al. (2013), estimate an output gap indicator for the period 2005q1-2013q1. Their procedure consists of two stages. In the first stage, they choose the variables that can be informative to business cycles. Then they estimate business cycle within the small dynamic factor model setting by using selected variables which are capacity utilization rate, change in purchasing power, the level of orders compared to their normal, the adequacy of production capacity with respect to orders and expected demand, the views of manufacturing firms on demand conditions and the number of job announcement. Following Stock and Watson (1981), Camacho and Perez Quiros (2010), they estimate the model and conclude that their filter-free measure is superior to HP filter. The second study, Şahinöz and Atabek (2016) suggest an alternative measure to assess the state of the business cycle by utilizing firm-level micro-data. Following Köberl and Lein (2011), they consider the capacity utilization gap as an alternative indicator to the output gap.

Andıç (2018) constructs a multivariate filter for Turkey similar to Blagrave et al. (2015) to capture some basic economic theory. While Andıç (2018) uses maximum likelihood estimation for a quarterly basis, Blagrave et al., (2015) use Bayesian estimation for annual data. The model consists of three blocks: output, unemployment and inflation and data spans the 2005q1-2016q4 period. Her findings suggest that as in Öğünç and Sarıkaya (2011), potential growth fell significantly during the global financial crisis, improved later. Although she develops a robust model checked by distinct calibration values and exploiting some quantitative criteria, the most important deficiency of the study is that it has endpoint problem and does not take expectations into account. Çelgin and Yılmaz (2019) derive the alternative output gap indicator which can be tracked on a monthly basis. They match the demand indicators with 4 and 5-digit level sub-items in CPI for the period 2006q1-2018q4. Then, they obtain the sectoral output gap series by using the HP filter and calculate aggregate sectoral

output gap series. They suggest that policymakers should consider sectoral factors as well as other macroeconomic variables.

Similar to potential output and output gap estimations, NAIRU has a large share in the literature since it is a key variable for monetary policy to understand whether presence of upward and downward pressures on the inflation rate also. Since equilibrium unemployment rate only depends on the structural factors of the labor market but cyclical factors, early studies by Phelps (1967, 1968) state that it returns to the original level called as natural rate when the effect of the shocks fade away. As the unemployment rate did not return to its previous levels in the 1970s, new theories began to emerge. Modigliani and Papademos (1975) extend the natural rate of unemployment theory and introduce the non-inflationary rate of unemployment (NAIRU). They argue that NAIRU is a time-varying variable and consistent with inflation while the natural rate of unemployment is constant over time even if NAIRU converges to the natural rate of unemployment in the long run. Since then, NAIRU has predominated the natural rate hypothesis[16]. In the 1980s, Blanchard and Summers (1986) clarify that NAIRU highly depends on past values so they attach great importance to hysteresis. The main motivation is that insider-outsider theory, human capital depreciation and weakening attachment to the labor market resulted from long and deep recession might hamper unemployment back to its pre-shock level. In the light of this hypothesis, NAIRU has been modeled across wide range approaches. Like potential output gap estimation, NAIRU can be modeled by simple statistical techniques as deterministic function of time or detrending (Staiger et al., 1997a, 1997b; King et. al., 1995; Gordon, 1997). As discussed above, NAIRU can be derived jointly with potential output by using a multivariate filter within the framework of the small macroeconomic model (Benes et al., 2010; Blagrave et al., 2015; Alichi et al., 2018; Alichi et al., 2019).

[16] Gordon (1997), Estrella and Mishkin (2000), Ball and Mankiw (2002) has a consensus on the NAIRU as a time varying variable.

As for NAIRU estimations for Turkey, there are a few studies[17]. In the nonlinear framework, Us (2014) estimates NAIRU for Turkey by using the Extended Kalman Filter (EKF). The model is based on the Philips curve and the Okun's law. Its findings imply that NAIRU is more volatile than the actual unemployment rate and it harshly responds during the crisis. The weak link between unemployment and inflation, significant pass-through and rigidity in the inflation are the key findings of the study.

Main contributions of this study to empirical literature are threefold. Firstly, previous studies on the Turkish economy use data of inflation, output and unemployment rate to extract the cycles. Although they have important information on determination of the business cycle conditions, we believe that there is also significant information in capacity utilization rate that can help to improve estimates of output gap and NAIRU. Against this background, we differentiate from other studies on the Turkish economy by adding the capacity utilization block to our model. This extension enables us to compare the course of the cyclicality of the output, capacity utilization and unemployment rate in the downturn periods of Turkey. Secondly, we can also collate multivariate filtering estimations with a wide range univariate filtering estimations by considering their pros and cons. Lastly, it is believed that our results also serve useful implications on the fiscal and monetary policies and are adaptable for whatever policy will be implemented.

[17] Şıklar et al. (1999), Bildirici (1999), Yavan (1997), Kaya and Yavan (2007), Yiğit and Gökçe (2012), Temurlenk and Başar (2012).

CHAPTER 4

DATA AND METHODOLOGY

This chapter consists of two parts. Following a brief introduction of the data used in the study, we present details on the methodology of the constructed univariate and multivariate filters. Afterwards, we continue with the pros and cons of the filters in terms of decomposing output and the unemployment rate into trend and cycle components.

4.1. Data

We use quarterly real gross domestic product, real domestic demand, real exports of goods and services, real imports of goods and services, core consumer inflation indicator (D index), import prices (TL denominated), nominal exchange rate basket, real unit labour costs, Brent oil prices, unemployment rate, real effective exchange rate, real commercial loan rates, export weighted global growth index[18], capacity utilization rate series for 2005Q1-2019Q4 to obtain output gap and NAIRU (Table 2). All series are used in seasonal adjusted form. If any variable is not published in seasonal adjusted form by officials, we use TRAMO-SEATS[19] for seasonally adjustment by using JDemetra 2.2.0 programme.

Table 2 shows the variables employed in the analysis and provides summary statistics for the quarter-on-quarter growth rate of these variables. For 2005q2-2019q4 period, average quarterly growth rate for the real gross domestic product (gdp) is 1.2 percent.

[18] For further details on the series, see Çıplak et al. (2011) and Erduman and Ekşi (2018).

[19] For further details on the TRAMO-SEATS method for seasonal adjustment, see Gomez and Maravall (1998).

While average quarterly growth rate for exports of goods and services is higher than imports of goods and services, both series are more volatile than real gdp and real domestic demand. While CPI-D price index has average 2.2 percent quarterly growth rate, real effective exchange rate depreciates on average. Information on summary statistics guides us to choose the priors and calibrate some parameters that are requires during the estimation process.

Table 2.

Descriptive Statistics for the Dataset (2005Q2-2019Q4)

Series	Description	QoQ Growth Rates		Source
		Average	Standard Deviation	
Gross Domestic Product	Chain-linked volume index (2009=100), seasonally adjusted	1.2	2.0	TURKSTAT
Domestic Demand	Chain-linked volume index (2009=100), seasonally adjusted	1.1	2.8	TURKSTAT
Exports of Goods and Services	Chain-linked volume index (2009=100), seasonally adjusted	1.5	5.4	TURKSTAT
Imports of Goods and Services	Chain-linked volume index (2009=100), seasonally adjusted	1.2	5.8	TURKSTAT
CPI excluding Unprocessed Food and Tobacco	CPI-D price index (2003=100), seasonally adjusted	2.2	1.3	TURKSTAT
Import Prices	Import Unit Value Index (2010=100, TL)	2.9	6.7	TURKSTAT
Nominal Exchange Rate Basket	0.5*US dollar/TL+0.5*Euro/TL	2.5	6.0	CBRT
Real Unit Labour Costs	Non-farm real unit labor cost indicator, seasonally adjusted	0.2	2.9	CBRT
Brent Oil Prices	Brent crude oil prices $ per barrel	1.7	14.7	Bloomberg
Unemployment Rate	Household Labour Force Survey, seasonally adjusted	0.8	5.4	TURKSTAT
Real Effective Exchange Rate	CPI-based, 2003=100	-0.5	4.8	CBRT
Real Commercial Loan Rates	Nominal Commercial Loan Rated deflated by 12-month ahead inflation expectations	-0.2	2.1	CBRT
Export-weighted Global Growth Index	Seasonally adjusted	0.6	0.6	CBRT
Capacity Utilization Rate	Seasonally adjusted	-0.1	2.8	CBRT

4.2. Methodology

Any real variable can be decomposed into trend and gap components. The trend component captures long term changes and low-frequency events. It is driven by structural changes and factors such as productivity etc. which are outside the scope of the monetary policy. On the other hand, gap, related to output or unemployment, reflects the business cycle dynamics and varies from country to country and is within the scope of both monetary and fiscal policies. It is often measured as a percentage deviation from the trend. Both trends and gaps are unobserved variables and need to be identified. As previously elaborated on in the literature chapter, the filters are the tools for extracting trend and cycle parts of any series.

This section consists of two parts. The first part reviews the procedures on the several univariate filters to estimate business cycle oscillations and trends from a time series. The second part explains the multivariate filter including structural equations created with macroeconomic motivation and simultaneously giving the estimation on the output gap and NAIRU.

4.2.1. Univariate Filtering

4.2.1.1. Deterministic Polynomial Trend (DPT)

As stated in Canova (1998), this is the simplest detrending method. It assumes that the trend component of the series is a deterministic polynomial function of time and it is uncorrelated with the cycle of the series. While y_t represents the natural logarithm of the series, its trend and gap represented by x_t and c_t , respectively as:

$$y_t = x_t + c_t \quad (1)$$

$$x_t = a + bt + ct^2 + \cdots \quad (2)$$

Coefficients of equation (2) are estimated by Ordinary Least Squares (OLS) method, then set

$$\hat{c}_t = y_t - \hat{a}_{ols} - \hat{b}_{ols}\, t - \cdots \quad (3)$$

The filter has several problems. The first one is that no acceleration/deceleration in trend is possible. The second one is that it cannot capture structural breaks.

4.2.1.2. First Order Differencing (FOD) Method

Stationary cyclical component and random walk with no drift structure of the trend component are the main assumptions of the first-order difference method. Moreover, two components are uncorrelated with each other like the DPT approach. Original series y_t has a unit root because of the trend component structure only. Then, y_t, trend and cyclical components can be represented as:

$$y_t = y_{t-1} + \varepsilon_t \tag{4}$$

$$x_t = y_{t-1} \tag{5}$$

$$c_t = \Delta y_t = \varepsilon_t \tag{6}$$

Although it is easy to conduct, there might be potential problems. For instance, it may give very volatile growth rates and detrended data could be still near non-stationary or estimation results might heavily depend on transformation.

4.2.1.3. Hodrick and Prescott (HP) Filter

HP filter (1981, 1997) is arguably the most commonly used method to decompose a series into trend and cycle components. The reason why the filter is widely adopted is that it is easy to apply and have the flexibility to accommodate analysists' needs (Kydland and Prescott, 1990). Unlike the pure statistical filters, the filter incorporates economic justification besides its own statistical technique (Canova, 2007). Also, the algorithm of the filter is quite easy. It smooths series to estimate its trend component which is obtained by the first orders conditions and the cycle is extracted as the difference between the actual series and the estimated trend, i.e. the filter treats the cycle component as a residual. Moreover, zero correlation among the unobserved components and small trend variations are the main assumptions of the filter (Morley,

2003; Zivot 2005). An estimate of the trend component is obtained by minimizing with respect to trend component:

$$\sum_{t=1}^{T}(y_t - x_t)^2 + \lambda \sum_{t=2}^{T-1}[(x_{t+1} - x_t)^2 - (x_t - x_{t-1})^2] \quad (7)$$

where y_t is the original series which comprises of trend (x_t) and cycle (c_t), λ is the smoothness parameter and penalizes the variability of the trend and T indicates the number of observations of the series. λ determines the degree of volatility allowed to be associated with the trend and can have only non-negative values. Higher λ values imply less volatility in the trend component. There are two extreme cases. If λ goes to infinity, x_t becomes linear i.e. no trend variations. On the other hand, if λ is equal to zero, then $y_t = x_t$ and the cycle vanishes. When λ gets larger, trend becomes smoother.

The penalty parameter is not obtained from an optimization problem and it is imposed on the minimization problem (Harvey and Trimbur, 2008). As a rule of thumb, it is accepted to be 1600. It means that the standard deviation of the cyclical component is 40 times more volatile than the standard deviation of the second difference of the trend. It is considered as a convenient value for quarterly data; however, the magnitude of the penalty parameter is controversial. Nelson and Plosser (1982) use λ in the range [1/6, 1] for most of the series. Canova (1998) argues that λ could take different values depending on the development level of the countries. He suggests that λ equals to 40 gives a more smoothed trend and captures cycles correctly for developing countries. Ravn and Uhlig (2002) state that if λ=12900 for monthly data and 6.25 for annual data, the filter picks cycles with similar periodicity for monthly, quarterly and annual data. Philips and Jin (2015) criticize that the choice of the smoothness parameter may determine characteristics of the filter so the results of the filter are highly dependent on its value. Also, Harvey and Jaeger (1993) present that imprudent utilization of the filter may cause artificial results. Therefore, there is no consensus regarding what true value for λ should be.

In addition to criticism on the choice of the magnitude of the λ, there are several different concerns on using the HP filter as a tool for decomposition. Cogley and Nason (1995) emphasize that the filter could generate spurious cycles. It means that

there is a difference between cycles of the original series and the filtered series. Hamilton (2017) agrees with this argument and adds that filtered values at the end of the sample could be very different from those in the middle. Cyclical components might not reflect any true dynamics of the data generating process itself. He also specifies other problems related to the HP filter. First of all, he claims that it has starting and end-point problems. Secondly, it makes stationary series with up to 4 unit roots but if the series had lower than 4 unit roots, the filter may cause over-differencing problems which are creating spurious autocorrelations in filtered series, spurious variability in the filtered data and producing spurious co-movements among series. Related to this, De Jong and Sakarya (2016) state that the nonstationary part coming from the beginning and end of the sample could still stay even if the series had 4 unit roots. Also, cross-country comparisons are difficult via HP filter since cycles may have different lengths. Hamilton (2017) suggests that HP filter should be never used for non-stationary time series. Thus, many economists are concerned about using the HP filter since it has the potential to generate spurious variability, spurious serial and cross variable correlations besides concerns on the magnitude of the λ[20].

4.2.1.4. One-Sided HP Filter

Standard two-sided HP filter has many shortcomings as discussed above and it may provide unreliable results. More specifically, it may produce an artificial trend and cycle (Hamilton, 2017) since it is a two-sided (symmetric) filter that considers both future and past observations to extract the cycle. One-sided HP filter is an alternative to overcome such problems. The methodology is based on the state space representation represented by equations (8-11) (Stock and Watson, 1999) and also the filter utilizes Kalman filter[21] iterations to estimate trend and cycle of the series. The state-space representation[22] is as follows:

[20] Following the country-specific literature, alternative values for smoothing parameter as 98 and 814 for output and unemployment rate decomposition respectively as well as its common value, 1600. Alp et al. (2011) compares that usual smoothing parameter, 1600, for Hodrick-Prescott filter and alternative smoothing parameters such as 19 and 98.

[21] For a general discussion on the Kalman filter, see Hamilton (1994).

[22] For further details on both state-space form and Kalman filter, see Appendix A.

$$y_t = x_t + c_t \quad (8)$$

$$(1-L)^2 x_t = \varepsilon_t \quad (9)$$

$$\begin{bmatrix} x_{t/t} \\ x_{t/t-1} \end{bmatrix} = \begin{bmatrix} 2 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_{t/t} \\ x_{t/t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_t \\ 0 \end{bmatrix} \quad (10)$$

$$y_t = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_{t/t} \\ x_{t/t-1} \end{bmatrix} + \begin{bmatrix} c_t \\ 0 \end{bmatrix} \quad (11)$$

where x_t is the trend component, c_t is the cyclical component and$\{\varepsilon_t\}$ is a white noise sequence. While equation (8) is the state equation, equation (9) represents the observation equation.

Thus, trend and cycle components of the series are obtained from (8-11) by using the Kalman filter. Although the one-sided HP filter could eliminate the limitations of the two-sided HP filter, it may still produce artificial results since HP filters impose patterns that recognize shocks as temporary in real-time rather than using the true data generating process (Hamilton, 2017).

4.2.1.5. Hamilton's Regression Filter

As discussed above, Hamilton (2017) emphasizes the drawbacks of the HP filter. It induces spurious dynamic relations with original series due to its non-appropriateness for typical economic time series. Moreover, it has the artificial ability to predict its future values and suffers from an end-of sample bias since it is a two-sided filter and lastly the choice of the smoothing parameter is debatable. Based on his critiques on the HP filter, he suggests an alternative technique that uses local projection to extract cycles. If $(1-L)^d y_t$ is stationary for some d>0, then his model for all finite h>0 is defined as follows:

$$y_{t+h} = \kappa_h{}^{(1)} y_t + \kappa_h{}^{(2)} \Delta y_t + \cdots \kappa_h{}^{(d)} \Delta^{d-1} y_t + \mathrm{w}_t{}^{(h)} \quad (12)$$

with $\Delta^s = (1-L)^s$, $\kappa_l{}^{(1)} = 1$ for l=1,2,… and $\kappa_j{}^{(s)} = \sum_{l=1}^{j} \kappa_l{}^{(s-1)}$ for s=2,3,…,d and $\mathrm{w}_t{}^{(h)}$ which is an estimate of the cyclical component at t+h and a function of h and d is a stationary process.

He proposes that if $\Delta^d y_t \sim$ I (0) and y_{t+h} is regressed on a constant and the d most recent values of y as of date t, the coefficients converge to the value of the $\kappa_h{}^{(j)}$obtained from equation (12). His procedure depends on Den Haan's (2000) finding that forecast errors will be stationary if the above procedure is done. He recommends d=4 and h=8 for quarterly data since using more than 4 lags increases the number of parameters estimated, which may lead to an overestimation problem. Also, a 2-year horizon could be used for business cycles as a benchmark and effects of the shocks vanish to a large extent for longer than two years. Although the choice of h and d is debatable like smoothing parameter in the HP filter, the author emphasizes that the filter is superior to the HP filter since the filter can be applied to seasonally non-adjusted data having any frequency, $w_t{}^{(h)}$ is free for model and assumption. The main feature of the filter is that $w_t{}^{(h)}$ is stationary if the y_t has up to 4 unit roots, whereas HP filter imposes 4 unit roots. Also, unlike HP, it is an asymmetric filter so that it does not use information on the future realizations.

4.2.1.6. Baxter and King Filter and Christiano-Fitzgerald Filter

The band pass filter allows to decompose time series into different components based on different frequency ranges and relies on the theory of spectral analysis of time series data. It is defined as the combination of high pass and low pass moving average filters. It determines the components with periodicities larger than business cycle as trend and the components with shorter periodicities than business cycle as noise. BK (1995) and CF filter (2003) are two of the most popular ideal band pass filters. Similar to HP filter, BK filter could be problematic when y_t is nearly integrated. Also, the sample size needs to be large for the approximation to be good. CF filter uses a nonstationary and asymmetric approximation to make the approximation error as small as possible. The ideal band pass filter procedure is as follows:

$$c_t = \sum_{j=0}^{q} w_j y_{t-j} + \sum_{j=1}^{q} w_j y_{t+j} \qquad (13)$$

where $w_0 = \frac{c-a}{\pi}$; $w_j = \frac{\sin(jc)-\sin(ja)}{\pi}$ for $j \geq 1$ $a = \frac{2\pi}{P_U}$; $c = \frac{2\pi}{P_L}$ and t = q+1,...,n-q. P_U and P_L represents the cut-off cycle length[23].

Since the band pass filter eliminates the higher frequency, band pass filters give a smoother cycle than HP filter does. Christiano and Fitzgerald (1999) state that BP filter outperforms the HP filter.

Univariate filters are easy and fast to implement. They generally use a weighted average of past, current and future observations, except one-sided HP filter. On the other hand, there are several drawbacks of using univariate filters. Firstly, the risk of end-point bias exists due to having no future observations at the last data point. Secondly, limited information is used in implementing univariate filters. The basic idea behind multivariate filtration is that there exists a close relationship between macroeconomic variables and that relationship should be taken into account during the decomposition procedure.

4.2.2. Multivariate Filtering

Following Benes et al. (2010), Blagrave et al. (2015), Alichi et al. (2015, 2019), we construct a multivariate filter by considering a stylized New Keynesian small open economy model including output gap and its components, capacity utilization rate, inflation, unemployment rate and rational formation of expectations for some variables, in other words, model-consistent expectations. Our model consists of structural equations as the Philips curve, dynamic Okun's law constructed with macroeconomic motivation and an equation linking with output gap and capacity utilization slack. The multivariate filter consists of four blocks. The first block shows how the output gap equation is created by using the components of the output. The second one demonstrates the Philips curve equation linking with inflation and output gap. The third one includes dynamic Okun's law. The last one is the capacity

[23] Following the OECD's system of composite leading indicator, Coşar and Yavuz (2019) obtained mean duration of cyclical phases of output and unemployment rate. For the former, while the average duration is five quarters to recession period, thirteen quarters to expansionary period. For the latter, average durations are eight and twelve quarters to recession and expansionary periods respectively. Cut-off lengths are determined by using the information on the durations.

utilization gap which could capture the slack that is not involved by the unemployment gap and has high correlation with the output gap (Alichi, 2019). The last block shows the link between output and capacity utilization gaps.

The first block is given as follows:

Natural logarithm of the output level (real GDP), Y_t , consists of its potential level $(\overline{y_t})$ and output gap $(\tilde{y}_t)$:

$$Y_t = \bar{y}_t + \tilde{y}_t \tag{14}$$

Unlike Blagrave et al. (2015), Alichi et al. (2015), Andıç et al. (2018), Alichi et al. (2019), we closely follow Alp et al. (2012) to model the output gap and its components. Policy makers may choose to stimulate domestic demand via incentives and adjustments when foreign demand is not sufficiently supported for economic activity. Such a situation was found to overcome the negative effects on the economic activity of the 2008 crisis in Turkey. In addition to tax incentives on certain commodity groups, monetary policy began to cut the interest rates in November 2008 (Figure 12). Similarly, many precautions have been taken in order not to deepen the contraction in economic activity that has weakened since 2018-3. While the public sector has taken a more supportive stance, tax cuts have been applied to many durable goods groups. Supportive adjustments and incentives such as restructuring credit card debts, installment of credit card spending and cash withdrawals and provision of additional credit opportunities to small and medium scale enterprises (SMEs) may be counted as other measures taken. During the period, while net exports were the main driver of annual growth, domestic demand remained was weak due to high interest rates and high volatility in exchange rates (Figure 2). It is clear that it is of great importance to consider the separation between domestic and foreign demand. Therefore, the output gap $(\tilde{y}_t)$ is defined as the weighted average of domestic demand gap $(\tilde{d}_t)$, export demand gap $(\tilde{x}_t)$ and import demand gap $(\tilde{m}_t)$[24] as

[24] The values of ω_1, ω_2, ω_3 are calibrated as 1.02, 0.22 and 0.24 respectively, based on sample ratios of period 2005q2-2019q4.

$$\tilde{y}_t = \omega_1 \tilde{d}_t + \omega_2 \tilde{x}_t - \omega_3 \tilde{m}_t \quad (15)$$

Since domestic demand is composed of consumption and investment, real exchange rate and real interest rate determining the consumption and investment decisions of the households and investors are used. While an increase in real interest rates adversely affects consumption and investments, the appreciation of the real exchange rate supports domestic demand due to the cheapening of imported goods. Therefore, domestic demand gap ($\tilde{d}_t$) equation consists of lagged values of domestic demand gap, rational expectations of domestic demand gap which is model-consistent, lagged values of real interest rate gap ($\tilde{r}_t$) and real exchange rate gap ($\tilde{q}_t$) and it is formed as:

$$\tilde{d}_t = \alpha_1 \tilde{d}_{t-1} + (1-\alpha_1)\tilde{d}_{t+1} - \alpha_2 \tilde{r}_{t-1} + \alpha_3 \tilde{q}_{t-1} + \varepsilon_t^d \quad (16)$$

The real interest rate determines the decisions to substitute between consumption and savings today to consume and savings in the future. Higher real interest rate postpones the consumption and investments today since cost of them is high. Since it encourages the savings, tight monetary conditions dampen the domestic demand. Therefore, the coefficient α_2 enters the equation with a minus sign. The real exchange rate impacts decisions to demand between domestically and foreign produced goods. Due to its definition, the coefficient of α_3 enters the equation with a positive sign.

Export demand gap ($\tilde{x}_t$) is defined as a function of lagged values of the export demand gap, real exchange rate gap, $\tilde{q}_t$, foreign output gap, $\tilde{y}_t^*$, oil gap, $\tilde{o}_t$[25], shocks (ε_t^x) and it is formed as:

$$\tilde{x}_t = \varphi_1 \tilde{x}_{t-1} - \varphi_2 \tilde{q}_t + \varphi_3 \tilde{y}_t^* + \varphi_4 \tilde{o}_t + \varepsilon_t^x \quad (17)$$

[25] The flexibility of the market diversification recently Turkey has made a huge leap. While exports of goods and services continue to be at the forefront of the European region, exports of goods and services to the Middle East and North Africa (MENA) regions have increased. Oil prices are added to the equation as a proxy for the growth rate of these regions.

Coefficient of φ_2 enters with a minus sign in the equation since appreciation in domestic currency in real terms leads to more expensive domestically produced goods compared to foreign goods. Coefficient of φ_3 enters in the equation with a positive sign since more foreign output gap leads to more demand for goods produced by other countries.

Import demand gap ($\tilde{m}_t$) depends on its lagged values, aggregate demand[26] which consists of domestic demand gap and export gap and real exchange rate gap and shocks (ε_t^m) and it is as follows:

$$\tilde{m}_t = \vartheta_1 \tilde{m}_{t-1} + \vartheta_2(\vartheta_3 \tilde{d}_t + (1-\vartheta_3)\tilde{x}_t) + \vartheta_4 \tilde{q}_t + \varepsilon_t^m \qquad (18)$$

For Turkey, the presence of high number of imported goods in consumption and investment and high import content of exports leads coefficient of ϑ_2 to enter with a positive sign in the equation. Sign of ϑ_4 is positive since more appreciated domestic currency gives our importers less domestic currency per one unit of foreign goods.

Similarly the gap component of the output, the level of potential output ($\bar{y}_t$) is constructed as the weighted average of the level of the potential domestic demand, potential export demand and potential import demand.

Following Öğünç and Sarıkaya (2010) and Kara et. al (2017), the second block is given by the following equations:

$$\pi_t = \sigma_1 \pi_{t-1} + (1-\sigma_1)\pi_{t+1} + rmc_t + \varepsilon_t^{\pi} \qquad (19)$$

$$rmc_t = \sigma_2 \tilde{y}_t + +\sigma_3 \widetilde{rpm}_t + \sigma_4 \widetilde{ruw}_t + \sigma_5 \tilde{s}_t \qquad (20)$$

[26] The value of ϑ_3 is calibrated as 0.82, based on sample ratios of period 2005q2-2019q4.

The representation of the Philips curve is based on 'triangle' model[27] of inflation by Gordon (1991). Seasonally-adjusted annualized quarter on quarter change of core inflation (π_t)[28] depends on its lagged values (π_{t-1}), its rational expectations with model-consistent (π_{t+1}) , real marginal costs (rmc), including the output gap ($\tilde{y}_t$), real import price gap ($\widetilde{rpm}_t$), real unit labour costs gap ($\widetilde{ruw}_t$) and the nominal exchange rate basket gap ($\tilde{s}_t$), and structural shock named as cost-push shock (ε_t^{π}) . While the coefficient of lagged core inflation (σ_1) represents the persistence of the inflation[29], the coefficient of the output gap (σ_2) indicates the sacrifice ratio which indicates how much output will be used by disinflation the economy. Higher output increases input costs for domestic producers since firms utilize higher capacity rates to deliver more output. Higher capacity utilization rate leads to depreciation in the capital more in the short run. Firms would like to replace and compensate depreciated capital, which would increase marginal costs. To preserve their profit margins, firms reflect increasing marginal costs into their prices. There are two channels, direct and indirect, for how the exchange rate affects inflation. For the former, if the domestic currency appreciates, imported goods become cheaper than domestically produced goods. Therefore, lower cost of imported goods reduces inflationary pressures. $\tilde{s}_t$ captures this situation. For the latter, as domestic currency appreciates in real terms, foreign goods become cheaper compared to domestically produced goods. Since demand shifts away from domestically produced goods to imported goods, lower demand for domestic goods will determine lower domestic costs pressures. $\widetilde{rpm}_t$ captures this statement. Moreover, $\widetilde{ruw}_t$ shows pressures of the real labor cost on inflation since it leads to the high cost.

[27] The model assumes inflation having three drivers: built-in inflation, demand-pull inflation and cost-push inflation.

[28] We use CPI-D index rather than headline inflation since CPI and its sub-componets differ in shocks behind their dynamics and strength of business cycle. Most monetary policies follow CPI-sub components along with headline inflation rate since they enable them to understand the drivers behind inflation dynamics. For instance, food price inflation is less affected business cycle and highly volatile and also energy price inflation is determined by exogenous factors. Therefore, when constructing a Philips curve, it is important to use the CPI sub-component, which is mostly related to the business cycle.

[29] It means that σ_1 captures inertia in firms' price setting behavior. A friction σ_1 of firms is backward-looking and relies on past inflation when deciding on current price changes. Lower σ_1 indicates that inflation returns to pre-shock level much faster.

Following the Benes et al. (2010), Blagrave et al. (2015), Alichi et al. (2015, 2019), the third block is given as follows:

The actual seasonally adjusted unemployment rate (u_t) is the equilibrium unemployment rate ($\bar{u}_t$) , NAIRU, minus the unemployment gap ($\tilde{u}_t$) :

$$u_t = \bar{u}_t - \tilde{u}_t \tag{21}$$

NAIRU has a stochastic process and it is a time-varying variable that depends on lagged values ($\bar{u}_{t-1}$) , variation in the trend ($G_{\bar{u},t}$), steady-state value ($\bar{u}^{ss}$)[30] and shocks ($\varepsilon_t^{\bar{u}}$):

$$\bar{u}_t = \bar{u}_{t-1} + (1-\tau)\bar{u}^{ss} + G_{\bar{u},t} + \varepsilon_t^{\bar{u}} \tag{22}$$

Variation in the trend of the NAIRU also follows an autoregressive process:

$$G_{\bar{u},t} = \tau G_{\bar{u},t-1} + \varepsilon_t^{G_{\bar{u}}} \tag{23}$$

Equation (24) represents dynamic Okun's law linking with unemployment gap and output gap:

$$\tilde{u}_t = \gamma_1 \tilde{u}_{t-1} + \gamma_2 \tilde{y}_t + \varepsilon_t^{\tilde{u}} \tag{24}$$

Following the Benes et al. (2010), Blagrave et al. (2015), Alichi et al. (2015, 2019), the last block is as follows:

The seasonally adjusted capacity utilization rate ($capu_t$) consists of equilibrium level of capacity utilization rate ($\overline{capu}_t$) plus capacity utilization gap ($\widetilde{capu}_t$).

[30] By conducting similar approach in first block, steady-state value of unemployment rate ($\bar{u}^{ss}$) is determined as 10.3 percent. The coefficent τ is calibrated as 0.8.

$$capu_t = \overline{capu}_t + \widetilde{capu}_t \quad (25)$$

Similar to NAIRU, the equilibrium level of capacity utilization has a stochastic process and it is a time-varying variable. It depends on lagged values ($\overline{capu}_{t-1}$) , variation in the trend ($G_{\overline{capu},t}$), steady-state value ($\overline{capu}^{ss}$)[31] and shocks ($\varepsilon_t^{\overline{capu}}$):

$$\overline{capu}_t = \overline{capu}_{t-1} + (1-\mu)\overline{capu}^{ss} + G_{\overline{capu},t} + \varepsilon_t^{\overline{capu}} \quad (26)$$

Variation in the trend of the $\overline{capu}_t$ also follows an autoregressive process:

$$G_{\overline{capu},t} = \mu G_{\overline{capu},t-1} + \varepsilon_t^{G_{\overline{capu}}} \quad (27)$$

Equation (28) represents dynamic linking capacity utilization gap and output gap:

$$\widetilde{capu}_t = \gamma_3 \widetilde{capu}_{t-1} + \gamma_4 \tilde{y}_t + \varepsilon_t^{\widetilde{capu}} \quad (28)$$

Equations (14-28) comprise the core of our model for output gap, NAIRU, unemployment gap and capacity utilization gap. Following Benes et al. (2010), Öğünç and Sarıkaya et al. (2011), Alp et al. (2012), Blagrave et al. (2015), Alichi et al. (2019), Bayesian methodology is employed to estimate the model for the period 2005q2-2019q4. The next subsection describes the Bayesian methodology and explains its superiority on the maximum likelihood (ML) estimation.

4.2.2.1. Assessment of Model Properties and Methods in Model Parametrization

There are several reasons why we prefer to employ Bayesian methodology to obtain unobservable variables rather than the ML estimation procedure that is used in Andıç (2018) for Turkey's case. ML estimation maximizes the log likelihood function with respect to the unknown parameters. It means that it searches for 'the' parameter that

[31] By conducting similar approach in the previous block, steady-state value of capacity utilization rate ($\overline{capu}^{ss}$) is determined as 77.0 percent. The coefficient μ is calibrated as 0.85.

produces the highest probability of observing data. It could be a powerful technique if the sample size is large enough and the data includes one extreme point. However, it might work poorly if the sample size scarce, the model is misspecified and the function has multiple extreme points. In the Bayesian methodology, on the other hand, the use of prior distributions in the model could help restrict parameters to reasonable areas and it could overcome problems confronted in ML estimation. Moreover, incorporating expert judgment in the model is quite easy and practical. The Bayesian methodology consists of prior probabilities, likelihood function and posterior probabilities. Prior probabilities ($p(\theta)$) , where θ denotes the set of parameters, describes the prior knowledge about the model and parameters and it does not depend on the data. Priors generally come from estimations on different datasets, expert judgment, or findings of previous studies. The likelihood function ($p(y\backslash\theta)$) is the density of the data conditional on the parameters of the model. Posterior distribution ($p(\theta\backslash y)$) revises prior probabilities by using information on data and likelihood function. It means that posterior is proportional ($\propto$) to likelihood times prior.

$$p(\theta\backslash y) \propto p(y\backslash\theta)p(\theta) \tag{29}$$

The algorithm of the Bayesian methodology has three steps. The likelihood function is evaluated for given parameters in the first step. The likelihood and prior density is combined in the second step. Lastly, the combination function is maximized with respect to θ to find the posterior mode. Blanchard-Kahn (1980) conditions ensure existence of a unique stable solution of the model. Following the related literature (Öğünç and Sarıkaya, 2011), the beta distribution is selected for the parameters considered to have a value in the range of (0, 1), the gamma distribution is determined for the parameters which are likely to receive a value greater than 1 and the normal distribution is used for parameters which can receive a positive or negative value. The inverse gamma distribution is adopted for the whole standard errors.

4.2.2.2. Prior Identification and Posterior Results

In Bayesian methodology, information from the outside models can be used in the estimation process in the form of the priors. Therefore, priors are selected from the

previous country-specific literature. In the Philips Curve equation, Çebi (2011), Öğünç and Sarıkaya (2011), Alp et al. (2012) and Blagrave et al. (2015) shows that firms's backward looking behavior outweighs in the price-setting process. The findings of those studies for backward looking component (σ_1) of the Philips Curve are 0.6, 0.8, 0.8 and 0.6, respectively. On the other hand, Kara et al. (2017)[32] and Andıç (2018) claims that forward-looking behavior is predominant. Therefore, it assumed that firms' backward and forward-looking behavior is the same in the price-setting process and the prior on the σ_1 is determined as 0.5. The result indicates that backward-looking behavior is somewhat more dominant and compatible with Çebi (2011), Öğünç and Sarıkaya (2011), Alp et al. (2012) and Blagrave et al. (2015). Although Öğünç and Sarıkaya (2011), Öğünç and Batmaz (2011), Blagrave (2015) find higher values, prior on the coefficient of the output gap (σ_2) in the Philips Curve is set to consider the Alp et al. (2012) and Kara et al. (2017) [33]. Furthermore, the choice of the priors on the coefficient of the real import price gap ($\widetilde{rpm}_t$), real unit labour costs gap ($\widetilde{ruw}_t$) and the nominal exchange rate basket gap ($\tilde{s}_t$) is based on Kara et al. (2017). Following Alp et al. (2012), the real interest rate gap is included in the domestic demand gap equation as well as real exchange rate gap. It is assumed that the real interest rate gap is predominant. Recent studies such as Sarıkaya (2004), Coşar (2012), Atabek et al. (2014), Çulha et al. (2014), Gül (2018), Çelgin et al. (2019) reveal that exports are more sensitive to foreign demand compared to the real exchange rate. Findings show that while the price elasticity of exports changes between -2.0 and 0, the income elasticity of exports is between 0 and 4.5. Many studies on the import demand are based on Goldstein and Khan (1985)' imperfect substitutes' model. It assumes that the demand for imports is determined by income, the price of the imported goods and the price of the domestic substitution of the good. In this framework, there are many studies on the modeling of import demand such as Senhadji (1998), Kotan and Saygılı (1999), Yavuz ve Güriş (2006), Kalyoncu (2006), Tolga and Berüment (2007), Aldan et al. (2012), Durmaz and Lee (2015), Çakmak, Gökçe and Çakmak (2016), Çulha et

[32] Kara et al. (2017) investigates the key drivers of the inflation and constructs a Philips Curve including time-varying parameter. Their findings suggest that coefficients in the Philips Curve are quite stable over time except for import prices.

[33] These findings on the coefficient of the output gap in the Philips Curve are 0.17, 0.25 and 0.3 respectively.

al. (2018) and Çelgin et al. (2019) in Turkey. It is possible to talk about a consensus in the studies[34] on that the income elasticity of imports is higher than the price elasticity. The choice of priors for the unemployment gap equation is based on the Andıç (2018)'s findings (Table 3).

[34] While the price elasticity of imports takes the value between 0.21 and 1.12, income elasticity of imports changes from 0.37 to 2.0 in the studies.

Table 3.

Parameter Estimates

Parameter	Prior Distribution			Posterior Distribution	
	Distribution	Mean	Standard Deviation	Mean	%90 Confidence Interval
Domestic Demand					
α_1	Beta	0.500	0.2000	0.4351	(0.3697, 0.4914)
α_2	Beta	0.300	0.1000	0.1734	(0.1148, 0.2271)
α_3	Beta	0.200	0.1000	0.0493	(0.0221, 0.0793)
Export Demand					
φ_1	Beta	0.300	0.2000	0.2822	(0.0888, 0.4900)
φ_2	Beta	0.500	0.2000	0.2847	(0.1055, 0.4481)
φ_3	Gamma	2.000	0.2000	1.9592	(1.6849, 2.2628)
φ_4	Beta	0.100	0.0500	0.0532	(0.0191, 0.0838)
Import Demand					
ϑ_1	Beta	0.200	0.1000	0.1690	(0.0862, 0.2566)
ϑ_2	Gamma	1.000	0.2000	1.7113	(1.4887, 1.9772)
ϑ_4	Beta	0.400	0.1000	0.3563	(0.2507, 0.4611)
Philips Curve					
σ_1	Beta	0.500	0.2000	0.5364	(0.4214, 0.6593)
σ_2	Beta	0.120	0.0500	0.1246	(0.0377, 0.1970)
σ_3	Beta	0.100	0.0500	0.1029	(0.0275, 0.1769)
σ_4	Beta	0.100	0.0500	0.0961	(0.0226, 0.1621)
σ_5	Beta	0.100	0.0500	0.1118	(0.0259, 0.1919)
Okun's Law					
γ_1	Beta	0.800	0.1000	0.6672	(0.5219, 0.8332)
γ_2	Gamma	0.800	0.2000	0.8552	(0.5763, 1.1289)
Capacity Utilization Gap					
γ_3	Beta	0.800	0.1000	0.7778	(0.6368, 0.9439)
γ_4	Gamma	0.800	0.2000	0.7667	(0.4991, 1.0187)
Shocks					
ε_t^d	InvGamma	0.020	Inf	0.0120	(0.0100, 0.0138)
ε_t^x	InvGamma	0.050	Inf	0.0450	(0.0371, 0.0515)
ε_t^m	InvGamma	0.030	Inf	0.0210	(0.0163, 0.0254)
ε_t^π	InvGamma	0.745	Inf	0.7858	(0.6157, 0.9438)
$\varepsilon_t^{\bar{u}}$	InvGamma	0.006	Inf	0.0052	(0.0016, 0.0096)
$\varepsilon_t^{G_{\bar{u}}}$	InvGamma	0.005	Inf	0.0250	(0.0127, 0.0383)
$\varepsilon_t^{\tilde{u}}$	InvGamma	0.025	Inf	0.0247	(0.0115, 0.0371)
$\varepsilon_t^{\overline{capu}}$	InvGamma	0.004	Inf	0.0024	(0.0010, 0.0038)
$\varepsilon_t^{G_{\overline{capu}}}$	InvGamma	0.003	Inf	0.0372	(0.0313, 0.0430)
$\varepsilon_t^{\overline{capu}}$	InvGamma	0.015	Inf	0.0073	(0.0038, 0.0108)

CHAPTER 5

EMPIRICAL RESULTS

This chapter consists of two parts. The first part describes the properties of the cyclical components of the output gap, unemployment gap, and capacity utilization gap extracted by univariate and multivariate filters. The last part documents the properties of the cyclical components of macroeconomic real variables estimated by multivariate filter constructed in Chapter 4 and shows the course of the NAIRU and potential output for Turkey.

5.1. The Properties of Cyclical Components of Macroeconomic Real Variables

The tables and plots of the estimates of the cyclical component of output, unemployment rate and capacity utilization rate are provided in this section. It is clear that different filter procedures provide different information and properties on the cyclical component of the variables.

According to Table 2 in Chapter 4, variability of quarterly growth rates of the unemployment rate is the highest among the other macroeconomic variables. Similarly, the whole filtering methods indicate that the cyclical component of the unemployment rate seems much more volatile than the other two macroeconomic variables. Furthermore, output has the lowest cyclical variability (Table 4). The results are compatible with the Turkish economy's dynamics. While firms might choose wait-and-see policy to recruit workers whenever volatility exists in labor markets, monetary or fiscal policymakers might intervene the course of economy to mitigate the volatility as discussed in Chapter 2. Although filtering procedures have almost consensus on ordering of the cyclical variability of the variables, they differ in terms of the magnitude of the variability. Since they eliminate periodicities which are shorter than

business cycle and evaluate them as noise, BK and CF filters provide the lowest cyclical variability for the macroeconomic variables. Similarly, HP filters give the smaller variabilities since they penalizes deviation from the trend. While Hamilton and DPT filters generate high cyclical variability in output, capacity utilization rate and unemployment rate, other filters give similar variabilities.

Table 4.

Cyclical Variability

	Output	Capacity Utilization Rate	Unemployment Rate
DPT	4.2	5.1	12.8
FOD	2.0	2.7	5.3
HP (1600)	3.3	4.0	9.7
HP (98)-HP(814)	2.0	4.0	9.7
One-sided HP	3.4	2.7	8.6
Hamilton	6.3	7.3	18.0
BK	1.8	2.7	5.8
CF	1.9	2.7	5.4
MF	3.1	6.1	6.2
Average	3.1	4.1	9.1

Table 5 shows the contemporaneous correlations between gap components of macroeconomic variables. As convenient for Turkey's labor markets, contemporaneous correlation between the output gap and unemployment gap is smaller than others since the effects of the downturns or expansions of the economic activity on the labor markets are delayed. Among detrending methods, the DPT filter gives the highest contemporaneous correlations between the output gap and capacity utilization gap due to its methodologic property; however, the HP (1600) filter generates the highest contemporaneous correlations between the output gap and unemployment rate gap. (Table 5). Moreover, the multivariate filter (MF) gives the highest contemporaneous correlation between the unemployment rate gap and capacity utilization gap. It shows that the MF filter captures relevant relationships between macroeconomic variables.

Table 5.

Contemporaneous Correlations

	Output Gap-Capacity Utilization Gap	Output Gap-Unemployment Rate Gap	Unemployment Rate Gap-Capacity Utilization Gap
DPT	0.88	0.66	0.58
FOD	0.64	0.46	0.55
HP (1600)	0.81	0.75	0.80
HP (98)-HP(814)	0.79	0.65	0.80
One-sided HP	0.50	0.68	0.55
Hamilton	0.82	0.74	0.76
BK	0.86	0.69	0.63
CF	0.85	0.74	0.69
MF	0.70	0.68	0.93
Average	0.76	0.67	0.70

While BK and CF filters produce the highest contemporaneous correlations between the output gap and inflation, HP (98) gives the largest correlations between the lagged output gap and lagged inflation (Table 6). On the other hand, it seems that the relationship between the cycles created by filtering methods and other macroeconomic variables such as inflation is highly weak. In addition to this, end-point problem exists. Some filters such as FOD, HP (98), BK and CF produce positive output gap for the last period; while, DPT, HP (1600), one-sided HP, and Hamilton filters give negative output gap. It is highly important for both monetary policy and fiscal policy in the following sense. On the one hand, if monetary policy believes the filters give the positive output gap, it should tighten the economy to halt the heating up the economy. On the other hand, if monetary policy rests on the filters giving the negative output gap, it should ease the economy. It is clear that there is no consensus among the univariate detrending methods on the end-point.

Table 6.

Correlation between Inflation and Output Gap

	Cor $(\pi_t, \tilde{y}_{t-2})$	Cor $(\pi_t, \tilde{y}_{t-1})$	Cor $(\pi_t, \tilde{y}_t)$
DPT	0.35	0.43	0.28
FOD	0.20	0.20	-0.31
HP (1600)	0.32	0.45	0.27
HP (98)	0.32	0.55	0.31
One-sided HP	0.17	0.20	-0.01
Hamilton	0.16	0.25	0.14
BK	0.32	0.44	0.33
CF	0.36	0.47	0.35
MF	0.26	0.37	0.14
Average	0.27	0.37	0.17

For the first cyclical downturn period, DPT filter produces the lower output gap, unemployment rate gap and capacity utilization gap estimates than FOD filter does. Moreover, the economy operated a longer period under the potential according to the DPT filter compared to FOD. The whole HP filters indicate the lowest output gap and capacity utilization slack estimates in 2009-1. Although the one-sided HP filter generates deeper contraction, its recovery period is shorter than other HP filters. Among the univariate detrending methods, Hamilton's filter gives the lowest output gap estimates, around -17.7 percent. BK and CF filters' estimates are similar to other filters' estimates since they indicate that recovery began at 2009-1. Except for FOD and one-sided HP filters, remaining all filters indicate that economic activity leads the labor market. As indicated by Coşar and Yavuz (2019), firms might choose wait-and-see policy and make sure that economic activity has been recovered. In addition, they firstly increased their capacities and then started recruiting workers. As of the second cyclical downturn period, all macroeconomic variables' gaps are less negative than the former period. It means that the global financial crisis dragged the Turkish economy far below its potential further compared to the recent downturn. Therefore, it was more supportive in reducing demand pressures on inflation. While FOD, HP (98) indicate that the economy operated above its potential in 2019-4, according to the results generated by DPT, HP (1600), one-sided HP and Hamilton it was below its potential. Moreover, BK and CF filter point out that the economy is almost at its potential level

in 2019-4. Although the output gap and the capacity utilization gap do not decrease much, there is a high decrease in the unemployment gap. There are several reasons why unemployment is more responsive than the output gap and capacity utilization gap. As discussed in Chapter 2, one reason is that employment has deteriorated with a sectorial diffusion in recent periods and so it may be longer to recover. Second, the decline in risk premium and exchange rate volatility as well as improvement in financial conditions and momentum of the credit growth in 2019-4 backed up the economic activity and firms considerably. While Hamilton's filter gives too much oscillations for expansions and downturns periods of the three macroeconomic variables, HP filters indicate too much slack for labor markets and firms' capacities. Furthermore, HP filters have end-point problem. As expected, while the BK and CF filters do not capture small volatility and gives the regular cycle patterns, FOD method gives the too much volatile cycles. As discussed above, end-point problem and producing existence of the weak relationship other macroeconomic variables are drawbacks of the univariate filters and it is valid for Turkey data as well. Due to these drawbacks, univariate filters give the confusing results. On the other hand, it seems that slacks in the output, capacity rate and unemployment rate are fairly reasonable for both 2008 and 2018 downturns (Figure 15, 16 and 17). Against this background, we choose the multivariate filtering procedure to estimate the potential output and NAIRU for Turkey. The next subsection shows the course of the potential output and NAIRU for Turkey and discusses both downturns in terms of sub-gap components.

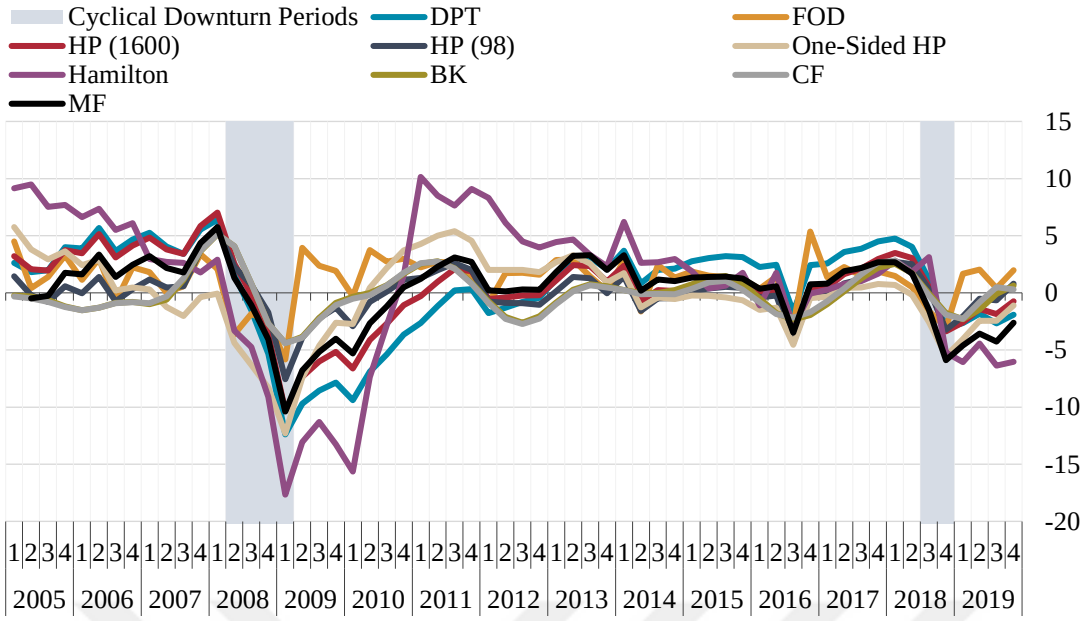


Figure 15: Estimates of Output Gap (Percent)

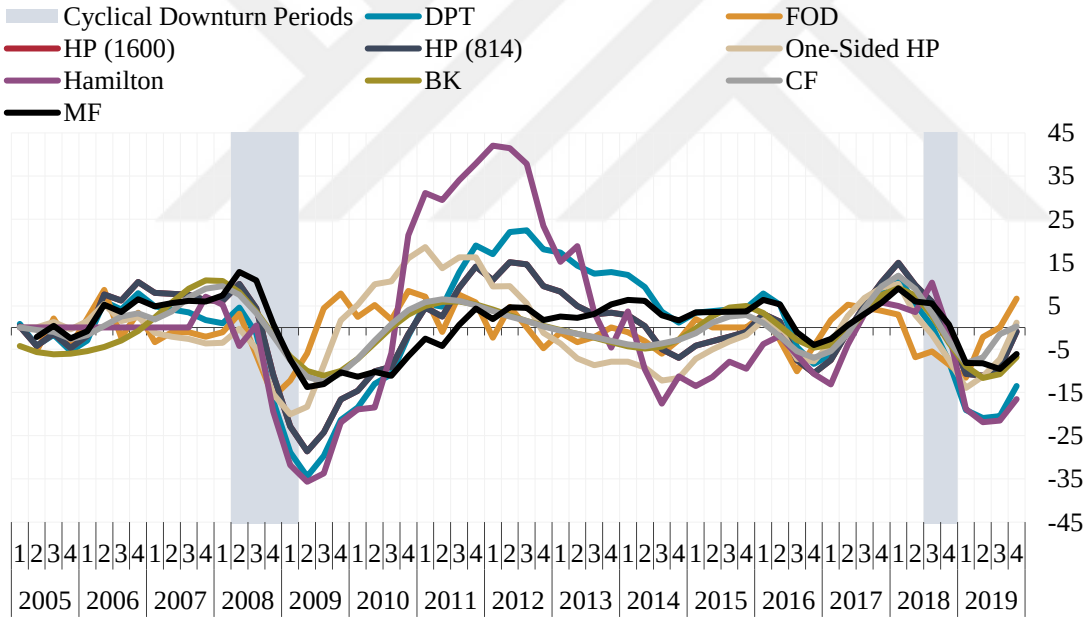


Figure 16: Estimates of Unemployment Rate Gap (Percent)

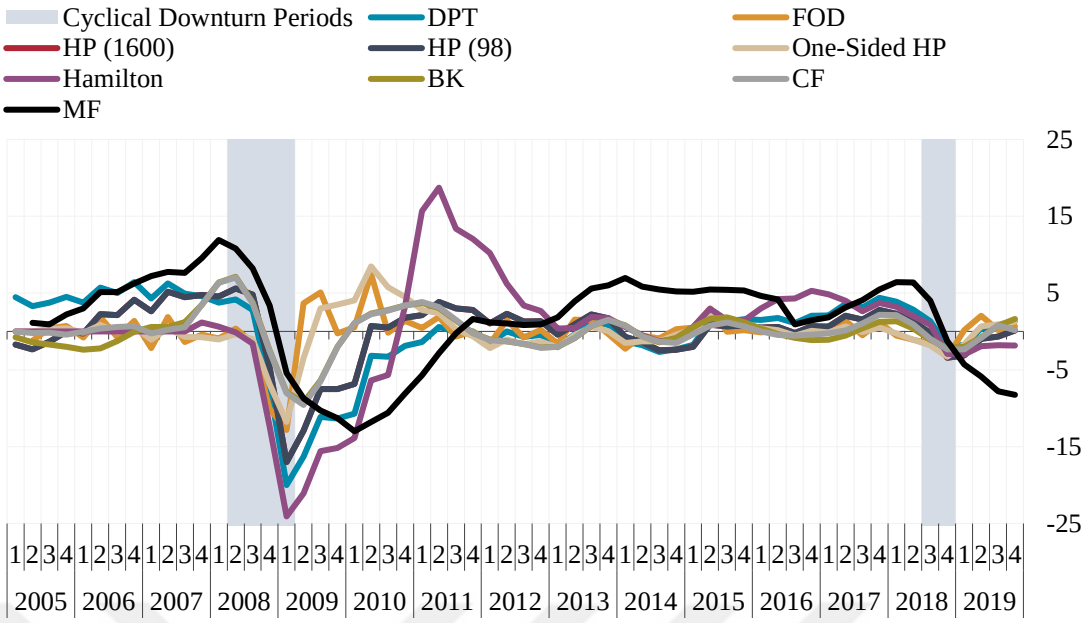


Figure 17: Estimates of Capacity Utilization Rate Gap (Percent)

5.2. Potential Output and NAIRU for Turkey

Figure 18 shows the output gap estimates extracted by the multivariate filter together with the annualized quarterly change in core inflation. According to the Figure, the output gap is less negative in the recent turmoil than it is during the global financial crisis. Turmoil in the international credit markets and deterioration in the expectations of the global economic outlook has intensified slowdown in the economy and restrained both domestic and export demand (Figure 19). Considering the export composition, Turkey is a country that is largely an exporter of manufactured products. Automotive, machinery, transportation vehicles, iron and steel products have a high share in exports. The countries that are importers for such products were the ones most affected by the crisis, which caused the foreign demand to decrease considerably during the global crisis. For the recent downturn, there has been a sharp depreciation in the Turkish Lira (TL) and uncertainties have increased since 2018-3. Perceptions of uncertainty and tight financial conditions, which strengthened significantly due to financial volatility, suppress domestic demand as well as decrease in credit momentum and in real wages, worsening employment opportunities and increase in unemployment. Therefore, the slowdown in economic activity was driven by domestic demand. On the other hand, net exports compensated for the slowdown in domestic

demand due to the relatively strong course in the global economic outlook, the increasing competitiveness due to the long-term depreciation in TL, and the flexibility of market diversification during the period (Figure 19). After 2018-4, significant acceleration in loans as well as remarkable improvement in the risk premium, exchange rate volatility and uncertainty indicators supported domestic demand. In both periods, total demand conditions contribute to the disinflation process. While the shock during the global economic crisis is demand shock, the recent shock is a cost-push shock. Differentiation of shocks resulted in different developments after the slowdown. For the former, when the output gap is closing, inflation has a moderate course and the course of the economy is compatible with the divine-coincidence discourse[35]. For the latter, while the output gap is closing, an increase in inflation is observed for a while.

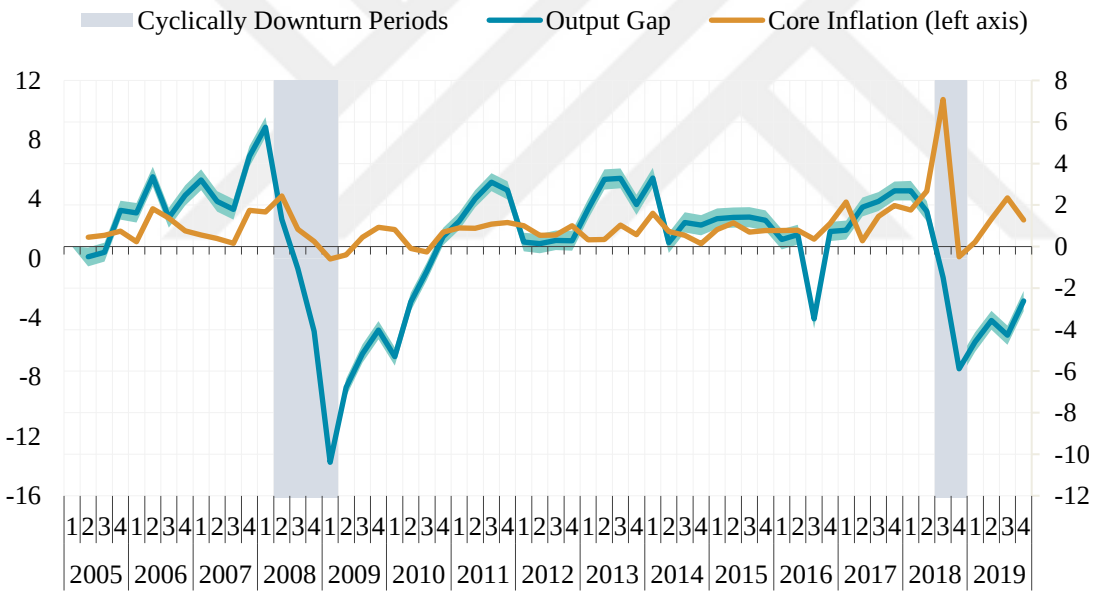


Figure 18: Output Gap Estimate with 2-Standard Deviation Confidence Interval (Percent) and Core Inflation (Annualized quarterly change, percent)

[35] Divine coincidence means that there is no trade-off between the stabilization of inflation and the stabilization of the welfare-relevant output gap for central banks (Blanchard and Gali, 2007).

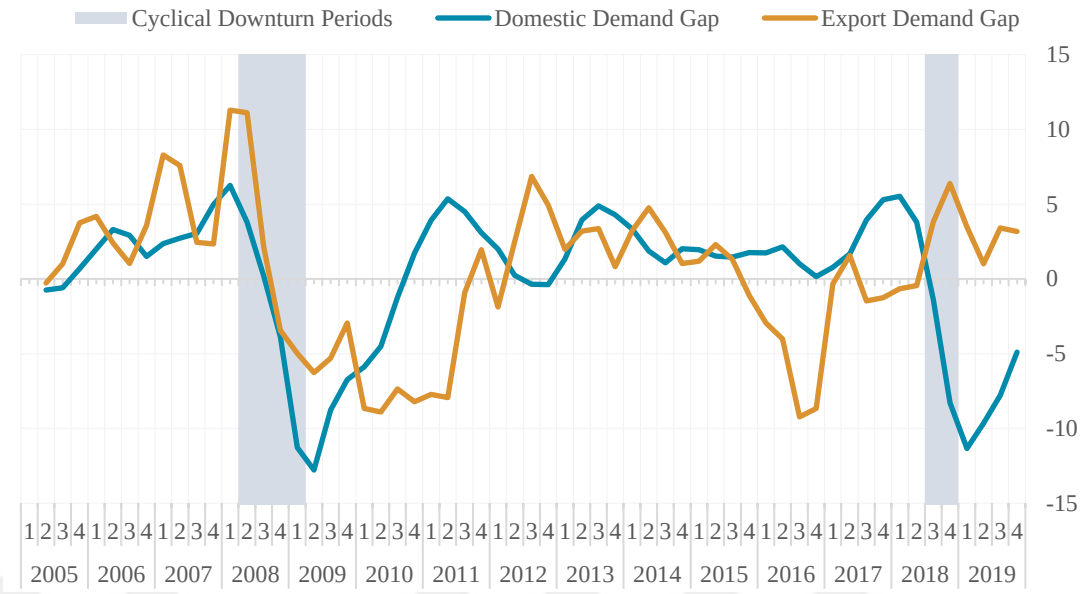


Figure 19: Domestic Demand Gap and Export Demand Gap (Percent)

Figure 20 indicates the course of the potential growth estimated by multivariate filtering procedure. It seems that potential growth is correlated with annualized quarterly change in actual growth, though potential growth is smoother. The average potential growth during the period is 4.9 percent. Potential growth decreases to the lowest level, 1.3 percent, in 2009-1 and then recovers; however, it continued to decline until 2019-3 even after 2018-4, then became flat for the recent downturn. One explanation for the ongoing decline in potential output for a while in the 2018 downturn might be the continuation of the increase in unemployment. On other hand, it did not fall as much as the first one and has dropped to the 2.4 level in 2019-3 due to more supportive foreign demand and more incentives.

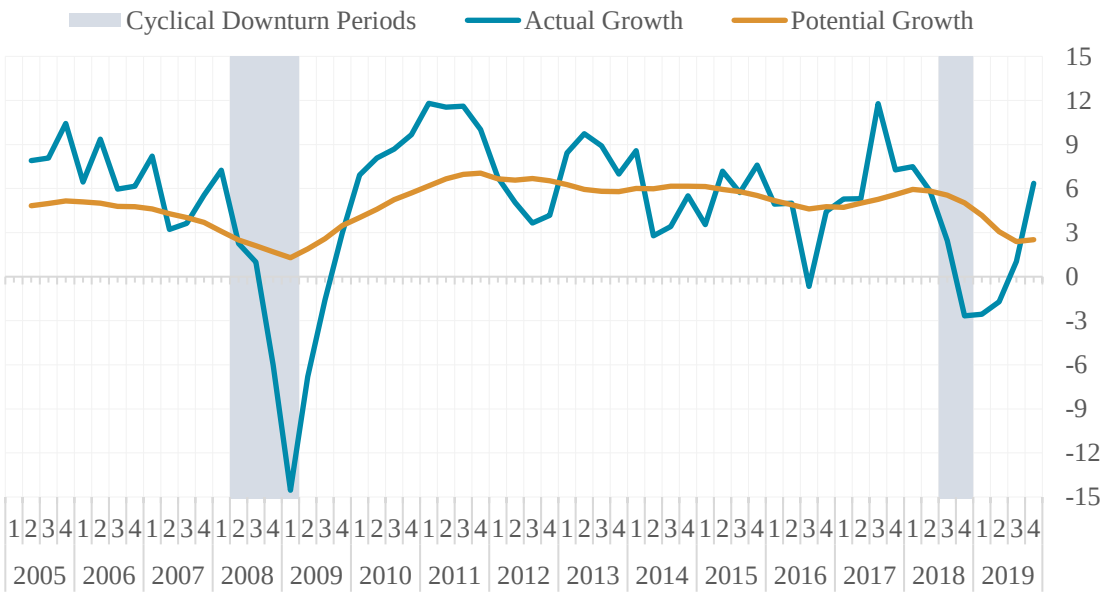


Figure 20: Actual Growth (Annualized quarterly change, percent) and Potential Growth (Percent)

Figure 21 indicates the unemployment rate and time-varying NAIRU extracted by MF. As of the fourth quarter of 2008, the effects of the global crisis on the labor market began to be felt significantly, and the deterioration in the labor market continued until mid-2009. As of the third quarter of 2009, non-agricultural employment started to recover, while unemployment rates started to decline. While the effects of the global financial crisis focused on industrial employment, the impact on construction and services employment remained limited (Figure 5, 6 and 7). Similar to the findings of Andıç (2018), the unemployment rate is below the NAIRU before the global financial crisis but it rises above its trend in 2008-4 and it stays above the trend for a long period of time. Regarding the global financial crisis, the unemployment rate and NAIRU register a sharp increase during the 2018 downturn. Despite the positive quarterly growth rates after 2018-4, NAIRU's increase continued for a while. One of the most significant explanations for this is a widespread employment loss in this period, unlike the 2009 period. Unemployment rates increased in 2019 since the second half of 2018 due to the slowdown in economic activity. The increase in unemployment rates was due to the decrease in employment observed in non-agricultural sectors, especially in the construction sector.

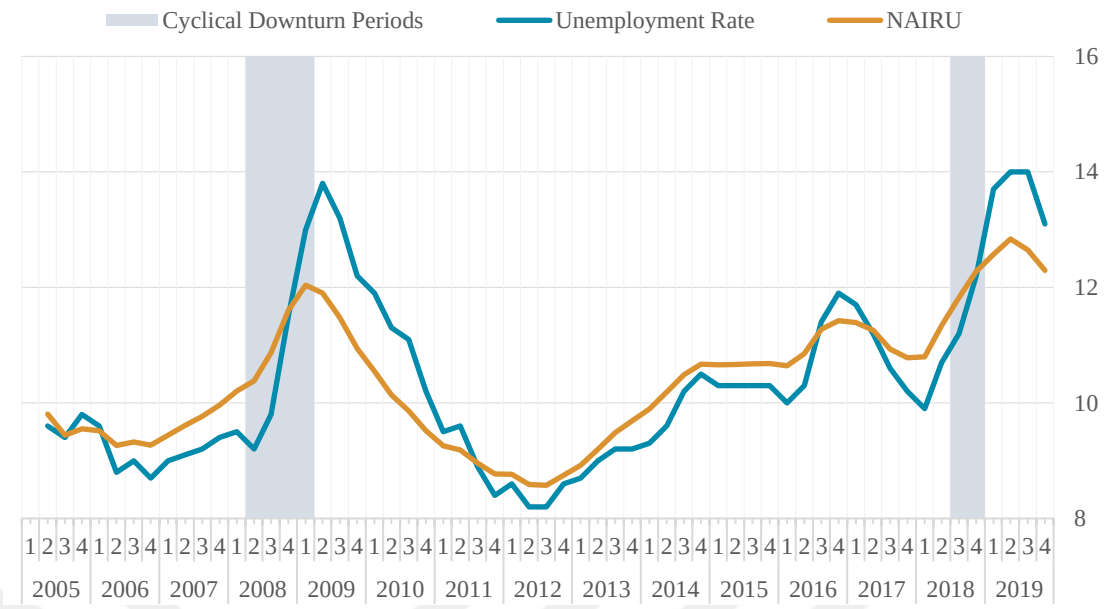


Figure 21: NAIRU Estimate and Unemployment Rate (Percent)

The MF estimates of the output gap, unemployment gap and capacity utilization gap are shown in Figure 22. It easily seems that goods market leads the labor market and manufacturing industry. It means that recovery in goods market begins earlier than other markets. As stated in the Coşar and Yavuz (2019), firms determine the time of recruitment and increasing the capacity utilization rate depending on the sustainability of the recovery of economic activity. The deepest slack in the labor market in both periods exists. Due to weaker external demand in the global financial crisis, there appears to be a slacker in capacity utilization rate during the period.

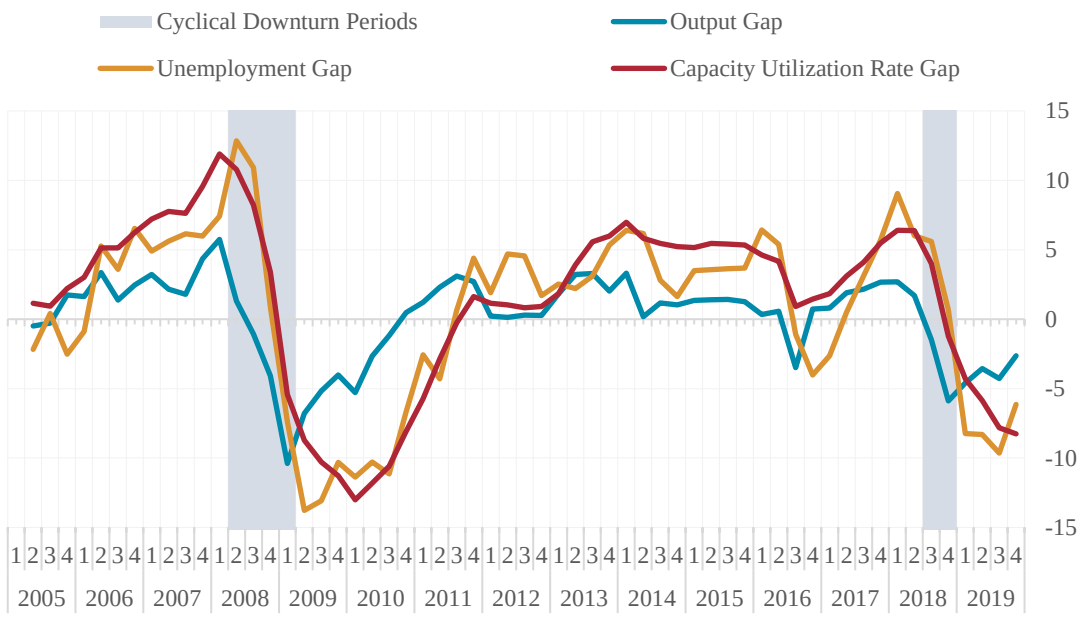


Figure 22: Output Gap, Unemployment Gap and Capacity Utilization Rate Gap (Percent)

CHAPTER 6

CONCLUSION

It is crucial to identify the state of the economy for both monetary policy-makers and fiscal policy authorities. Central banks determine a policy stance that is compatible with their own objective function. Governments also would like to know whether the budget deficit is sustainable or not. To fulfill these requirements properly, we utilize a wide range of univariate filtering methods such as deterministically linear trend (DPT), the first-order differencing (FOD) method, Hodrick-Prescott (HP) filter, one-sided HP filter, Hamilton's regression filter, Baxter and King (BK) filter and Christiano-Fitzgerald filter. The estimations on the cyclical components of the output, capacity utilization and unemployment rate are used to compare the dynamics of the two cyclical downturns in Turkey since 2001. The first one was due to the global financial crisis, which spans the period 2008-Q2 and 2009-Q1, while the second one took place between 2018-Q3 and 2018-Q4 when strong and abruptly depreciation in the Turkish Lira and high country's risk premium existed. Similar to previous studies, the filter results indicate that the global financial crisis dragged the Turkish economy far below its potential further than 2018 downturn. The output gap and capacity utilization gap do not decrease as much as the unemployment gap in both downturns. Therefore, monetary policymakers and non-monetary policy makers should concentrate on the developments in the labor markets as well as developments in the goods markets during the recession periods since reflections on the downturn periods on the markets could differentiate and output gap could not be only indicator to identify business cycle conditions.

Although univariate filters guide to understand the course of the macroeconomic variables during the downturn periods, they give some confusing results. The filters specifically differentiate in the magnitude of the slack. Moreover, weak relationship

between macroeconomic variables exist as well as end-point bias problem. Due to these drawbacks, we construct a multivariate filter to decompose the variables into trend and cycles for the 2005q2-2019q4. Our model takes structural macroeconomic relationships into account. In addition to Philips Curve and Okun's Law, the model also includes the capacity utilization block. This addition differentiates our study from other studies on the Turkish economy. This extension enables us to compare the course of the cyclicality of the output, capacity utilization and unemployment rate in the downturn periods of Turkey. It is estimated by the Bayesian estimation with the Kalman filter. It seems that our multivariate filter can produce intuitive and consistent estimates with the economic theory of slack in output, capacity utilization rate and unemployment rate.

According to our multivariate filter results, estimate of output gap is smaller in 2018 downturn than global financial crisis since foreign demand is more supportive in 2018 downturn due to competitive exchange rate and strengthening market diversification flexibility in exports. Potential growth considerably decreased in both periods. NAIRU, unemployment rate consistent with stable inflation, moves in tandem with actual unemployment rate. It has been above the trend for a long time during the both downturns. It captures the idea that long and deep downturns in Turkey resulted in persistent damage to the labor market. It means that labor market hysteresis happened due to negative effects of the cyclical downturn periods. Though estimate of the slack in the output is smaller in recent period, unemployment rate and NAIRU increase sharply and reach the highest levels historically in both periods. While the employment losses in the labor market were predominantly in the industry sector during the global financial crisis, sectorial diffusion in the employment losses has been seen in the recent period. Due to weaker foreign demand and composition of industrial sector products, slack in capacity utilization rate is higher in the global financial crisis. As a result, the labor market has been the most affected by these turmoil negatively.

The future work can extend our study in several ways. Although our model tries to include many macroeconomic relationships and has high inclusiveness, some macroeconomic variables such as fiscal stance, credit growth, housing prices could be added to the model. To cover the foreign trade developments which are significant for

the Turkish economy, the model can be augmented with current account equation. It is believed that such extensions improve reliability of the real-time estimates of the model and assist policy choice.

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APPENDICES

A. STATE-SPACE MODELS AND THE KALMAN FILTER ALGORITHM[36]

Kalman filter requires the model in the state-space form and details information on them is needed to understand processes of one-sided HP filter including in univariate filters and multivariate filtration.

Cochrane (1998) states that at least one unobserved components representation exists for any given Auto Regressive Integrated Moving Average (ARIMA) process. Therefore, any macroeconomic model can be written in state space form consisting of two type of equations which are measurement and transition equations. Measurement equation includes static relationship between the observable variables and unobservable variables. Dynamics of unobservable, state, variables are described in transition equations. Let's define Y_t and X_t as vector of observable and unobservable variables, state, respectively. While C and A are matrix of known parameters, v_t is a vector of measurement errors and ε_t is a vector of errors. Both v_t and ε_t are independent and identically distributed with zero mean and covariance matrix R and Q respectively. Also, errors are independent of each other. Therefore, equations (30) and (31) represent measurement and transition equations in turn.

$$Y_t = CX_t + v_t \tag{30}$$

$$X_t = AX_{t-1} + \varepsilon_t \tag{31}$$

[36] Source: IMF.

The Kalman filter needs to starting values for the unobserved variables for the first period and the filter works a recursion. There are two steps, prediction and update, used by the filter for each period in the Kalman filter procedure.

Step 1. It predicts values of the observed and unobserved variables using the model. Prediction values of Y_t and X_t based on conditional information up to period t-1 are $Y_{t/t-1}$ and $X_{t/t-1}$ respectively.

$$Y_{t/t-1} = CX_{t/t-1} \tag{32}$$

$$X_{t/t-1} = AX_{t-1/t-1} \tag{33}$$

For the first step, prediction error variance of state variables given the information up to period t-1 is called as:

$$P_{t/t-1} = Var_{t-1}[(X_t - X_{t/t-1})] = Var_{t-1}[(AX_{t-1} + \varepsilon_t - AX_{t/t-1})] = AP_{t-1/t-1}A' + Q \tag{34}$$

Moreover, $F_{t/t-1}$ describes the prediction error variance of observed variables and it is represented as follows:

$$Var_{t-1}[(Y_t - Y_{t/t-1})] = Var_{t-1}[(CX_t + v_t - CX_{t/t-1})] = CP_{t/t-1}C' + R \tag{35}$$

Step 2. Once the observations arrive at period t, the Kalman filter updates the estimates of unobserved variables using the Kalman gain, K_t, matrix. K_t matrix comes from following process:

Similarly the first step, $P_{t/t} = Var_t[(X_t - X_{t/t})]$ is prediction error variance of state variables given information up to period t. Since the multivariate distribution for the vector Y_t and X_t is as follows:

$$\begin{bmatrix} Y_t \\ X_t \end{bmatrix} | \, Y_t, \dots, Y_{t-1} \sim N\left(\begin{pmatrix} Y_{t/t-1} \\ X_{t/t-1} \end{pmatrix}, \begin{pmatrix} F_{t/t-1} & CP_{t/t-1} \\ P_{t/t-1}C' & P_{t/t-1} \end{pmatrix}\right) \tag{36}$$

$$X_{t/t} = X_{t/t-1} + \ P_{t/t-1}C'F_{t/t-1}{}^{-1}[(Y_t - Y_{t/t-1})] = X_{t/t-1} + \ K_t(Y_t - Y_{t/t-1}) \quad (37)$$

$$P_{t/t} = P_{t/t-1} + \ P_{t/t-1}C'F_{t/t-1}{}^{-1}CP_{t/t-1} = (\mathrm{I} - K_tC)P_{t/t-1} \quad (38)$$

where $K_t = \ P_{t/t-1}C'F_{t/t-1}$. When rearranging the equations, Kalman filter algorithm is as follows:

$$K_t = \ P_{t/t-1}C'(CP_{t/t-1}C' \ + R)^{-1} \quad (39)$$

$$X_{t/t} = X_{t/t-1} + \ K_t(Y_t - Y_{t/t-1}) \quad (40)$$

$$P_{t+1/t} = A(\mathrm{I} - K_tC)P_{t/t-1}A' + Q \quad (41)$$

Kalman gain depends on the state prediction error variance, $P_{t/t-1}$, positively and measurement equation variance, R, negatively.

As discussed earlier, Kalman filter requires starting values called as $X_{0/0}$ and $P_{0/0}$. Once the starting values are obtained, filter works as a recursion. Literature states that steady-state values of variables could be used as starting points if the model is stationary. For each period, Kalman filter uses only information up to that period; however, it is useful to use all the available information up to end of the data sample. That's what the Kalman smoother does. Its algorithm works backwards starting from the last data point to obtain smoothed state estimates.

B. TURKISH SUMMARY / TÜRKÇE ÖZET

Türkiye ekonomisinde 2001 krizi sonrasında uygulanan yapısal reformlar sonucunda (Kara, 2006) istikrarlı bir büyüme patikası görülmüş, enflasyon oranları tek haneli seviyelere indirilmiş ve faiz oranlarında kayda değer bir iyileşme gerçekleşmiştir. Bu olumlu gelişmelere rağmen Türkiye ekonomisi bu dönemde iki dönemsel gerileme yaşamıştır. Bunlardan ilki küresel finansal krizin etkisiyle 2008-2 ve 2009-1 döneminde yaşanırken ikincisi ise Türk Lirasında güçlü ve ani bir değer kaybının yaşandığı ve ülke risk priminin yüksek olduğu 2018-3 ile 2018-4 arasında gerçekleşmiştir. İkinci gerilemenin derinliği ve süresi öncekinden daha kısa olsa da, her iki dönemde de iktisadi faaliyetteki yavaşlama ve artan belirsizlik kaynaklı istihdam kayıpları yaşanmış ve işsizlik oranları tarihi yüksek seviyelere çıkmıştır. Küresel finans krizi sırasında istihdam kayıplarının büyük bir kısmı sanayi sektöründe görülürken 2018 döneminde ise istihdam kayıplarının sektörler geneline yayıldığı görülmektedir. Bu görünüm altında her iki dönem için de tek ve çok değişkenli filtreler yardımıyla iş çevrimlerinin gidişatını ve enflasyonu hızlandırmayan işsizlik oranını (NAIRU) tahmin etmeye çalışıyoruz. Bu çalışma çıktı açığındaki düşüş ve NAIRU'daki yükselişin boyutlarını karşılaştırdıktan sonra bu gelişmelerin makroekonomik görünüm üzerindeki etkilerini araştırmaktadır.

Potansiyel çıktı ve çıktı açığı hem para politikası yapıcıları hem de mali otorite gibi parasal olmayan politika yapıcılar için oldukça önem arz etmektedir. Çıktı açığının doğru bir şekilde tahmin edilmesi ekonomilerin mevcut ve gelecekteki dinamikleri için önemli politika sonuçlarına sahiptir. Güvenilir bir çıktı açığı tahmini merkez bankacılarının para politikası duruşlarının uygunluğunu değerlendirmelerini sağlar. Çıktı açığının seviyesi enflasyon üzerinde yukarı yönlü (aşağı doğru) bir baskı oluşturuyorsa birincil amacı düşük ve istikrarlı bir enflasyon düzeyini korumak olan merkez bankaları politika duruşunu sıkılaştırabilir (gevşetebilir). Bu nedenle çıktı açığının yanlış tahmin edilmesi enflasyona veya düşük büyüme oranlarına yol açan para politikalarına neden olabilir. Hükümetler ise mali politikayı belirlemek için bütçe

açığının sürdürülebilir olup olmadığını bilmek isterler. Bunu yapmak için, hesaplaması çıktı açığını gerektiren döngüsel olarak ayarlanmış bütçe dengesi doğru bir şekilde tahmin edilmelidir. Aşırı iyimserlik ve ekonominin potansiyel kapasitesinin fazla tahmin edilmesi bütçe açıklarında ve kamu borcunda önemli bir bozulmaya yol açabilir. Kangur ve diğ. (2019) kamu borç seviyeleri ve kamu borcu ile gerçek zamanlı çıktı açıklarına yönelik yukarı yönlü revizyonlar arasında pozitif bir korelasyon olduğunu söylemektedir. Bu nedenle, makroekonomik istikrarın sağlanması açısından ekonominin konumunu kesin olarak belirlemek çok önemlidir. Burns ve Mitchell (1943) ve Lucas (1977) iş çevrimleriyle ilgili iki farklı kavram öne sürmüşlerdir. Burns ve Mitchell'in (1943) klasik görüşü düzey verilerini ele alırken ikincisi büyüme döngüleriyle ilgilenir. Enflasyon ve finansal döngülerle daha ilgili olduğu düşünüldüğünden iş döngüsü modellerini oluşturmak için büyüme döngüsünü düşünmek son zamanlarda daha yaygın hale gelmiştir. Büyüme döngüsü veya çıktı açığı gerçek çıktının potansiyelden yüzde sapması olarak tanımlanabilir. Çıktı açığının gizemi gözlemlenemeyen potansiyel çıktı terimini içerdiği için tanımından ortaya çıkmaktadır. Okun (1962) potansiyel çıktıyı enflasyona yol açmadan üretilebilecek maksimum çıktı miktarı olarak tanımlamıştır.

Merkez bankalarının enflasyonist baskıyı yakından izlemesini sağlayan bir başka önemli bileşen ise NAIRU'dur. Ayrıca, NAIRU işgücü piyasasının durgunluğu olarak kabul edilir ve kapasite baskısını ölçmek için kullanılır. Modigliani ve Papademos (1975) tarafından ortaya konulan NAIRU, Phelps (1967) ve Friedman (1968) tarafından ortaya atılan doğal işsizlik oranının geliştirilmesiyle elde edilmiştir. Ball ve Mankiw (2002) istikrarlı bir enflasyon ile tutarlı olan bir işsizlik seviyesi olan NAIRU'nun olması gerektiğini belirtmektedir. Uzun vadede şokların etkisi azaldığında NAIRU doğal işsizlik oranına yakınsa da ikisi birbirinden farklı kavramlardır. Doğal işsizlik oranı yapısal ve kurumsal değişikliklerden etkilenmektedir. Bu nedenle sabit ve zaman içinde değişmediği öngörülmüştür. NAIRU ise kısa vadede enflasyon ve işsizlik arasındaki ödünleşimden yararlanması nedeniyle zamanla değişen bir değişkendir. Bu nedenle, merkez bankalarının NAIRU'yu etkileyebildiği ancak doğal işsizlik oranını etkileyemeyeceği kabul edilmiştir.

Türkiye'de 2000'li yılların başında iktisat temellerindeki aksaklıklar, yüksek borç dinamikleri ve finans sektörlerinin sorunlarından kaynaklanan makroekonomik istikrarsızlığın olumsuz etkilerini azaltmak için yeni bir ekonomik program uygulanmıştır. Bu dönemde yüksek bir bütçe açığı, çok kısa borçlanma vadeleri, yüksek reel faiz oranları, birikmiş iç ve dış borç ve yüksek bir cari açık vardı. Program bu sorunlara çözüm bulamadı ve döviz kuru ve faiz oranlarının önemli ölçüde yükseldiği kriz Şubat 2001'de patlak verdi. Kriz sırasında ekonomik aktivite keskin bir şekilde daraldı, işsizlik oranları yüksek seviyelere çıktı, enflasyon oranları yükseldi ve finansal göstergeler kötüleşti.

Kriz sonrasında makroekonomik istikrarı sağlamak için uygulanan çok sayıda yapısal reform sayesinde Türkiye ekonomisinde olumlu gelişmeler yaşanmıştır. 2002 yılının ilk çeyreğinden itibaren birbirini izleyen yüksek büyüme oranları görülmekle beraber enflasyon oranında hızlı bir düşüş, işgücü piyasalarında ve kamu bütçesinde kayda değer iyileşmeler gerçekleşmiştir. Ancak yüksek büyüme oranları dönem boyunca devam etmiş olsa da Türkiye ekonomisi 2001'den bu yana iki büyük döngüsel gerileme yaşamıştır. Bunlardan ilki 2008'in ikinci çeyreğinde başlamış ve 2008'de küresel finansal krizin yansımaları nedeniyle dört çeyrek sürmüştür. İkincisi ise 2018'in ikinci yarısında etkili olmuştur. Bu iki dönemin karşılaştırılması her iki dönem arasındaki benzerlikleri ve farklılıkları belirlememizi sağlayacak ve bu da makroekonomik şokların makro değişkenler üzerindeki etkilerini anlamamıza yardımcı olacaktır. Böyle bir karşılaştırma model sonuçlarımızın anlaşılmasını kolaylaştıracaktır. Karşılaştırmanın ana noktalarını şu şekilde sıralamak mümkündür. İkinci dönemdeki toparlanma daha hızlı olmuştur. Birinci ve ikinci döngüsel gerileme dönemlerinde Gayri Safi Yurt İçi Hasıla (GSYİH)'nın eski düzeyine dönmesi sırasıyla 10 ve 6 çeyrek sürmüştür. Ayrıca daralma seviyesi 2008 krizinde daha derin olmuştur. Zirveden en dibe çıktı kaybı birincisinde yaklaşık yüzde 13 ve ikincisinde yaklaşık yüzde 5 olarak gerçekleşmiştir. Dış talep 2008 krizinde keskin bir şekilde daralırken, iç talep 2018'deki gerilemenin asıl kaynağı olmuştur. İlk gerileme 2008-2'de başlayıp 2009-1'de sona ermesine rağmen etkisi 2009 yılında daha fazla hissedilmiştir. 2008'de yıllık GSYİH yüzde 0,8 artarken, 2009 yılında yıllık büyüme oranı yüzde 4,8 oranında gerilemiştir. 2008 yılında yıllık sınırlı pozitif büyüme esas olarak net ihracat ve kamu tüketiminden kaynaklanmıştır. Özel tüketim ve yatırımlardaki oldukça keskin bir

düşüş 2009 yılında kuvvetli bir negatif daralmaya neden olmuştur. İkinci dönemde yıllık olarak düşük büyüme oranları görülmesine rağmen yılın ilk yarısında pozitif büyümeye bağlı olarak yıllık büyüme oranlarında daralma yaşanmamıştır. Yıllık GSYİH 2018'de yüzde 3,0 artarken, 2019'da yüzde 0,9 artmıştır. 2009'da olduğu gibi 2019 yılında da yatırım harcamaları yıllık büyümeye en yüksek negatif katkıyı vermiştir.

Her iki dönemin daralma genişliği ve süresi birbirinden farklı olsa da işgücü piyasası her iki dönemde de ciddi şekilde etkilenmiştir. İşsizlik oranlarının gerileme dönemlerinden sonra da bir süre daha artmaya devam etmesi gerilemelerin işgücü piyasası üzerindeki gecikmeli etkilerinin yansıması olarak düşünülmektedir. Bu yansıma 2018 döneminde daha net görülmektedir. İşsizlik oranları 2008 yılındaki ekonomik gerileme döneminden sonra düşmeye başlamıştır. Fakat büyümenin kompozisyonu, süregelen belirsizlikler ve finansal koşullardaki sıkışıklık nedeniyle işsizlik oranları 2018 gerilemesinin bitiminden üç çeyrek ardından düşmeye başlamıştır. Mevsimsellikten arındırılmış işsizlik oranı ilkinde yüzde 13,8 seviyesine çıkmıştır. 2018-3'ten itibaren ekonomik faaliyetteki yavaşlama nedeniyle 2019-3'te (yüzde 14,0) tarihsel olarak en yüksek seviyeye çıkmıştır. Ayrıca, tarım dışı işsizlik oranları ve geniş tanımlı işsizlik oranları her iki dönemde de önemli ölçüde artmıştır. İktisadi faaliyetteki yavaşlama nedeniyle her iki dönemde de yoğun olarak istihdam kayıpları gözlenmektedir. İlk dönemde istihdam kayıplarının başlıca nedeni imalat sektöründeki özellikle ihracata yönelik sektörlerdeki istihdam kayıplarıdır. 2018 gerileme döneminde ise işgücü piyasasındaki bozulmanın sektörler geneline yayılmış ve sanayi, imalat, hizmet ve inşaat sektörlerinde istihdam kayıplarını görülmüştür. Özellikle inşaat istihdamında yaşanan önemli kayıplar dikkati çekmiştir. Birincisine kıyasla, ikinci dönemde kamu istihdamı daha çok desteklemiştir. İşsiz kalma süresi kriz dönemlerinde artmamış ancak dönemlerden sonra yükseliş eğilimi göstermiştir. İşsizlik süresindeki artış eğilimi becerilerin aşınmasına ve işgücüne bağlanmanın zayıflamasına neden olmuştur. Bu durum durgunluklar sırasında ve / veya sonrasında cesareti kırılmış işçilerin neden arttığını açıklamaktadır.

Enflasyondaki artışa yönelik maliyet kaynaklı faktörler 2018 döneminde daha önemli hale gelmiştir. İktisadi faaliyetteki daralma ve işsizlik oranlarının yüksek seyri

enflasyon üzerindeki talep yönlü baskıları azaltmasına rağmen maliyet kaynaklı faktörler enflasyonun gerileme dönemlerinde önemli ölçüde artmasına neden olmuştur. Manşet enflasyon ilk resesyonda yüzde 12,06 ile zirveye ulaşırken, 2018 döneminde neredeyse 12 puan artarak yüzde 25,24 seviyesine çıkmıştır. Bu artışa eşlik eden çekirdek enflasyon göstergelerindeki bozulma ise daha belirgin olmuştur. 2018 döneminde enflasyon oranının bu kadar yüksek bir seviyeye çıkmasının birkaç nedeni vardır. Birincisi, Türk Lirasındaki güçlü ve ani değer kaybının fiyatlama davranışlarını bozması ve döviz kurunun fiyatlara geçişkenliğinin tarihsel ortalamalarından daha hızlı ve daha yüksek olmasıdır. İkincisi ise emtia fiyatlarının 2008 yılında çok düşmesi ve döviz kurlarının enflasyon üzerindeki olumsuz etkilerini azaltmasıdır. Ayrıca enflasyon beklentilerinde farklılaşma da bir diğer nedendir. Bu görünüm Türkiye'de talep baskısının yanı sıra maliyet faktörlerinin de enflasyonun oluşumunda belirleyici rol oynadığını göstermektedir.

Her iki dönemde de döviz kurundaki oynaklığı kontrol altına almak ve döviz kurunun enflasyonist etkisini azaltmak için para politikası duruşu sıkılaştırılmıştır. İlk dönemde enflasyondaki düşüşle birlikte faiz oranları kriz öncesi seviyelerinin oldukça altına çekildiği gözlenmiştir. Bunun nedeni gelişmiş ülkelerde faiz oranlarının çok düşük olması ve krizin etkilerinin ortadan kaldırılmaya çalışılması olabilir. 2018 dönemi için ise enflasyon oranlarındaki keskin artış faiz oranlarında da hızlı bir artışa neden olmuştur. Enflasyon oranlarının düşmesiyle birlikte merkez bankası faiz oranlarını düşürmeye başlamıştır. Maliye politikasının her iki dönemde de krizin etkilerini ortadan kaldırma eğiliminde olduğu gözlenmiştir. Ancak genel bütçe açığı ikinci dönemde daha çok artmıştır.

Politika yapıcılar için önemli etkileri nedeniyle potansiyel çıktı, çıktı açığı ve NAIRU tahmini üzerine çok sayıda çalışma bulunmaktadır. Geniş yazında tahminler elde etmek için farklı yaklaşımlar geliştirilmiştir. Beveridge ve Nelson (BN) (1981) kısıtsız bir Otoregresif Entegre Hareketli Ortalama (ARIMA) modeline dayalı bir filtre geliştirmiştir. Filtre serideki oynaklığın çoğunun eğilimdeki varyasyonla belirlendiğini döngü bileşenindeki varyasyonun sabit ve nispeten küçük olduğunu varsaymaktadır. Bu nedenle eğilim bileşeni serinin durağan olmayan davranışını açıklamaktadır. BN filtresinin aksine, Hodrick-Prescott (HP) filtresi (1981, 1997) çok düzgün bir eğilimi

ima etmektedir. Döngünün serideki varyasyonun çoğunu içerdiğini varsaymaktadır. HP filtresine benzer şekilde, Harvey (1985) ve Clark (1987) tarafından sunulan gözlenemeyen bileşenler (UC) modeli döngüsel hareketleri belirlemek için yaygın olarak kullanılan bir başka yöntemdir. Temel varsayımı seküler bileşenin rastgele bir yürüyüş kaymasını takip ettiği ve döngüsel bileşenin durağan sonlu sıralı bir Otoregresif (AR) süreç olduğudur. Bant geçiş filtresi zaman serilerini farklı frekans aralıklarına dayalı olarak farklı bileşenlere ayırmaya izin verir ve zaman serisi verilerinin spektral analiz teorisine dayanmaktadır. Yüksek ve alçak periyottaki hareketli ortalama filtrelerin kombinasyonu olarak tanımlanmaktadır. Periyotları iş döngüsünden daha büyük olan bileşenleri trend olarak, periyotları iş döngüsünden daha kısa olan bileşenleri gürültü olarak belirler. BK (1995) ve CF filtresi (2003) literatürde yaygın olarak bu tarzda kullanılan yöntemlerdendir. Daha güncel bir çalışma olan Hamilton (2017) seriyi trend ve döngüye ayırmak için alternatif bir yaklaşım önermektedir. Yaklaşımı döngüleri çıkarmak için yerel projeksiyonu kullanmaya dayanmaktadır.

Tek değişkenli filtreleme yöntemlerinin kendilerine özgü artıları ve eksileri vardır. Örneğin, HP filtresi gözlemlenen bir değişkeni eğilim ve döngüye ayırmak için kısa bir süre içinde ekonomistler ve akademisyenler arasında yaygın bir şekilde benimsenmiştir. Filtre Baxter ve Stockman (1989), Kydland ve Prescott (1990), Stock ve Watson (1990), Backus ve Kehoe (1992), Canova (1998) gibi çok sayıda çalışmada ve diğer güncel çalışmalarda kullanılmıştır. Filtre analizcilerin ihtiyaçlarını karşılama esnekliğine sahiptir (Kydland ve Prescott, 1990). Basit istatistiksel filtrelerin aksine HP filtresi ekonomik sezgiyi de içermektedir (Canova, 2007). Ayrıca filtrenin algoritması oldukça kolaydır. Ek olarak gözlenemeyen bileşenler arasındaki sıfır korelasyon ve küçük trend varyasyonları filtrenin ana varsayımlarıdır (Morley (2003), Zivot (2005)). Öte yandan Hamilton (2017) HP filtresinin sakıncaları nedeniyle asla kullanılmaması gerektiğini önermektedir. Çünkü çalışma HP filtresinin orijinal serilerle tutarsızlık gösterebilecek seriler üretebileceğini ve uç nokta sorununun yanı sıra doğru düzleştirmesi parametresi değerinin seçilmesiyle ilgili endişelerden bahsetmektedir. Yazar mevsimsel olarak düzeltilmemiş verilere herhangi bir sıklıkta uygulanabileceğinin yanı sıra model ve varsayımlardan bağımsız olduğu için kendi önerdiği filtrenin HP filtresinden daha üstün olduğunu vurgulamıştır.

Genel olarak, tek değişkenli filtreler basit kullanım kolaylığına sahip oldukları ve herhangi bir varsayım ve herhangi bir yapısal ekonomik model gerektirmedikleri için çekicidir. Ancak, tamamen istatistiksel teknikler olarak kabul edilirler ve Okun yasası ve Philips eğrisi gibi ekonomik ilişkileri içermezler. Dahası, son nokta tahminleriyle ilgili sorunları vardır. Bu sebeplerden ötürü çıktı açığının ve NAIRU'nun ekonomik yorumunu yakalamak için yazında önemli bir miktarda çok değişkenli filtre geliştirilmiştir. Çok değişkenli filtre denklem sistemleri altında potansiyel çıktıyı ve NAIRU'yu aynı anda tahmin eder. Laxton ve Tetlow (1992), Kuttner (1994) ve Butler (1996) potansiyel çıktıyı ve NAIRU'yu birlikte tahmin eden çok değişkenli bir filtre oluşturmak için yapılan ilk çalışmalardandır. Daha sonra Benes ve diğ. (2010) ekonomi teorisi ile tutarlı sonuçlar üretmek için ABD ve Euro bölgesi ile birlikte 10 ülke için potansiyel çıktı ve NAIRU ölçmek için enflasyon, işsizlik ve kapasite kullanımı ile ilgili verileri içeren bir model geliştirmişlerdir. Parametreleri anlamsız bölgelerin dışında tutmak için Bayes metodolojisinde yer alan düzenlenmiş maksimum olasılık (Ljung, 1999) yöntemini kullanmışlardır. Çalışmanın temel amacı potansiyel GSYİH, işgücü piyasası durgunluğu, çekirdek enflasyon ve kapasite kullanımı arasındaki ilgili ampirik ilişkileri dahil eden bir model geliştirmektir. Bu yöntemin HP filtresine göre karşılaştırmalı üstünlüğü olduğu sonucuna varmışlardır. Blagrave ve diğ. (2015) çalışması GSYİH ve enflasyon tahminlerinin modelde kullanılmasının örnekleme döneminin sonundaki tahminleri iyileştirebileceğini göstermişlerdir. Önceki çalışmaları takip eden Alichi ve diğ. (2018) filtrenin sağlamlığını ve güvenilirliğini artırmak için modelin içine Philips eğrisi, Okun yasası ile birlikte para politikası bloğunu dâhil etmişlerdir. Hansen ve diğ. (2019) ise cesareti kırılmış işçileri dikkate alarak daha geniş tanımlı işsizlik oranına modellerinde yer vermişlerdir. Buradaki mantık geleneksel işgücü piyasasındaki durgunluğun Kore ekonomisi için işsizlik oranı ile enflasyon arasındaki kesin ilişkiyi yansıtmamasıdır. Önerilen filtrelerinin geleneksel işgücü piyasası gevşekliği kullananlara kıyasla daha fazla negatif çıktı açığı tahmini sağladığını bulmuşlardır. Blanchard ve Summers (1986) ve Ball (2009) şokların histerezis etkisi olduğunda geçici şokların kalıcı çıktı kayıpları yaratabileceğini söylemişlerdir. Böylece uzun ve derin durgunlukların becerilerde bozulmaya ve işgücü piyasasına bağlanmada zayıflamaya neden olduğunu belirtmişlerdir. Bunların potansiyel çıktı kaybını kademeli olarak beslediği ifade etmişlerdir. Bu fikrin ardından Alichi ve diğ. (2019) histerezis etkisini içeren yeni bir

model geliştirmişlerdir. Histerezisin NAIRU ve çıktı açığında çok daha büyük dalgalanmalar yarattığını bulgulamışlardır. Borio ve diğ. (2013) enflasyon oranı, işsizlik oranı ve kapasite kullanım oranına ek olarak potansiyel çıktıyı belirleyen modele finansal değişkenlerin dâhil edilebileceğini çünkü düşük enflasyon oranı olsa bile finansal dengesizlikler var olduğunda potansiyel çıktının sürdürülebilir olmayabileceğini belirtmişlerdir. Çıktı açığı hakkında daha güvenilir tahminler elde etmek için finansal değişkenler olarak kredi büyümesini, reel faiz oranlarını ve konut fiyatlarını kullanmışlardır. Finansal faktörlerin potansiyel çıktıları ve bunları içeren çok değişkenli filtrenin türetilmesinde kilit bir rol oynaması ve gerçek zamanlı olarak daha sağlam tahminler vermesi çalışmanın ana sonuçları arasındadır. Finansal göstergelere ek olarak ticaret dengesi, ticarete konu olan ve olmayan sektörler Philips eğrisi yoluyla enflasyon ve işsizlik üzerinde aşırı talep yaratma açısından farklılaşabildiğinden potansiyel çıktının belirlenmesi için önemli olabilmektedir. Ticarete açık sektörlerde aşırı talebinin etkisi ticaret ile absorbe edilebilirken ticarete konu olmayanların aşırı talebi enflasyon üzerinde daha fazla yukarı yönlü baskı oluşturabilmektedir. Bu nedenle Darvas ve Simon (2015), temel modele cari hesap bloğunu eklemiştir. Gözlemlenmemiş bileşen modelleri çerçevesinde maksimum olasılık tahmin tekniğini kullanarak 45 ülke için bir model tahmin etmişlerdir. Potansiyel çıktıyı elde etmede cari hesap denkleminin Philips eğrisinden daha önemli olduğunu bulgulamışlardır.

Türkiye'de 2000'li yılların başından itibaren veri birikimi sayesinde benzer çalışmalar başlatılmıştır. Sarıkaya ve diğ. (2005) parametrenin zaman içinde değişmesine izin vermek için genişletilmiş bir Kalman filtre tekniğini kullanarak Türkiye için çıktı açığını tahmin etmişlerdir. Türkiye için yükselme ve gerileme döngülerini yakalamak açısından filtrelerinin HP filtresi gibi tek değişkenli filtrelere göre üstünlüğü olduğunu belirtmişlerdir. Benzer bir çalışma olarak Öğünç ve Ece (2006) modelde arz tarafının kullanılmasının parametre belirsizliğini azalttığı ve Türkiye için çıktı açığı tahminini iyileştirdiği sonucuna varmışlardır. Kara ve diğ. (2007) de Türkiye'nin çıktı açığını tahmin etmeye çalışmışladır. Genişletilmiş Kalman filtresi yaklaşımı ile parametrelerin zaman içinde değişmesine izin vermişlerdir. Daha sonraki çalışmalar çıktı açığını tahmin etmek için daha çeşitli yöntemler kullanmışladır. Örnek olarak Öğünç ve Sarıkaya (2011) yeni Keynesyen model çerçevesinde Bayesçi teknikleri

kullanarak 2002-2010 dönemi için çıktı açığını tahmin etmişlerdir. Çalışma 2008-2009 yılında yaşanan uzun resesyon döneminin bu dönemde enflasyon üzerinde aşağı yönlü baskı oluşturduğunu göstermiştir. Ayrıca, yazarlar ekonominin iş döngüsünü değerlendirirken para politikasının toplam talebin iç ve dış dinamiklerini dikkate alması gerektiğini vurgulamışladır. Ek olarak enflasyona yönelik geriye dönük endeksleme eğiliminin yüksek olduğunu ve küresel büyümenin çıktı açığının kilit değişkeni olduğunu bulgulamışladır. Bu çalışmanın ardından Alp ve diğ. (2012) Bayes metodolojisini kullanarak 2002ç1-2011ç3 dönemi için yeni Keynesçi küçük açık ekonomi çerçevesinde Türkiye için iç ve dış çıktı açığı bileşenlerini birlikte tahmin etmişlerdir. Bulguları küresel krizin olumsuz etkilerini hafifletmek için ekonomiye verilen bazı teşvikler nedeniyle ihracat bileşeninin bir süre düşük kaldığı ancak yurt içi tarafın potansiyeline daha kısa sürede yaklaştığı ve toplam talep bileşenlerinin farklılaştığıdır. Bu nedenle para politikasının bu farklılıkları dikkate alması gerektiğini öne sürmüşlerdir.

Sonraki iki çalışma veri kaynağı açısından öncekilerden farklılık göstermektedir. Son nokta sorununu ortadan kaldırmak ve iş döngüsü tahmininde daha zamanlı sonuçlar elde etmek için anket göstergelerini kullanmıştır. İlk çalışma olarak Coşar ve diğ. (2013) 2005ç1-2013ç1 dönemi için bir çıktı açığı göstergesi tahmin etmiştir. Prosedürleri iki aşamadan oluşmaktadır. İlk aşamada, iş döngüleri için bilgilendirici olabilecek değişkenleri seçmişlerdir. Daha sonra kapasite kullanım oranı, satın alma gücündeki değişim, siparişlerin normallerine göre düzeyi, siparişlere ve beklenen talebe göre üretim kapasitesinin yeterliliği gibi seçilmiş değişkenleri kullanarak küçük dinamik faktör modeli çerçevesinde iş döngüsünü tahmin etmişlerdir. Filtresiz ölçümlerinin HP filtresinden daha üstün olduğu sonucuna varmışlardır. İkinci çalışma, Şahinöz ve Atabek (2016)'e aittir. İşletme düzeyinde mikro verileri kullanarak iş döngüsünün durumunu değerlendirmek için alternatif bir ölçü önermişlerdir. Köberl ve Lein (2011) 'in yöntemini örnek alarak kapasite kullanım açığını çıktı açığına alternatif bir gösterge olarak görmüşlerdir.

Andıç (2018), Blagrave ve diğ. (2005) çalışmasını örnek alarak Türkiye için çok değişkenli bir filtre oluşturmuştur. Andıç (2018) çeyreklik verileri ve yöntem olarak maksimum olasılığı (ML) kullanırken, Blagrave ve diğ. (2015) yıllık verileri ve

Bayesçi yöntemi benimsemiştir. Bulguları, Öğünç ve Sarıkaya'da (2011) olduğu gibi küresel finansal kriz sırasında potansiyel büyümenin önemli ölçüde düştüğünü daha sonra iyileştiğini göstermektedir. Çelgin ve Yılmaz (2019) aylık olarak izlenebilen alternatif çıktı açığı göstergesini ortaya koymuşlardır. 2006ç1-2018ç4 dönemi için talep göstergelerini TÜFE'de yer alan 4 ve 5 basamaktaki alt kalemler ile eşleştirmişlerdir. HP filtresini kullanarak sektörel çıktı açığı serisini teker teker elde ettikten sonra toplulaştırılmış çıktı açığı göstergesini türetmişlerdir. Çalışma politika yapıcıların diğer makroekonomik değişkenlerin yanı sıra sektörel faktörleri de dikkate almaları gerektiğini öne sürmektedir.

Potansiyel çıktı ve çıktı açığı tahminlerine benzer şekilde para politikasının enflasyon oranı üzerinde yukarı ve aşağı yönlü baskıların olup olmadığını anlamak için kilit bir değişken olan NAIRU tahmini literatürde büyük bir paya sahiptir. Yukarıda belirtildiği üzere NAIRU küçük makroekonomik model çerçevesinde çok değişkenli bir filtre kullanılarak potansiyel çıktıyla birlikte türetilebilir (Benes ve diğ., 2010; Blagrave ve diğ., 2015; Alichi ve diğ., 2018; Alichi ve diğ., 2019). NAIRU'nun Türkiye tahminlerine gelince ise oldukça az çalışma olduğu görülmektedir. Us (2014) Türkiye için NAIRU'yu Genişletilmiş Kalman Filtresini (EKF) kullanarak tahmin etmiştir. Model Philips eğrisine ve Okun yasasına dayanmaktadır. NAIRU'nun gerçek işsizlik oranından daha oynak olduğunu ve 2008 krizi sırasında daha sert tepki verdiği çalışmada anlatılmaktadır. İşsizlik ve enflasyon arasındaki zayıf bağlantı, enflasyondaki önemli geçişkenlik ve katılık çalışmanın temel bulgularıdır.

Bizim çalışmamızın ampirik literatüre temel katkıları üç yönlüdür. İlk olarak Türkiye ekonomisi üzerine yapılan önceki çalışmalarda döngüleri çıkarmak için enflasyon, çıktı ve işsizlik oranı verileri kullanılmaktadır. Değişkenlerin iş döngüsü koşullarının belirlenmesi konusunda önemli bilgilere sahip olmalarına rağmen kapasite kullanım oranın çıktı açığı ve NAIRU tahminlerinde yardımcı olabileceği düşünülmektedir. Bu düşünce doğrultusunda bu çalışmada yer alan model kapasite kullanım blokunu içererek Türkiye ekonomisi üzerine yapılan diğer çalışmalardan farklılaşmaktadır. Bu iyileşme Türkiye'nin gerileme dönemlerinde üretim, kapasite kullanımı ve işsizlik oranının döngüsel seyrini karşılaştırmamızı sağlamaktadır. İkinci olarak çalışma çok değişkenli filtreleme tahminlerini artılarını ve eksilerini göz önünde bulundurarak

oldukça geniş çerçevede tek değişkenli filtreleme tahminleriyle karşılaştırma imkânı vermektedir. Son olarak sonuçlarımızın maliye ve para politikaları üzerinde de yararlı sonuçlar doğuracağına ve uygulanacak her türlü politikaya uyarlanabilir olduğuna inanılmaktadır.

2005ç1-2019ç4 dönemi için çeyreklik bazda reel gayri safi yurtiçi hasıla, reel yurt içi talep, reel mal ve hizmet ihracatı, reel mal ve hizmet ithalatı, çekirdek tüketici enflasyon göstergesi (D endeksi), ithalat fiyatları (TL cinsinden), nominal döviz kuru sepeti, reel birim iş gücü maliyeti, Brent petrol fiyatları, işsizlik oranı, reel efektif döviz kuru, reel ticari kredi oranları, ihracat ağırlıklı küresel büyüme endeksi ve kapasite kullanım oranı verileri çıktı açığı ve NAIRU serilerini tahmin etmek için kullanılmıştır.

Benes ve diğ. (2010), Blagrave ve diğ. (2015), Alichi ve diğ. (2015, 2019) çalışmaları izlenerek çıktı açığı ve bileşenleri, kapasite kullanım oranı, enflasyon, işsizlik oranı ve bazı değişkenler için rasyonel beklenti oluşumunu içeren yeni Keynesçi küçük açık ekonomi model çerçevesinde bu çalışmada çok değişkenli bir filtre türetilmiştir. Modelimiz, Philips eğrisi gibi yapısal denklemlerden, makroekonomik motivasyonla oluşturulmuş dinamik Okun yasasından, çıktı açığı ve kapasite kullanım oranı ile bağlantılı denklemlerden oluşmaktadır. Çok değişkenli filtrenin türetilme aşaması dört bloktan oluşmaktadır. İlk blok çıktı bileşenleri kullanılarak çıktı açığı denkleminin nasıl oluşturulduğunu göstermektedir. İkincisi enflasyon ve çıktı açığı ile bağlantılı Philips eğri denklemini göstermektedir. Üçüncüsü dinamik Okun yasasını içermektedir. Sonuncusu ise işsizlik açığının içermediği durgunluğu yakalayabilecek ve çıktı açığı ile yüksek korelasyona sahip kapasite kullanım açığının yer aldığı denklemlerden oluşmaktadır. Bu çalışmada ML tahmin prosedürü yerine gözlemlenemeyen değişkenler elde etmek için Bayes metodolojisini kullanmasının birkaç nedeni vardır. ML tahmini bilinmeyen parametrelere göre olabilirlik fonksiyonunu maksimize eder. Örneklem boyutu yeterince büyükse bu güçlü bir teknik olabilir. Bununla birlikte, örneklem büyüklüğü kısıtlı ve model yanlış tanımlanmışsa yöntem yanlış sonuçlar doğurabilir. Bayes metodolojisinde ise modelde önceki dağılımların kullanılması parametrelerin makul alanlarla sınırlandırılmasına

yardımcı olabilir ve ML tahmininde karşılaşılan sorunların üstesinden gelebilir. Dahası, modele uzman görüşünü dâhil etmek oldukça kolay ve pratiktir.

Model sonuçlarına göre 2018 gerilemesinde çıktı açığı küresel finansal kriz dönemine göre daha az negatiftir. 2008 döneminde uluslararası kredi piyasalarındaki çalkantı ve küresel ekonomik görünümün beklentilerindeki bozulma ekonomideki yavaşlamayı yoğunlaştırmış ve hem iç hem de ihracat talebini sınırlamıştır. Çünkü ihracat yapısına bakıldığında Türkiye büyük ölçüde mamul ürünlerin ihracatçısı olan bir ülkedir. İhracatta otomotiv, makine, ulaşım araçları, demir-çelik ürünleri yüksek paya sahiptir. Küresel kriz sırasında dış talebin önemli ölçüde azalmasına neden olan krizden en çok etkilenen ülkeler bu tür ürünleri Türkiye'den ithal eden ülkeler olmuştur. Son dönemde finansal dalgalanma nedeniyle önemli ölçüde güçlenen belirsizlik algısı ve sıkı finansal koşullar yurt içi talebi baskılamış, kredi ivmesi ve reel ücretlerdeki düşüş ve istihdam olanaklarının kötüleşmesi işsizliği artırmıştır. Bu nedenle, ekonomik aktivitedeki yavaşlama iç talep kaynaklı olmuştur. Öte yandan, net ihracat TL'deki uzun vadeli değer kaybı nedeniyle artan rekabet gücü ve dönem boyunca pazar çeşitlendirmesinin esnekliğinin artması sayesinde iç talepteki yavaşlamayı telafi etmiştir. 2018-4 sonrasında kredilerdeki önemli hızlanma, risk priminde, döviz kuru oynaklığında ve belirsizlik göstergelerinde göze çarpan iyileşme iç talebi desteklemiştir. Her iki dönemde de toplam talep koşulları enflasyondaki düşüş sürecine katkı sağlamaktadır. Küresel ekonomik kriz sırasındaki şok talep şoku iken, son şok bir maliyet şokudur. Şokların farklılaşması yavaşlamanın ardından farklı gelişmelere yol açmıştır. Birinci dönemde çıktı açığı kapandığında enflasyon ılımlı bir seyir izlemiş ve literatürde yer alan ilahi-tesadüf (divine-coincidence) söylemiyle uyumlu bir görüntü çizilmiştir. İkinci dönemde ise çıktı açığı kapanırken bir süre daha enflasyonun arttığı gözlenmiştir.

Potansiyel büyüme her iki dönemde de azalmıştır fakat birinci dönemdeki gelişmeler ekonominin potansiyelini ikinci döneme kıyasla daha aşağı çekmiştir. Ancak ikinci dönemde potansiyel büyümedeki düşüşün gerileme dönemi bittikten sonra bir süre daha düşmeye devam ettiği gözlenmiştir. Bunun nedenlerinden birinin işsizlik oranlarının 2019ç3'e kadar artmaya devam etmesi olduğu düşünülmektedir.

Son dönemde çıktı açığı daha az gerçekleşmiş olsa da her iki dönemde de işsizlik oranı ve NAIRU birlikte hareket ederek keskin bir şekilde artmış ve tarihsel olarak en yüksek seviyeye çıkmıştır. Küresel finansal kriz döneminde işgücü piyasasında istihdam kayıpları ağırlıklı olarak sanayi sektöründe gerçekleşirken son dönemde istihdam kayıpların sektörel bir yayılım göstermiştir. Dönemler sırasında ve sonrasında işsizlik oranı uzun bir süre eğilimin üzerinde kalmıştır.

Çıktı açığı, işsizlik açığı ve kapasite kullanım açığı ile ilgili çok değişkenli filtre tahminleri mal piyasasının işgücü piyasasını ve sanayi sektöründeki gelişmeleri öncelediğini göstermektedir. Mal piyasasındaki toparlanmanın diğer piyasalara göre daha erken başladığı görülmektedir. Bu durumun nedeni Coşar ve Yavuz'un (2019) da belirttiği gibi firmalar iktisadi faaliyetteki toparlanmanın sürdürülebilirliğine bağlı olarak işe alım zamanını belirlemesi ve kapasite kullanım oranını arttırmasıdır. Küresel finansal krizinde zayıflayan dış talep ve sanayi sektörünün kompozisyonu nedeniyle ilk dönemde kapasite kullanım oranındaki gerilemenin ikinci döneme kıyasla daha çok olduğu izlenmiştir. Sonuç olarak işgücü piyasası bu çalkantılardan en olumsuz etkilenen sektör olmuştur.

Bizden sonraki çalışmaların bizim yöntemimizi çeşitli şekillerde genişletebilir. Modelimiz birçok makroekonomik ilişkiyi dâhil etmeye çalışmasına ve kapsayıcılığı yüksek olmasına rağmen mali duruş, kredi büyümesi, konut fiyatları gibi bazı makroekonomik değişkenlere gelecek modellerde yer verilebilir. Türkiye ekonomisinde önemli bir yere sahip dış ticaret gelişmelerini kapsayacak şekilde model cari işlemler denklemi ile de genişletilebilir. Bu tür uzantıların modelin gerçek zamanlı tahminlerinin güvenilirliğini artıracağına ve politika seçimine yardımcı olacağına inanılmaktadır.

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YAZARIN / AUTHOR

Soyadı / Surname : GÖKCÜ
Adı / Name : Mert
Bölümü / Department : İktisat/Economics

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