OUTPUT GAP ESTIMATION FOR THE CASE OF TURKEY

A Master's Thesis

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ABSTRACT

OUTPUT GAP ESTIMATION FOR THE CASE OF TURKEY

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This study investigates the output gap estimation using dynamic, stochastic, and general equilibrium models. In macroeconomics, output gap is defined as the difference between the actual output and the potential output. Actual output refers to the GDP, which measures the monetary value of the total production in the domestic economy in a certain time period. Potential output is the maximum amount of production that can be reached with the available resources and technology. Potential output is measured by HP-Filtering and DSGE methods. In this thesis, these methods are used to estimate the maximum output gap for the Turkish Economy. It is shown that both these methods predict the maximum output gap accurately. In particular, Csminwel and Monte-Carlo simulation methods are used to obtain the maximum output gap between the first quarter of 2005 and the second quarter of 2014.

Keywords: Output Gap Estimation, Smets-Wouters Model, Monte-Carlo Simulation, Csminwel method, HP-Filter.

ÖZET

TÜRKİYE'DEKİ ÜRETİM ÇIKTISI AÇIĞI'NIN TAHMİN EDİLMESİ

AYTAÇ, ALİCAN

Yüksek Lisans, Ekonomi Bölümü

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Bu tez, dinamik, stokastik genel denge modelleri kullanarak üretim çıktısı açığının tahmin edilmesi üzerinde durmaktadır. Makro İktisat'ta, üretim çıktısı açığı; üretimin asıl değeri ile potansiyel değeri arasındaki fark olarak tanımlanır. Üretimin asıl değeri, belirli bir zaman diliminde bir ülke sınırları içerisinde gerçekleştirilen toplam üretimin parasal değeri olan Gayri Safi Yurtiçi Hasıla'dır. Üretimin potansiyel değeri ise, bir ülke sınırları içerisinde; var olan kaynaklar ve teknoloji kullanılarak gerçekleştirilebilecek maksimum üretim miktarıdır. Potansiyel üretim değeri, HP-Filtrelemesi ve DSGE yöntemleriyle hesaplanmaktadır. Bu tezde, bu iki yöntem de Türkiye'deki çıktı açığını hesaplamak için kullanılmaktadır. Bu iki yöntemin de gösterdiğine göre, maksimum çıktı açığı, doğru bir şekilde tahmin edilmektedir. Özellikle, Csminwel ve Monte-Carlo simulasyonu yöntemleri kullanılarak, 2005'in 1. çeyreği ve 2014'ün 2. çeyreği arasındaki maksimum çıktı açığı hesaplanmıştır.

Anahtar Kelimeler: Üretim Çıktısı Açığı Tahmini, Smets-Wouters Modeli, Monte-Carlo Simülasyonu, Csminwel Yöntemi, HP Filtrelemesi.

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CHAPTER 1

INTRODUCTION

In macroeconomics, output gap is simply defined as the difference between the Gross Domestic Product(GDP) and the potential output. GDP is the monetary value of the aggregate production that takes place in the boundaries of a country, whereas the potential output is the maximum amount of production that can be realized with the available resources and technology. Output gap is used for several purposes in macroeconomic theory. To evaluate the economic performance of any country, we need to know whether economy is growing or shrinking. In particular, the estimation of the output gap accurately is necessary for the conduct of monetary policy.

There are several methods to estimate the output gap. In one method, one directly estimates the potential output using a microeconomic production function approach. Once potential output is estimated accurately, we can simply get the difference between actual and the potential output by this approach. However, it has been suggested in [Vetlov, 2011] that shocks affecting the economy at business cycle frequencies are overlooked in the estimation of the potential output. Another difficulty lies in specifying the appropriate production function.

This shortcoming of the microeconomic production function approach can potentially be overcome by the DSGE method to estimate the output gap. One of the key problems in this approach is to set the prior values for the parameters in consideration. Even a minuscule amount of change in the parameters could alter the result. Therefore, we need to be able to choose the initial values in a way that best reflects the country-specific properties of the data. This choice of initial values can be based upon the estimates derived in prior studies or on the posterior values computed during an estimation of the output gap.

In addition to the models that employ economic theory, there also exist econometric methods that are used to estimate the output gap such as HP and Kalman Filtering. The HP Filter minimizes the squared distance between the actual output and the lagged output subject to the growth rate of trend output for the whole sample of observations. As a result, it gives a smooth estimate of the output gap. In Kalman Filter approach, the model is built in a state space form and the unobserved variables are estimated with a recursive formulation. These are useful methods, but we need to incorporate economic theory into them. Moreover, there may be an end sample bias in the HP-Filter. In other words, estimates of trend output could be affected by the recent developments in the actual output. Nonetheless, such estimates are still important, since they can form a benchmark for comparison.

There are examples of HP-Filter output-gap estimates for the case of Turkey, but that of output-gap estimates based on DSGE model are relatively few.

The model that we use to carry out the output gap estimation for Turkish Economy is the New Keynesian model. We solve the utility maximization problem for households subject to the inter-temporal budget constraint, using sticky price and flexible price economies. The flexible price economy is based on the assumption that there exists a perfect competition in the markets. In a sticky price economy, prices are set in a monopolistically competitive environment. The output we obtain for the flexible price economy is the potential output and the one we obtain for the sticky price economy is the actual output.

In the rest of the thesis, a survey of the relevant work and the output gap estimation of the Turkish Economy will be presented.

CHAPTER 2

LITERATURE SURVEY

The DSGE model was first introduced by Kydland and Prescott in 1982 to determine the effect of shocks on business cycles. The New Keynesian version of the DSGE model was subsequently developed by Rotemberg and Woodford in 1997 to investigate similar effects in a monopolistically competitive economy. In 2002, Smets and Wouters extended the DSGE model to study the business cycle fluctuations in the Euro Zone. They developed their model further to study the business cycle fluctuations in the US and the Europe in 2005.

[Smets & Wouters, 2002] deals with the Euro Zone over the period 1970-1999 with a quarterly data. In the model they use, there is a continuum of households, each of whom has a monopoly power over their labor supply. They use the linearized equations to estimate the model with the data for real GDP, real consumption, real investment, real GDP deflator, real wages, employment and the nominal interest rate. They introduced five supply and demand shocks when prices and wages are flexible. What they found is that there is a high degree of price stickiness in the Euro Zone, and prices adjust slowly to changes in marginal costs. Using a price setting equation, they determined that the forward looking component of inflation dominates.

Their model is an important contribution to the literature in terms of the evaluation of the effect of forward looking pricing behavior on monetary policy. It is a good model to analyze the sources of business cycle fluctuations, but they do not make a distinction between potential output and natural output. Potential output is estimated under the assumption that all markets are perfectly competitive, whereas natural output is estimated under the assumption of imperfect competition with flexible prices and wages.

[Justiniano & Premiceri,2008] study the US business cycle with a model similar to that of [Smets & Wouters, 2002], but they employ two different notions as potential output and natural output. They assume that, there is a perfect competition in the final good's sector and monopolistic competition in the intermediate good's sector. They make the assumption that capital accumulation is exogenous and there is a wage mark-up shock and a productivity shock. They determined that wage mark-up shocks have a significant effect on output, when prices and wages are flexible. They attribute this to the steepness of the labor supply curve.

In contrast to [Justiniano & Premiceri, 2008] finding, [Oliveira & Savina, 2013] determined that business cycle fluctuation comes from the demand side. Using the dataset they use covers the period between the first quarter of 2002 and the last quarter of 2012, they introduced three types of shocks, which are cost shock, demand shock and productivity shock. They found that negative demand shock was the main reason of decline in output gap.

Both supply and demand shocks could be the reason of fluctuation in the output; as [Smets & Wouters, 2005] observed by comparing the effects of shocks in the US and Euro Zone for the period between 1974 and 2002. Their methodology is essentially the same as the one in [Smets & Wouters, 2002]. They only added a preference shock that follows a first order Markov process. In both US and the Euro Zone, they found that output fluctuations are caused by short-term demand shocks, whereas supply shocks and investment specific technology shocks matter in the long run.

Our literature survey suggests that, DSGE models have not been employed for output gap estimation for the Turkish economy. It rather indicates that, such studies have been limited to more traditional methods. For example, [Üngör, 2014] estimated the output gap for Turkish Economy during 1988 to 2014 by using the production function approach combined with the HP Filter. He used non-accelarating inflation rate of unemployment and the labor force participation rate to estimate the labor. He further determined that the actual total factor productivity growth exceeds the potential total factor productivity growth between 2003 and 2008, and this is consistent with the data.]

In a similar study, [Kara et. al.,2007] used both standard and extended versions of the Kalman Filter to estimate the output gap for Turkey for the period between 1990 and 2005. They reported that, the standard Kalman Filter approach indicates that the output gap in Turkey reduced to zero in 2000. They employed the extended Kalman Filter to deal with the stability issues of the short-term shocks.

In this thesis, we will use the DSGE model to estimate the output gap for the Turkish Economy for the years between the first quarter of 2005 and the second quarter of 2014. We will also employ the HP Filter for the same output gap estimation for comparison. The rest of the thesis is organized as follows. In Chapter 3, we review [Smets & Wouters, 2007] model. In Chapter 4, we use [Smets & Wouters, 2007] model to obtain our results. In particular, we show that the output gap for the Turkish Economy reached the maximum during the first quarter of 2009 under both DSGE and HP-Filter models. The thesis is concluded in Chapter 5.

CHAPTER 3

THE SMETS AND WOUTERS MODEL

In [Smets & Wouters, 2007] two entities of interest are households and firms; where households solve the utility maximization problem and firms solve the profit maximization problem. The household problem is defined as:

$$\max_{\{C_t^\tau, H_t\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t \varepsilon_t^b \left(\frac{1}{1-\sigma_c} (C_t^\tau - H_t)^{1-\sigma_c} \exp \frac{(\sigma_c - 1)(L_t^{1+\sigma_l})}{1+\sigma_l} \right)$$

$$\text{s.t. } C_t + I_t + \frac{B_t}{\varepsilon_t^b R_t P_t} \le \frac{B_{t-1}}{P_t} + \frac{W_t L_t}{P_t} + \frac{R_t Z_t K_{t-1}}{P_t} + a(Z_t) K_{t-1} + \frac{Div_t}{P_t}$$

$$K_t = (1-\delta) K_{t-1} + \varepsilon_t^i \left[1 - S(\frac{I_t}{I_{t-1}}) \right] I_t$$

Here, ε_t^b represents a shock to the preferences of households, ε_t^l represents a shock to the labor supply, and σ_c represents the coefficient of relative risk aversion. H_t is the habit stock, which is defined as $H_t = hC_{t-1}$. It represents the habit formation effect of past consumption on the future consumption.
In the inter-temporal budget constraint, b_t represents the single period security price, and B_t represents the bond holdings of households. Household income includes dividends and net return from capital holdings in addition to the wage income. The other constraint is the investment equation. Here, δ represents the depreciation rate, ε_t^i is the shock to the investment cost and S(.) is a positive function of the changes in investment. Moreover, ε_t^i follows a first

order autoregressive process.

First order conditions are as follows.

Consumption Euler equation:

$$E_t\left[\beta\frac{\lambda_{t+1}}{\lambda_t}\frac{R_tP_t}{P_{t+1}}\right] = 1 \tag{3.1}$$

Marginal Utility of Consumption:

$$\lambda_t = \varepsilon_t^b(C_t - H_t)^{-\sigma_c}\exp\frac{(\sigma_c - 1)(L_t^{1+\sigma_l})}{1+\sigma_l} \tag{3.2}$$

Euler equation for the value of the capital stock:

$$Q_t = E_t\left[\beta\frac{\lambda_{t+1}}{\lambda_t}(Q_{t+1}(1-\delta) + z_{t+1}r_{t+1} - \Psi(z_{t+1}))\right] \tag{3.3}$$

Investment Adjustment Cost Equation:

$$Q_t\left[\frac{-\varepsilon_t S'(\frac{\varepsilon_t^i I_t}{I_{t-1}})I_t}{I_{t-1}} + 1 - S\left(\frac{\varepsilon_t^i I_t}{I_{t-1}}\right)\right] + \beta E_t\left[Q_{t+1}\varepsilon_{t+1}^i\left((\frac{I_{t+1}}{I_t})^2 S'(\frac{\varepsilon_{t+1}^i I_{t+1}}{I_t})\right] = 1 \tag{3.4}$$

Optimal Capital Utilization:

$$r_t = \Psi'(z_t) \tag{3.5}$$

Household supplies its' labor monopolistically in the labor market. Each household gets a random wage-change signal $1 - \xi_w$ each period. Households re-optimize each period according to the following rule.

$$W_t = \left(\frac{P_{t-1}}{P_{t-2}}\right)^{\gamma_w} W_{t-1} \tag{3.6}$$

Here, γ_w represents the degree of wage indexation. When $\gamma_w = 0$, wage indexation is zero. Since wages are not re-optimized, they remain constant. When

$\gamma_w = 1$, households re-optimize and wages adjust perfectly with respect to inflation.

In a final goods' sector, a single final good is produced by using a continuum of intermediate goods $Y_t(i)$. Moreover, final goods' sector is perfectly competitive and final good producers solve the following profit maximization problem.

$$\max_{Y_t, Y_t(i)} P_t Y_t - \int_0^1 P_t(i) Y_t(i) di$$
$$\text{s.t.} \left[\int_0^1 G(\frac{Y_t(i)}{Y_t}; \epsilon_t^p) di \right] = 1$$

Here, P_t denotes the price of final good and $P_t(i)$ denotes the price of intermediate good. G is a strictly concave and increasing function such that $G(1) = 1$. Also, $\epsilon_t^p \in (0, \infty)$ and it follows an ARMA process.

Profit maximization in the final goods sector gives the demand for intermediate good as:

$$Y_t(i) = Y_t G'^{-1} \left[\frac{P_t(i)}{P_t} \int_0^1 G' \left(\frac{Y_t(i)}{Y_t} \right) \frac{Y_t(i)}{Y_t} di \right] \tag{3.7}$$

In the intermediate goods sector, the technology is defined as follows:

$$Y_t(i) = \varepsilon_t^a K_t^s(i)^\alpha [\gamma^t L_t(i)]^{1-\alpha} - \gamma^t \Phi \tag{3.8}$$

Here, $K_t^s(i)$ represents the capital services, $L_t(i)$ represents the mixed labor input, γ is the deterministic growth rate and Φ is a fixed cost and ε_t^a is the total factor productivity. The process for TFP is given as:

$$\ln \varepsilon_t^a = (1 - \rho_z) \ln \varepsilon_a + \rho_z \ln \varepsilon_{t-1}^a + \eta_t^a, \;\; \eta_t^a \sim N(0, \sigma_a) \tag{3.9}$$

Firms set the optimal price based on Calvo pricing and they solve the following maximization problem.

$$\max_{\tilde{P}_t(i)} E_t \sum_{s=0}^{\infty} \xi_p^s \frac{\beta^s \lambda_{t+s} P_t}{\lambda_t P_{t+s}} [\tilde{P}_t(i)(\prod_{l=1}^{s} \pi_{t+l-1}^{\iota_p} \pi_\star^{1-\iota_p}) - MC_{t+s}] Y_{t+s}(i)$$
$$\text{s.t.} Y_{t+s}(i) = Y_{t+s} G'^{-1}\left(\frac{P_t(i) X_{t,s}}{P_{t+s}} \tau_{t+s}\right)$$

Here, $\frac{\beta^s \lambda_{t+s} P_t}{\lambda_t P_{t+s}}$ is the stochastic discount factor, and $\tau_t = \int_0^1 G'\left(\frac{Y_t(i)}{Y_t}\right)\frac{Y_t(i)}{Y_t} di$. Also, $X_{t,s}$ is defined as:

$$X_{t,s} = \begin{cases} 1 & \text{for } s = 0 \\ (\prod_{l=1}^{s} \pi_{t+l-1}^{\iota_p} \pi_\star^{1-\iota_p}) & \text{for } s = 1, ...\infty \end{cases}$$

3.1 Linearized Equations

The Smets and Wouters equations given in the preceding section can be linearized by taking their natural logs and applying a first order Taylor Approximation to all the terms. These linearized equations are stated below.

Consumption Equation:

$$\hat{C}_t = \frac{\frac{h}{\gamma}}{1+\frac{h}{\gamma}} \hat{C}_{t-1} + \frac{(\sigma_c - 1)(\frac{W_*^h L_*}{C_*})}{\sigma_c(1+\frac{h}{\gamma})} E_t \hat{C}_{t+1} - \frac{1-\frac{h}{\gamma}}{(1+\frac{h}{\gamma})\sigma_c}(r_t - E_t \pi_{t+1} + \varepsilon_t^b) \quad (3.10)$$

Investment Equation:

$$\hat{I}_t = \frac{1}{1+\beta\gamma^{1-\sigma_c}} \hat{I}_{t-1} + \frac{\beta\gamma^{1-\sigma_c}}{1+\beta\gamma^{1-\sigma_c}} E_t \hat{I}_{t+1} + \frac{\hat{Q}_t}{(1+\beta\gamma^{1-\sigma_c})\gamma^2\varphi} + \varepsilon_t^i \quad (3.11)$$

Price of capital stock:

$$\hat{Q}_t = \frac{1-\delta}{1-\delta+\bar{r}^k}\hat{Q}_{t+1} + \frac{\bar{r}^k}{1-\delta+\bar{r}^k}\bar{r}^k_{t+1} - (r_t - E_t\pi_{t+1} + \varepsilon^b_t) \tag{3.12}$$

Capital Accumulation:

$$\hat{K}_t = (1-\delta)\hat{K}_{t-1} + \delta I_{t-1} \tag{3.13}$$

New Keynesian Philips Curve:

$$\hat{\pi}_t = \frac{\beta\gamma^{1-\sigma_c}}{1+\beta\gamma^{1-\sigma_c}\iota_p}\hat{\pi}_{t+1} + \frac{\iota_p}{1+\beta\gamma^{1-\sigma_c}\iota_p}\hat{\pi}_{t-1} + \frac{1}{1+\beta\gamma^{1-\sigma_c}\iota_p}\frac{(1-\beta\xi_p)(1-\xi_p)}{\xi_p((\phi_p-1)\varepsilon_p+1}\mu^p_t + \varepsilon^p_t \tag{3.14}$$

Wage Markup-MRS Equation

$$\mu^w_t = w_t - mrs_t \tag{3.15}$$

Wage Equation:

$$\begin{aligned} w_t = \frac{1}{1+\beta\gamma^{1-\sigma_c}}w_{t-1} + \frac{\beta\gamma^{1-\sigma_c}\iota_w}{1+\beta\gamma^{1-\sigma_c}}(E_t w_{t+1} + E_t\pi_{t+1}) - \frac{1+\beta\gamma^{1-\sigma_c}\iota_w}{1+\beta\gamma^{1-\sigma_c}}\pi_t + \\ \frac{\iota_w}{1+\beta\gamma^{1-\sigma_c}}\pi_{t-1} - \frac{1}{1+\beta\gamma^{1-\sigma_c}}\frac{(1-\beta\gamma^{1-\sigma_c}\xi_w)(1-\xi_w)}{\xi_w((\phi_w-1)\varepsilon_w+1}\mu^w_t + \varepsilon^w_t \end{aligned} \tag{3.16}$$

Rental Rate-Wage Rate Equation:

$$r_t = -(k_t - l_t) + w_t \tag{3.17}$$

Goods' Market Clearing Condition:

$$Y_t = (1-g_y-i_y)C_t + (\gamma-1+\delta)k_y I_t + R^k_\star k_y Z_t + \varepsilon^g_t \tag{3.18}$$

Monetary Policy Reaction Function:

$$\hat{r}_t = \rho r_{t-1} + (1-\rho)\{r_\pi \pi_t + r_Y(Y_t - Y_t^p)\} + r_\triangle y \Big[(Y_t - Y_t^p) - (Y_{t-1} - Y_{t-1}^p)\Big] + \varepsilon_t^r \tag{3.19}$$

Production Function:

$$Y_t = \phi_p(\alpha K_t^s + (1-\alpha)L_t + \varepsilon_t^a) \tag{3.20}$$

CHAPTER 4

ESTIMATION AND RESULTS

In this chapter, the maximum output gap is estimated by solving Smets and Wouters linearized equations using the Bayesian VAR methodology and DYNARE [Adjemian, 2011] software package. Kalman Filtering is incorporated into this estimation to make our computation more accurate. In the model, there are nine endogenous variables,i.e, $\bar{\pi}_t, \bar{w}i_t, \hat{K}_{t-1}, \hat{Q}_t, \hat{I}_t, \hat{C}_t, \hat{R}_t, \hat{r}_t^k, \& \hat{L}_t$. The unobservable variables are real interest rate, potential output, technology, shocks and change variables.

The initial values of the parameters are shown in Table 2. The parameter values are based on 100000 draws of Metropolis Hastings Algorithm with Monte Carlo simulation. For estimation purposes, inflation, output, real wage, consumption, investment, interest rate and employment were used as variables. The data for consumption, output, and investment were obtained from the OECD statistical database in terms of seasonally adjusted current prices. They were normalized by dividing them by the consumer price index and taking the natural logarithm. The data about inflation, employment and real wage are obtained from the Central Bank of the Republic of Turkey. The growth rate of real wage was seasonally adjusted and used in the estimation. The estimation period covers between the first quarter of 2005 and the second quarter of 2014, as data for some variables were not available before 2005. Estimation results were evaluated against the HP-Filter estimation for the same period. The results are shown in Figures 4.1 through 4.3.

It is seen in Figure 4.1 that the maximum output gap occurs in the first quarter of 2009. Thus, the HP-Filter method accurately estimates the quarter and year of the maximum output gap for the Turkish Economy for the period stated. DSGE-Csminwel estimation shown in figure 4.2 also accurately predicts the quarter and year of the maximum output gap. However, there are some significant differences between two estimations. In HP-Filtering estimation, the output gap remains pretty steady until the beginning of the second quarter of 2008 before it dips to the maximum output gap in the first quarter of 2009. In contrast, the DSGE-Csminwel output gap estimation fluctuates within a larger envelope of output gap values thorough out the estimated period. The third estimation,i.e., the DSGE-Monte Carlo method also accurately predicts the quarter and the year of the maximum output gap for the stated period of the Turkish Economy. The problem is that, there is a large difference between DSGE-Monte Carlo and DSGE-Csminwel in terms of the scale of output gap. Nevertheless, DSGE model well in reflecting the impact of global economic crisis.

It makes sense because all the variables used in the estimation process also make trough at the 1^{st} quarter of 2009. Since there was a drop in consumption, investment and output during global economic crises; it is not surprising that the output gap estimate also makes trough at the same time interval.

CHAPTER 5

CONCLUDING REMARKS

In this thesis, we estimated the output gap for Turkey between the first quarter of 2005 and the second quarter of 2014. It has been determined that DSGE results are in agreement with the HP-Filter results in predicting the trough in the first quarter of 2009. In terms of the actual fluctuations in output gap, the Monte Carlo simulation based on a 100000 draws of Metropolis-Hastings Algorithm is more consistent with the HP-Filter estimate. The only inconsistency between the two methods is the discrepancy in the output gap around the third quarter of 2011. This could be related to some of the Bayesian estimation parameters used in the DYNARE [Adjemian, 2011] estimation. It is likely that the results could be made more consistent by fine-tuning these parameters.

Output gap estimations for the Turkish Economy during the stated period suggest that the economy recovered after the trough at the first quarter of 2009 within 10 quarters. On the other hand, there is a rapid decline in the output gap after the peak in Quarter 1 of 2011 in all three estimations. This drop in output gap is more pronounced in the DSGE-Csminwel and DSGE Monte-Carlo estimations than the HP-Filter estimation. Another observation is that DSGE-Monte Carlo estimation remains pretty steady after the first quarter of 2013, whereas in DSGE-Csminwel, the output gap continues to increase all the way to the end of the stated period. This can be explained in part by the inability of the method to estimate the output gap near the end points of the interval.

All three estimations indicate that the economic state of Turkey has significant volatility. This volatility can be attributed to over-dependence of Turkish Industry on Foreign Currencies, specially Euro and US Dollar. In particular, recent devaluation of Turkish Lira against US dollar and Euro and the political uncertainty seem to have impacted the new investments and initiatives.

BIBLIOGRAPHY

Adjemian, Stephane and Bastani, Houtan and Juillard, Michel and Mihoubi, Ferhat and Perendia, George and Ratto, Marco and Villemot, Sebastien(2011), "Dynare Reference Manual, version 4," *Dynare Working Papers 1, CEPREMAP* .

Central Bank of the Republic of Turkey(2015), Real Wage, Employment, Inflation and Interest Rate [datafile], retrieved from http://www.tcmb.gov.tr.

Justiniano, Alejandro and Premiceri, Giorgio(2008), "Potential and Natural Output," *Manuscript, Northwestern University.*

Kara, Hakan and Öğünç, Fethi, and Özlale, Ümit and Sarıkaya, Çağrı. 2007. "Estimating the Output Gap in a Changing Economy," *Southern Economic Journal*74: 269-289.

Kydland, Finn E. and Prescott, Edward C (1982), "Time to Build Aggregate Fluctuations," *Econometrica: Journal of the Econometric Society*, 1345-1370.

Oliveira, da Cruz and Savino, Marcelo(2013), "Structural Estimation of the Output Gap: The Case of Brazil."

OECD Statistical Database (2015), Personal Consumption Expenditures, GDP, Investment [datafile], retrieved from http://www.oecd.org.

Rotemberg, Julio and Woodford, Michael(1997), "An Optimization Based Econometric Framework for the Evaluation of Monetary Policy," *NBER Macroeconomics Annual* MIT Press,12: 297-361.

Smets, Frank and Wouters, Rafael(2002). "An Estimated Stochastic Dynamic General Equilibrium Model of the Euro Area," *Unpublished Working Paper.*

Smets, Frank and Wouters, Rafael(2003), "An Estimated Stochastic Dynamic General Equilibrium Model of the Euro Area," *Journal of the European Economic Association*, Wiley Online Library, 1: 1123-1175.

Smets, Frank and Wouters, Rafael(2005), "Comparing Shocks and Frictions in US and Euro Area Business Cycles: A Bayesian DSGE Approach," *Journal of Applied Econometrics*, Wiley Online Library, 20: 161-183.

Smets, Frank and Wouters, Rafael(2007), "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach," *National Bank of Belgium Working Paper*, 109.

Üngör, Murat(2014). "Estimating the Output Gap for Turkey: A Simple Production Function Approach".

Vetlov, Igor and Hledik, Tibor and Jonnson, Magnus and Henrik, Kucsera and Pisani, Massimilliano. 2011. "Potential Output in DSGE Models," *ECB Working Paper*.

Table 5.1: Initial Values

Parameters	Explanation	Initial Values
δ	Depreciation	0.025
α	Share of Capital Stock	0.24
h	Habit Formation Parameter	0.9121
ξ_w	Degree of Wage Stickiness	0.7413
ξ_p	Degree of Price Stickiness	0.6253
ι_w	Indexation to the Past Wage Rate	0.5400
ι_p	Indexation to the Past Inflation	0.3783
σ_c	Inverse Elas. of Subs. in Cons.	1.5
σ_l	Inverse Elas. of Labor Supply	2.1491
r_π	Interest Rate-Inflation Elasticity	1.3423
r_y	Interest Rate-Output Elasticity	0.1251
$r_{\triangle y}$	Interest Rate-Output Gap Elasticity	0.1279
β	Discount Factor	0.9995
φ	Elasticity of Capital Adjustment Cost	6.9544
ρ_a	Persistence of the Technology Shock	0.7725
ρ_b	Persistence of the Preference Shock	0.7418
ρ_g	Persistence of the Exogenous Spending Shock	0.7432

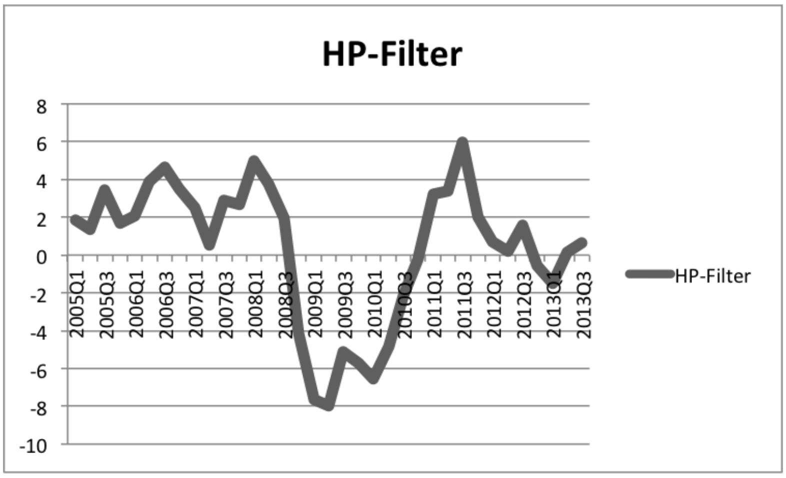

Figure 5.1: HP-Filtered Output Gap

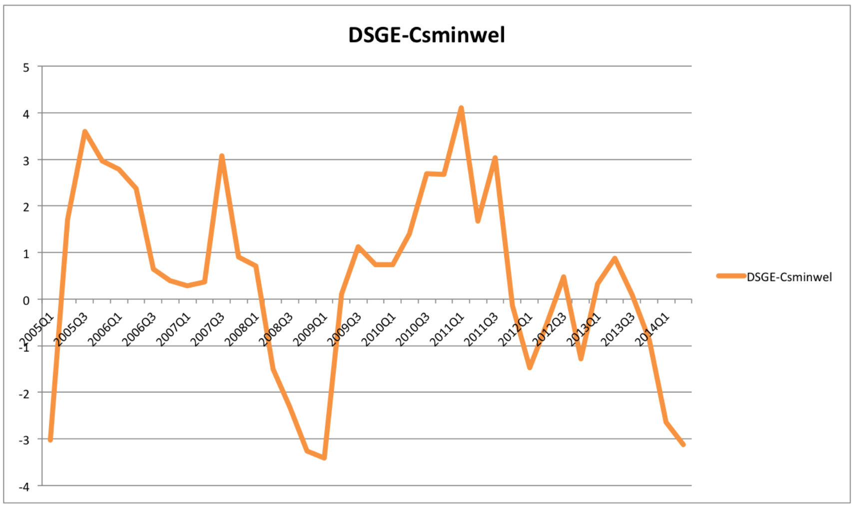

Figure 5.2: DSGE-Csminwel

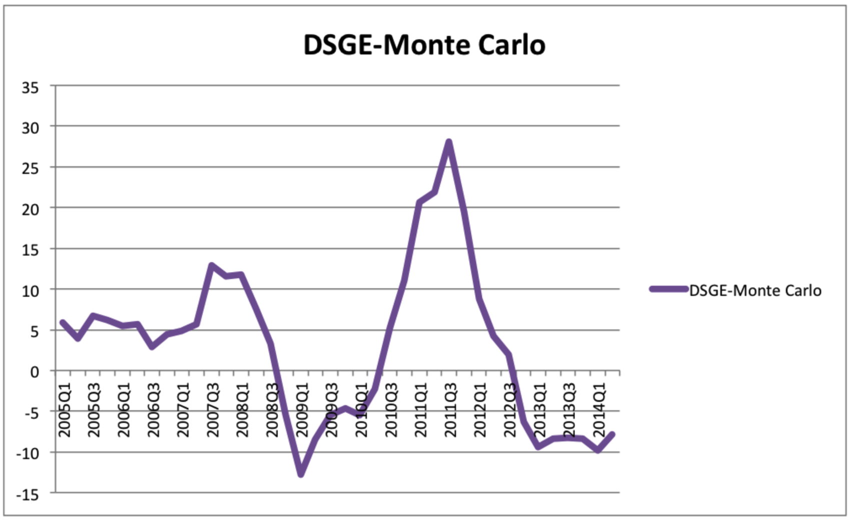

Figure 5.3: DSGE-Monte Carlo