ESTIMATING THE OUTPUT GAP FOR TURKEY: 
A SIMPLE PRODUCTION FUNCTION APPROACH

MURAT ÜNGÖR

Research and Monetary Policy Department
Central Bank of the Republic of Turkey

ABSTRACT

This paper estimates an output gap measure for Turkey using a production function approach relying on a simplistic representation of the production technology. There is a large positive swing in the output gap during 2005–2008 and output gap reached its peak in 2007:Q4. Output level fell below its potential dramatically as a result of the global economic crisis in 2009 hitting a trough in 2009:Q1 and negative output gap as a percentage difference from the potential output was around 12%. Output gap estimates in this study and the ones obtained in Alp, Öğünç, and Sarıkaya (2012), using Bayesian estimation of a New Keynesian model, exhibit a similar pattern qualitatively, whereas there are some differences in quantitative terms.

Keywords: Output gap, production function, Turkey.

JEL classification numbers: E23, E32, E58.

Correspondence: Murat Üngör, Research and Monetary Policy Department, Central Bank of the Republic of Turkey, İstiklal Caddesi 10, Ulus, 06100 Ankara, Turkey. E-mail address: Murat.Ungor@tcmb.gov.tr. The author wishes to thank Harun Alp, Cengiz Cihan, Ufuk Demiroğlu, Mahmut Günay, and Şeref Saygılı for sharing data and Mustafa Kılınç for fruitful discussions. The views expressed herein are those of the author and not necessarily those of the Central Bank of the Republic of Turkey.
I. INTRODUCTION

Turkey has grabbed the attention of international economics as the country has shown high growth rates in recent years. Today, Turkey is an upper middle income country with a population around 75 million and a gross domestic product around US$800 billion, making it the 16th largest economy in the world. Turkey’s GDP growth rate in 2010 averaged about 9% ranking it in first place in Europe and it accelerated to 11% in the first quarter of 2011 outpacing China’s growth rate.

The recent economic performance of the Turkish economy provides motivation for the measurement of output gap in Turkey to be used for forecasting and policy simulations. For example, reasonably accurate output gap estimates are necessary to conduct monetary policies since central bankers would like to know the size of the gap between actual and potential GDP, so as to determine whether the economy needs more or less monetary stimulus. This paper presents a simple way of output gap calculation for Turkey based on the production function and the HP filtering.¹

II. METHODOLOGY AND DATA

A production function states a relationship between inputs (like labour and capital) and output (goods and services combined). The production function approach models potential output as a function of potential labour and capital inputs, as well as of potential total factor productivity (TFP). Therefore, output gap measures how far the economy is from its full employment or

potential level that depends on supply-side factors of the economy: the supply of labour and capital and their productivity. Output gap is defined as the percentage difference between actual and potential output:

\[
\text{Output gap} = 100 \times \frac{\text{Actual output} - \text{Potential output}}{\text{Potential output}} \tag{1}
\]

and actual output is given by:

\[
Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \tag{2}
\]

where \(Y_t\) represents real gross domestic product (GDP), \(A_t\) is TFP, \(K_t\) is real physical capital stock and \(L_t\) is employment at date \(t\); \(\alpha\) and \((1 - \alpha)\) are the elasticities of output with respect to capital and labour, respectively. Similarly, potential output is given by:

\[
Y_t^* = A_t^* K_t^{*\alpha} L_t^{*1-\alpha} \tag{3}
\]

where \(Y_t^*\) represents potential GDP, \(A_t^*\) is potential TFP, \(K_t^*\) is potential physical capital stock and \(L_t^*\) is potential employment at date \(t\).

The idea is, using minimum available information on the supply side of the economy (total employment and physical capital), to infer useful information for measuring the output gap for the Turkish economy. In this regard, this study departs from traditional production function approach in which labour variable (rather than employment) is estimated by taking into account
labour supply (usually linked to working-age population growth, participation rate and working hours) and NAIRU (or structural unemployment rate), and capital stock variable is used as actual values or corrected by using capacity utilization rates.²

Capital stock, employment, and real GDP data are from Saygılı and Cihan (2011). Saygılı and Cihan (2011) have seasonally adjusted quarterly data between 1988:Q1 and 2011:Q2. This sample period is extended to 2014:Q4 to avoid end-sample biases, which reflect the symmetric trending objective of the method across the whole sample and the different constraints that apply within the sample and at its edges.³ The next step is calculating TFP series using capital stock, employment, and real GDP data:

\[ A_t = Y_t / \left( K_t^{\alpha} L_t^{1-\alpha} \right) \quad (4) \]

where \( \alpha = 0.5 \) is used following Saygılı and Cihan (2011).⁴

Then, using a growth accounting method, the contributions of capital, labour, and TFP into real GDP growth are calculated.⁵ It is assumed that these calculated contributions for the period 2002:Q1-2011:Q2 will be valid through 2014:Q4. Next, using the forecasts for quarter-on-quarter growth rates of GDP, consistent with the official forecasts, the real GDP series are extended to 2014:Q4. After that, the growth contributions of capital, labour, and TFP for the

---

² Saygılı and Cihan (2008) study such a production function approach and report potential and actual growth rates between 1987 and 2007. The potential output estimates, using annual capital and employment data, obtained in this paper are compared with the ones obtained in Saygılı and Cihan (2008), who use capacity utilization rates, average working hours, and NAIRU figures to calculate potential output. The results are very similar.

³ This flaw is particularly severe when the focus of attention is directed at the most recent observations in the sample in an effort to draw conclusions for policy implementation and make projections for the immediate future (see, for example, Cerra and Saxena, 2000).

⁴ See Ismihan and Metin-Ozcan (2009) on the value of capital income share in Turkey.

⁵ This growth accounting exercise is carried out with annual data (with human capital input) as well. The results are available upon request.
period 2011:Q3-2014:Q4 are used to extend these series until the last quarter of 2014. Now, capital, labour, TFP, and real GDP series for the period 1988:Q1-2014:Q4 are available to be used for calculations. Potential output cannot be measured directly and therefore must be estimated. The HP filter is applied, using the standard value of 1600 for the smoothing parameter, to actual capital, labour, and TFP series separately. Then, the trends underlying the series of actual labour as potential labour input, actual capital as potential capital input, and actual TFP for potential TFP are used. Fig. 1 provides actual and potential data for capital, labour, and TFP for the period 2003:Q1-2014:Q4.

Fig. 1. Actual and potential series, 2003:Q1 = 100
Actual TFP growth exceeds the estimated potential TFP growth by a wide margin during between 2003 and 2008. Ismihan and Metin-Özcan (2009) list four factors that could have been responsible for the speed-up in TFP: (i) successful reduction of the inflation rate, fiscal discipline, and the resultant stable macroeconomic environment; (ii) institutional reforms to the central bank and public-sector spending and structural reforms to the financial sector; (iii) the relatively stable political and external environment; and (iv) the prospect of possible EU membership. Finally, potential employment ($L^*_t$) and potential capital ($K^*_t$) inputs and potential TFP ($A^*_t$) in equation (3) are used to estimate potential output.

III. OUTPUT GAP

Fig. 2(a) presents quarter-on-quarter growth rates for potential output and Fig. 2(b) displays the output gap estimates based on the production function for the period 2003:Q1-2014:Q4. There is a large positive swing in the output gap during 2005–2008. Output gap reached its peak in 2007:Q4 and output level fell below its potential dramatically as a result of the global economic crisis in 2009. Output level hit a trough in 2009:Q1 and negative output gap as a percentage difference from the potential output was around 12%. After the crisis, Turkish economy has entered a rapid recovery period. In the succeeding period output gap has started to decline compared to the year of 2009, the negative gap closed indicating the contribution of output gap to disinflation process has been diminishing compared

---

6 Since 2001, Turkey has put in place a very intense and ambitious structural reform agenda, coupled with sound monetary and fiscal policies, to establish macroeconomic and financial stability and to improve the business environment.

7 An alternative way in the literature to calculate potential output is assuming that potential capital equals the actual total capital stock (see, for example, Konuki, 2008). Output gap is also calculated with actual physical capital series as potential capital stock. The results are very similar.
to the global crisis era. These output gap estimates point out similar expansion and recession periods and are close to previous studies by Saygılı and Cihan (2008), Öğünç, and Sarıkaya (2011), and Alp et al. (2012).

Fig. 2(c) compares the output gap estimated in this paper with the findings of a recent study for the period 2003:Q1-2011:Q3. Alp et al. (2012) estimate an output gap measure for Turkey in a Bayesian framework considering a stylized New Keynesian small open economy model that describes the joint determination of output gap, its domestic and external components along with inflation. Fig. 2(c) reveals that, the output gap estimates in this study and the ones obtained in Alp et al. (2012) exhibit a similar pattern qualitatively, whereas there are some differences in quantitative terms. For example, it is estimated that output level hit a trough in 2009:Q1 and negative output gap as a percentage difference from the potential output was 11.84%. The corresponding figure in Alp et al. (2012) is 11.71%.

Fig. 2(d) provides alternative estimates of output gap using different smoothing parameter for the HP filter since a possible shortcoming of using the HP filter is the difficulty in identifying the appropriate smoothing parameter, which is generally overlooked by using arbitrary values popularized by the real business cycle literature. Alp et al. (2011) estimate the optimal smoothing parameter for the HP filter for Turkey using quarterly real GDP data between 1987 and 2007. They come up with two alternative estimates (compared to 1600, which is the benchmark smoothing parameter used in this study): 19 and 98. Therefore, the calculations are replicated to see the sensitivity of the results with respect to the smoothing parameter. It is observed that the qualitative nature of the results is similar. However, the smaller the value of the smoothing
parameter, the closer the output gap to zero. If 19 (98) is used as the value of the smoothing parameter, then output level hit a trough in 2009:Q1 and output gap was -7.66% (-9.47%).

Fig. 2. Actual and potential output

IV. CONCLUSIONS

This study can be considered a preliminary step to measure the output gap for the emerging market economies using minimum available information on the supply side of the economy. Any method of estimating potential output depends on numerous assumptions that are subject to
uncertainty and error. The approach in this study relies on a simplistic representation of the production technology omitting the direct information regarding the related supply-side factors such as capacity utilization, hours worked, labour force participation rate, technology adoption, regulation, human capital accumulation, etc. in addition to the alternative filtering methods.

However, the obtained results are fairly comparable with the ones obtained in more complicated studies (see Fig. 2(c)) suggesting that the approach used in this paper could be useful as an alternative method of output gap estimation for Turkey and, possibly, for other emerging market economies.

REFERENCES


