Vol. 12(4), pp. 241-250, October-December 2020
DOI: 10.5897/JEIF2019.0990
Article Number: 912C19D65125
ISSN 2006-9812

http://www.academicjournals.org/JEIF

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Journal of Economics and International Finance

Full Length Research Paper

Macroeconomic volatility of Turkey in comparison with South Africa and developed countries

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Received 30 July, 2019; Accepted 26 November, 2019

The purpose of this study is to investigate the business cycle volatility of Turkish economy using the quarterly data over the period 1961:Q1 to 2018:Q4 and to determine the smoothing parameter, λ, of HP filter for annual frequency of observations. The macroeconomic variables such as import, investment and export are more volatile followed by government spending; while consumption and real GDP are less volatile. Price in Turkey is highly volatile, which is about four times as volatile as the average price volatility of South Africa, Japan and USA. Output, consumption and investment in Turkey are twice as volatile as the average volatility of South Africa, Japan and USA. Import and export are more volatile in emerging economies as compared to developed countries. The trend component of annual frequency with λ_annual=6.25 is practically identical to the trend component of the quarterly data with λ_quarterly=1600. In Turkish economy, investment, consumption, import, export, and government spending are procyclical; price and inflation are countercyclical; whereas, the share of government consumption in output is acyclical.

Key words: Business cycle, correlation, Hodrick-Prescott (HP) filters, macroeconomic variables, volatility.

INTRODUCTION

Turkish economy has grown fast in the past years despite adverse shocks. This performance has been driven by policy stimulus and a dynamic, well-diversified but fragmented business sector. The overall investment has been strong; but it is excessively funded by debt, raising questions about its quality and allocation. Sustained job creation outside agriculture, which accelerated in the 2010s, has improved well-being, notably in less-developed regions of Turkey. The low-educated and previously inactive women have benefitted the most. Material living conditions have improved faster than other dimensions of quality of life, such as work-life balance, environmental quality and subjective well-being (OECD, 2018). In spite of these achievements, macroeconomic volatility is a fundamental concern in Turkey similar to other developing countries.

High aggregate instability results from a combination of large external shocks, volatile macroeconomic policies, microeconomic rigidities, and weak institutions. The effects of volatility on macroeconomic performance are even more marked in countries like Turkey, which are often subject to more significant external shocks but do

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not enjoy the internal conditions that would absorb the shocks easily. Since a stable economy with predictable future provides a better business environment for economic growth, ensuring macroeconomic stability is one of the most important targets for policy makers. On the other hand, higher output volatility may lead to a significant cost in terms of social welfare. Common definitions of volatility often refer to the notion of disequilibrium, and measuring economic volatility involves evaluating the deviation between the values of an economic variable and its equilibrium value. This equilibrium value in turn refers to the existence of a permanent state or trend.

The potential growth in Turkey is not sufficiently broad-based productivity growth. Though macroeconomic policy framework was provided in order to support the economy, there was wider fluctuation on the path of economic growth over the years. Over the long term, volatility contributes to a reduction in levels of consumption, investment, unpredictability of economic policy and deterioration in the institutional environment. Hence, the empirical connection between macroeconomic volatility and lack of development is undeniable, making volatility a fundamental development concern.

In the study of business cycles, Hodrick and Prescott (1997) detrend U.S. macro time series with what is known as the Hodrick-Prescott (HP) filter, and then compute standard deviations, correlations, and serial correlations of the major macroeconomic aggregates. This technique can be used to disaggregate a series into trend variations (long term) and cyclical variations (short term). This volatility indicator is therefore based on cyclical or cycle fluctuations. HP filter has become a standard method for removing trend movements in the business cycles literature. Most applications of HP filter have been for quarterly data. However, data is often available at the annual frequency or might be published on monthly basis. This raises the question on how one can adjust the HP filter to the frequency of the observations, so that the main properties of the results are conserved across alternative sampling frequencies. Although most researchers use the value of $\lambda = 1600$ for the smoothing parameter of HP filter when using quarterly data, there is less agreement in the literature when moving to other frequencies. Correia et al. (1992) suggest a value of $\lambda = 400$ for annual data, Backus and Kehoe (1992) use a value of $\lambda = 100$, while some others use the smoothing parameter of $\lambda = 25$ for annual frequency of observations. Ravn and Uhlig (2002) suggest the value of $\lambda = 6.25$ when moving from the quarterly data to the annual frequency. This study therefore aims to investigate macroeconomic volatility of Turkey over a half-century of quarterly data over the period 1961:Q1 to 2018:Q4, and determine the smoothing parameter, λ, of HP filter in moving from quarterly data to annual frequency of observations with empirical evidence on Turkey.

The remaining part of the article is organized as follows. Section two presents review of theoretical and empirical literature on some facts about the historical properties of business cycles, and on measuring the macroeconomic volatility using Hodrick-Prescott (HP) filter. This section briefly describes the HP filter as widely used technique in econometric work to extract the cyclical component from the time series, and as it has become widely used technique withstanding the criticism on using the smoothing parameter, $\lambda = 1600$, with quarterly data for all countries. Section three describes the methodology used to analyze the macroeconomic volatility of Turkey elaborating the technique of HP filter. Section four analyses the macroeconomic volatility of Turkey using both the quarterly data and annual frequency of observations with the smoothing parameter ($\lambda = 1600$) for quarterly data, and $\lambda = 6.25, 25, 100, and\ 400$ for annual data so as to select the possible smoothing parameter for the annual data. This section also compares the macroeconomic volatility of Turkey with South Africa, Japan and USA with the aim of determining whether or not Turkish economy is highly volatile as compared to other emerging country (South Africa) and developed countries with the evidence from Japan and USA. This section further presents the comparison of the contemporaneous co-movement with real GDP, and persistence of economic variables in Turkey compared with other countries. Finally, conclusions are provided based on the results of this specific study.

Historical properties of business cycles and measuring volatility with hodrick-prescott filter

Sometimes, confidence in government institutions and actions persuade that cyclical instability is a serious problem. Thus in the early success of the Federal Reserve System, 1922-1929, monetary policies were expected to help maintain prosperity. In the 1960s, the late success of Keynesian economics, fiscal fine-tuning, elicited similar hopes. However, the failure of the Keynesian theory in the 1970s has caused many economists to turn to the study of business cycles as equilibrium phenomena. The sequence of serious worldwide recessions in the last few decades soon disproved the perennially attractive idea that business cycles had become obsolete. Beyond that, the credibility of both Keynesian and monetarist explanations has diminished. Once again, the apparent failure of old solutions prompts the profession to pay more attention to the continued existence of business cycles (Zarnowitz, 1992).

The study of business cycles is almost coextensive with short-term macro dynamics, and it has a large interface with the economics of growth, money, inflation, and

expectations. Interest in business cycles is itself subject to a wavelike movement, waxing during and after periods of turbulence and depression, waning in periods of substantial stability and continuing growth. The business cycle can be described as the percentage difference between the observed output and the potential output being known as the output gap. Potential output in neoclassical macroeconomic thought is synonymous with the trend growth rate of actual output (Grech, 2014). In the analysis of the cyclical behavior of components of national output, Backus and Kehoe (1992) justify that though the magnitude of output fluctuations varies across countries and periods, relations among real quantities remain remarkably uniform. That means in spite of the fact that countries differ in their institutions, monetary and fiscal policies, and industrial compositions and structures, the cyclical behavior among variables are remarkably stable. Whereas, Basu and Taylor (1999) state that theoretical concerns of business cycle indicate that the properties of business cycle models depend not only on important structural aspects of the model such as money neutrality, labor market structure, and price adjustment, but also on the closure of the model in international markets. Econometric considerations suggest that more information about the country-specific versus universal features of cycles could be gathered from the study of panel data.

Most of the researches propose measuring volatility on the basis of the standard deviation of the growth rate of a variable, which assumes that the said variable is stationary at the first difference. In other words, this approach puts forward restrictive hypotheses as to the behavior of a series without any prior testing (Cariolle, 2012). Ramey and Ramey (1995) propose studying the effect of economic variability using the standard deviation of the growth rate of GDP per-capita. Raddatz (2007) also uses the standard deviation of the growth rate of several macroeconomic variables (price of primary products, terms of trade, aid per inhabitant, GDP per inhabitant and London interbank offered rate, to examine the contribution of external shocks to the volatility of GDP in African countries.

Potential output is unobservable and must be estimated. Although some institutions have tried to gauge potential output through direct means like surveys of capital utilization, the preferred way has been that of indirect estimation techniques. These can be divided into the statistical filtering methods and the structural approaches (Grech, 2014). However, it should be emphasized that the division between the two branches is not total as some methods use both approaches in the estimation of potential output. Moreover, all approaches claim that their estimation method is based on reasonable economic foundations and provide estimates that could be used uniformly for most analytical purposes. The output series can be decomposed into a permanent component and a cyclical one that exhibits stationary behavior in that it reverts always to the permanent level. According to Grech (2014), the permanent or equilibrium level of output is not stable rather exhibits an upward trend in most economies, reflecting mainly productivity shocks. Therefore, methods that attempt to extract the cyclical element must be able to identify movements in the time series that are due to the cycle and those that reflect changes in potential output. According to Uribe and Schmitt-Grohe (2017), to characterize business cycle facts, a time series is decomposed into a cyclical component and trend component, and there are various methods to extract the cyclical component: log-linear detrending, log-quadratic detrending, Band pass filtering, and HP filtering.

Like other trend removal techniques such as trend regression, moving average detrending, and band-pass filtering, the Hodrick and Prescott (HP) filter is frequently used to produce new time series such as potential GDP and output gap that are useful in macroeconomic modeling and monetary policy research (Phillips and Jin, 2015). In the study of business cycle, Hodrick and Prescott (1997) discover that consumption of services, consumption of nondurables, and state as well as local government purchases of goods and services are the series that vary least. The investment is about three times as variable as output. Covariabilities of consumption and investment with output are much stronger than the covariability of government expenditure with output. In the study of real business cycle models, Rebelo (2005) also find that investment is about three times more volatile than output, and nondurables consumption is less volatile than output. Almost all macroeconomic variables are strongly procyclical, that is, they show a strong contemporaneous correlation with output. Macroeconomic variables show substantial persistence. If output is high relative to trend in this quarter, it is likely to continue above trend in the next quarter. Habitually economic researchers have a theory that is specified in terms of a stationary environment and wish to relocate the theory to observed nonstationary data without modeling the nonstationarity. Hodrick and Prescott proposed a very popular method for doing this, commonly interpreted as decomposing an observed variable into trend and cycle (Hamilton, 2016). Although the use of the HP filter has been subject to heavy criticism, it has withstood the test of time and fire of discussion well, and today it is widely adopted in academic research, policy studies, and analysis by private-sector economists (Ravn and Uhlig, 2002). The Hodrick-Prescott filter involves the smoothing parameter, λ, and standard practise in the literature is to set this parameter equal to 1600 (in quarterly data) for all countries. Though, Ravn and Marcet (2003) caution that this choice might distort the results when the cyclical component is highly serially correlated and that care

should be taken in checking if the results are reasonable in the light of common wisdom. Ravn and Uhlig (2002) suggest that the λ parameter should be adjusted according to the fourth power of a change in the frequency of observations setting $\lambda = 6.25$ for annual observations, which is different from the value $\lambda = 100$ or $\lambda = 400$ typically found in the literature.

METHODOLOGY

The study of macroeconomic volatility of Turkey was based on the quarterly data over the period 1961:Q1 – 2018:Q4, and annual data of the period 1961 – 2018 with the aim of determining which smoothing parameter is used in moving from quarterly data to annual frequency of observation. The data were obtained from OECD Stat Data set: Quarterly National Account. According to Phillips and Jin (2015), for the last several decades, the Hodrick-Prescott (HP) filter has been used extensively in applied econometric work to detrend data, particularly to assist in the measurement of business cycles. This study also employs the HP filtering technique to extract the cyclical component using the smoothing parameter ($\lambda = 1600$) for quarterly data, and $\lambda = 6.25, 25, 100, and\ 400$ for annual data so as to determine which smoothing parameter (λ) is preferred in moving from quarterly data to annual frequency of observations. The technique of HP filter is explained as follows.

The observed time series are viewed as the sum of cyclical and growth components. Actually, there is also a seasonal component, but as the data are seasonally adjusted, this component has already been removed by those preparing the data series (Hodrick and Prescott, 1997). If growth accounting provided estimates of the growth component with errors that were small relative to the cyclical component, computing the cyclical component would be just a matter of calculating the difference between the observed value and the growth component. Growth theory accounting, in spite of its considerable success, is far from adequate for providing such numbers. If prior knowledge were sufficiently strong so that we could model the growth component as a deterministic component, possibly conditional on exogenous data, plus a stochastic process and the cyclical component as some other stochastic process, estimating the cyclical component would be an exercise in modern time series analysis. The prior knowledge is not of this variety, so these powerful methods are not applicable (Hodrick and Prescott (1997), rather is that the growth component varies "smoothly" over time.

The conceptual framework of the study is that a given time series y_t is the sum of a growth component τ_t and a cyclical component c_t:

$$y_t = \tau_t + c_t \quad \text{for t = 1, …, T.} \tag{1}$$

The measure of the smoothness of the $\{\tau_t\}$ path is the sum of the squares of its second difference. The c_t are deviations from τ_t and the conceptual framework is that over long time periods, their average is near zero. These considerations lead to the following programming problem for determining the growth components:

$$\underset{\{\tau_t\}_{t=-1}^{T}}{\text{Min}} \left\{ \sum_{t=1}^{T} c_t^2 + \lambda \sum_{t=1}^{T} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2 \right\} \tag{2}$$

Where, $c_t = y_t - \tau_t$.

The residual $y_t - \tau_t$ (the deviation from the trend) is then commonly referred to as the *business cycle component*. The parameter λ is a positive number which penalizes variability in the growth component series. When the smoothness penalty λ approaches zero, τ_t would be the series y_t itself, whereas when $\lambda \to \infty$, the procedure amounts to a regression on a linear time trend (*i.e.* produces a series whose second difference is exactly 0). In other words, the larger the value of λ, the smoother is the solution series. For a sufficiently large λ, at the optimum all the $\tau_{t+1} - \tau_t$ must be arbitrarily near some constant, β and therefore the τ_t arbitrarily near $\tau_t + \beta_t$. This implies that the limit of solutions to program (2) as λ approaches infinity is the least squares fit of a linear time trend model. The data analyzed are in natural logarithms; so the change in the growth component, $\tau_t - \tau_{t-1}$, corresponds to a growth rate.

As Hodrick and Prescott (1997) describe, the following probability model is useful for bringing to bear prior knowledge in the selection of the smoothing parameter λ. If the cyclical components and the second differences of the growth component were identically and independently distributed, normal variables with means zero and variances δ_1^2 and δ_2^2 (which they are not), the conditional expectation of the τ_t, given the observations, would be the solution to program (2) when $\sqrt{\lambda} = \delta_1/\delta_2$. Hodrick and Prescott (1997) (p.4) state that:

"Prior view is that a 5 percent cyclical component is moderately large, as is a one-eighth of 1 percent change in the growth rate in a quarter. This lead us to select $\sqrt{\lambda} = {}^{5}/_{1/8} = 40$ or $\lambda = 1600$ as a value for the smoothing parameter."

With a larger λ, the amplitudes of fluctuations are larger, but the relative magnitude of fluctuations of the series changes little. The reason for increasing the volatility with larger smoothing parameter (λ) is that in detrending the time series data, HP filter removes some values from a trend component and then adds to a cyclical component so that these added values do not represent the real fluctuations of the economy rather it biases up the cyclical component and merges the fluctuations to stretch unnecessarily higher amplitudes beyond the real fluctuation of the economy. So, it is important that all series be filtered using the same parameter λ. So, $\lambda = 1600$ has been used for the volatility analysis with the quarterly data.

RESULTS AND DISCUSSION

The time series of more than a half-century were considered for the analysis of the macroeconomic volatility of Turkey. The frequencies of observations of the time series were quarterly (*1961:Q1–2018:Q4*) and annual (*1961 – 2018*), with the aim of determining which value of smoothing parameter λ fits the annual frequency of observations. For the quarterly data the smoothing parameter $\lambda = 1600$ was used based on the recommendation of Hodrick and Prescott (1997). Whereas, in the case of annual frequency of observations, the parameter $\lambda = 6.25$, $\lambda = 25$, $\lambda = 100$, and $\lambda = 400$ were used to determine which parameter, λ, value best fits with the annual frequency.

These parameter values were selected based on the suggestion of Ravn and Uhlig (2002) who state that the λ parameter should be adjusted according to the fourth power of a change in the frequency of observations,

Table 1. Volatility of Turkish economy with the quarterly frequency of observations.

Real GDP (y)	Consumption (c)	Investment (i)	Government (g)	Export (x)	Import (m)	Price (p)
1.94	2.31	5.60	3.90	5.25	6.19	3.08

Table 2. Ranking of Turkish volatilities in comparison with the volatilities across-country.

Turkish ranking of volatilities		Global ranking of volatilities	
Business-cycle statistic	**Average**	**Business-cycle statistic**	**Average**
$\boldsymbol{\delta_m}/\boldsymbol{\delta_y}$	$\frac{6.19}{1.94} = 3.19$	δ_m/δ_y	3.23
$\boldsymbol{\delta_i}/\boldsymbol{\delta_y}$	$\frac{5.6}{1.94} = 2.89$	δ_i/δ_y	3.14
$\boldsymbol{\delta_x}/\boldsymbol{\delta_y}$	$\frac{5.25}{1.94} = 2.71$	δ_x/δ_y	3.07
$\boldsymbol{\delta_g}/\boldsymbol{\delta_y}$	$\frac{3.9}{1.94} = 2.01$	δ_g/δ_y	2.26
$\boldsymbol{\delta_c}/\boldsymbol{\delta_y}$	$\frac{2.31}{1.94} = 1.19$	δ_c/δ_y	1.05

which gives the parameter, $\lambda = {1600}/{4^4} = 6.25$ for the annual frequency; whereas $\lambda = 25$ $(i.e.\ 6.25x4^1)$ was used based on the recommendation of some other researchers for the annual frequency. The parameter $\lambda = 100$ $(i.e.\ 6.25x4^2)$ was also used to check the effectiveness of the smoothing parameter as suggested by Backus and Kehoe (1992) in their analysis of the behavior of cyclical components of national output. In addition, the parameter value λ = 400 $(6.25x4^3)$ was also checked with reference to Correia et al. (1992) for the annual frequency.

Turkish macroeconomic volatility

The volatility of investment is about three times as that of real GDP (Table 1). This finding is within the range of Backus and Kehoe (1992) conclusion who investigate the volatilities of ten countries and state that investment is consistently two to four times as variable as output. From Table 1, it is seen that δ is the variable's volatility, that is, the standard deviation of the variable's growth rate import is highly volatile followed by investment and export; whereas, real GDP and consumption are less volatile. The excess consumption volatility $\left(\frac{\delta_c}{\delta_y} = \frac{2.31}{1.94} = \mathbf{1.19}\right)$ shows that consumption is relatively more volatile than output. This finding agrees with the fact stated by Uribe and Schmitt-Grohe (2017) based on world average $\left(\frac{\delta_c}{\delta_y} = \mathbf{1.05}\right)$ that across countries, private consumption is more volatile than output. Ranking of standard deviations of Turkish national output from top to bottom is import, investment, export, government spending, consumption, real GDP (Table 2). This result is in line with the ranking of average standard deviations across-country. This reveals Turkey is not that different what is observed around the world.

Table 2 also reflects that output is less volatile in Turkish economy as well as the average around the world. The ranking of standard deviations shows that consumption in Turkey is relatively more volatile as compared to the average global ranking while the standard deviations of import, investment, export, and government are below the average standard deviations across-country. As compared to other variables, the standard deviation of consumption is not differing much from that of real GDP, which reflects that consumption is

Table 3. Volatility based on the quarterly frequency of period 1961:Q1 to 2018:Q4.

Parameter	GDP	Consumption	Investment	Government	Export	Import	Price
Turkey	1.94	2.31	5.60	3.90	5.25	6.19	3.08
South Africa	0.93	1.20	3.21	3.05	5.71	6.24	0.82
Japan	0.98	1.03	1.93	0.86	3.69	3.18	0.81
USA	0.73	0.58	1.78	0.77	3.19	3.10	0.55

Table 4. Volatility of annual frequency with different parameter **λ** of HP filter.

HP filter	GDP	Consumption	Investment	Government	Export	Import	Price
$\boldsymbol{\lambda = 6.25}$	3.24	4.39	12.13	6.78	10.18	13.65	5.57
$\boldsymbol{\lambda = 25}$	3.51	4.70	13.01	7.09	10.81	14.45	6.48
$\boldsymbol{\lambda = 100}$	3.65	4.82	13.55	7.26	11.23	14.83	7.64
$\boldsymbol{\lambda = 400}$	3.72	4.86	13.87	7.32	11.43	14.98	9.10

as volatile as output in Turkey as well as around the world, $\delta_c/\delta_y \approx 1$.

Volatility of Turkish economy relative to South Africa, Japan and USA

The aim of comparison of Turkish economy with South Africa, Japan and USA is to reflect the relative volatility of Turkish economy with the volatility of the country that has similar economic growth (such as South Africa) and the representative leading countries in economy (USA and Japan).

The volatility of national output reflects that real GDP, consumption, Investment, and government spending are more volatile in Turkey compared to South Africa, Japan and USA while import and export are more volatile in South Africa followed by Turkey (Table 3). Price in Turkish economy is highly volatile which is about four times as volatile as the average price volatility of South Africa, Japan, and USA. Real GDP, consumption and investment in Turkey are twice as volatile as the average volatility of South Africa, Japan and USA. Import and export are more volatile in emerging economies as compared to the developed countries.

These findings are consistent with that of Uribe and Schmitt-Grohe (2017) who summarize as business cycle in emerging or poor countries are about twice as volatile as business cycles in rich countries. Koren and Tenreyro (2007) state that developing countries specialize in a limited number of sectors, with relatively simple production technologies and a limited range of inputs, and are therefore more vulnerable to shocks in global prices.

Volatility of Turkey with annual frequency using different parameter, λ

Volatilities of macroeconomic variables increase with the smoothing parameter, λ (Table 4). Investment is four times as volatile as output; while price is twice as volatile as real GDP. The ranking based on volatility from top to bottom reveals import is highly volatile followed by export, investment, government, price, and consumption; while real GDP is the least volatile. This ranking is again coincides with the average ranking around the world.

Even though researchers commonly use the parameter $\lambda = 1600$ for quarterly frequency of observations, there is no agreement on the parameter value with annual frequency. In detrending the annual data, Ravn and Uhlig (2002) use $\lambda = 6.25$; whereas Backus and Kehoe (1992) use the smoothing parameter $\lambda = 100$. On the other hand, Correia et al. (1992) suggest $\lambda = 100$ for the annual frequency. Some other researchers also suggest different parameter ($\lambda = 25$). Now the question is, which smoothing parameter value is recommended for the frequency of annual observations?

To justify which smoothing parameter adjustment best outfits the annual frequency, the Turkish macroeconomic variables were examined for the period of 1961 – 2018, sampled at the quarterly and the annual frequency. The trend component of the quarterly data was compared, using $\lambda_{quarterly} = 1600$ with the trend components of the annual data using $\lambda_{annual} = 6.25,\ 25,\ 100,\ and\ 400$. The results are shown in Figures 1 and 2. The trend component of the quarterly data using $\lambda_{quarterly} = 1600$ and the trend component of the annual data using $\lambda_{annual} = 6.25$ are practically identical (Figure 1), whereas differences are observed for $\lambda_{quarterly} = 1600$

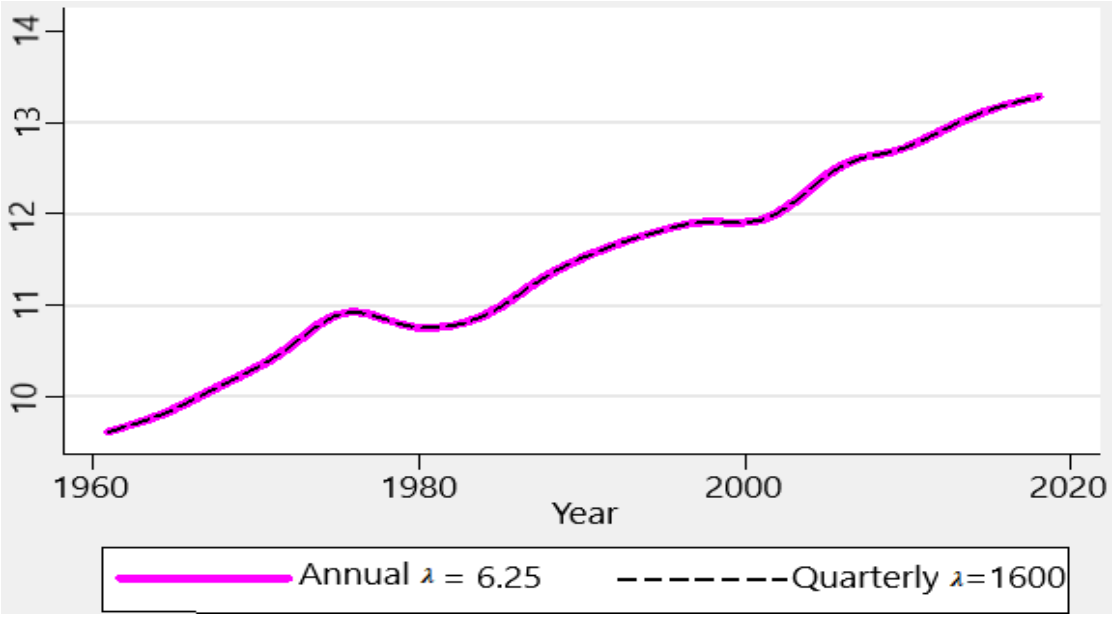

Figure 1. Trend component of Turkish investment at quarterly frequency $\boldsymbol{\lambda_{quarterly} = 1600}$ (broken line) and annual frequency of observations.

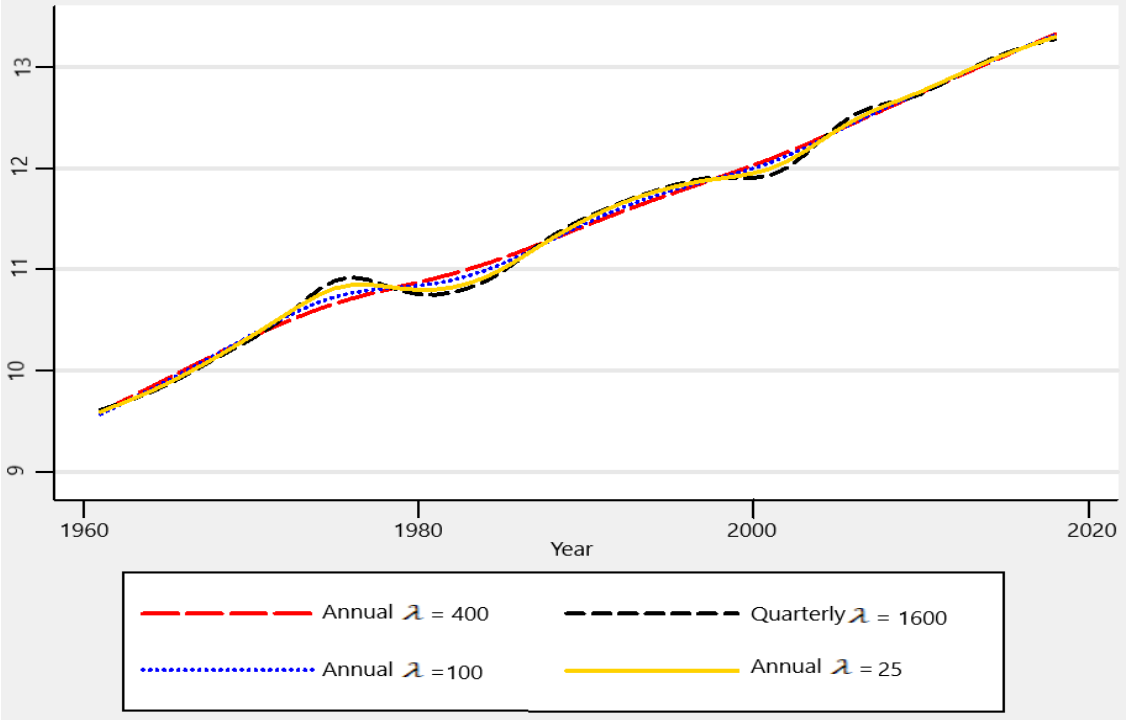

Figure 2. Trend component of investment at quarterly frequency annual frequency using different smoothing parameters.

and $\lambda_{annual} = 25,\ 100,\ and\ 400$ (Figure 2). These findings reflect that the annual frequency should be adjusted to the smoothing parameter $\lambda_{annual} = 6.25$. When the smoothing parameter increases from

Table 5. Cyclical behavior of Turkish economic variables deviations from trend of variables.

Business-cycle statistic	Correlation coefficient
corr(i, y)	0.73
corr(c, y)	0.68
corr(m, y)	0.56
corr(g, y)	0.37
corr(x, y)	0.31
corr(p, y)	-0.49
corr(π, y)	-0.15
corr(g/y, y)	-0.09

Source: Own computation from OECD data, 2019.

Table 6. Comparison of cyclicality across countries.

Business-cycle statistic	Turkey	South Africa	Japan	USA	World average
corr(i, y)	0.73	0.64	0.84	0.93	0.66
corr(c, y)	0.68	0.75	0.75	0.87	0.69
corr(m, y)	0.56	0.73	0.63	0.78	0.24
corr(x, y)	0.31	0.23	0.37	0.44	0.19
Corr(g/y, y)	-0.09	-0.38	-0.75	-0.74	-0.02

$\lambda_{annual} = 6.25$ to $\lambda_{annual} = 25,\ 100,\ or\ 400,$ the deviation from the trend value with the smoothing parameter $\lambda_{quarterly} = 1600$ becomes larger and larger (Figure 2). This clearly confirms that the adjustment in moving from the quarterly frequency to annual frequency observation should be $\lambda_{annual} = 6.25$. This adjustment holds true with all variables for Turkey, South Africa, Japan and USA as well. The investigation with different smoothing parameter, λ for the annual observation once again reflect that it is only with $\lambda_{annual} = 6.25$ that the trend component of the annual data coincides to that of the quarterly data with $\lambda_{quarterly} = 1600$.

Cyclical behavior of Turkish macroeconomic variables

Explaining the correlation coefficients of the cyclical deviations of each series with the cyclical deviations of real GNP, Kydland and Prescott (1990) state that a number close to one indicates that a series is highly *procyclical;* a number close to one but of the opposite sign indicates that a series is *countercyclical.* A number close to zero means that a series does not vary contemporaneously with the cycle in any systematic way, in which case the series is said to be *uncorrelated* with the cycle.

Table 5, the degree of contemporaneous co-movement with real GDP, indicates the correlation coefficients of the cyclical deviations of each series with the cyclical deviations of real GDP of Turkish quarterly frequency observations of period 1961 to 2018. Investment, consumption, import, export, and government are procyclical (positively correlated with output); whereas, price and inflation are countercyclical (negatively correlated with output). The share of government consumption in output (*g/y*) is acyclical or uncorrelated (Table 5). These findings also agree with the facts observed around the world as summarized by Uribe and Schmitt-Grohe (2017).

Comparison of contemporaneous co-movements with real GDP

Consumption and investment are highly procyclical across the countries. Import is highly procyclical in Turkey, South Africa, Japan, and USA as compared to the correlation of average import across the countries. The share of government consumption in output is more countercyclical in Japan and USA, unlike across countries that is roughly uncorrelated with output. This fact is well described by Uribe and Schmitt-Grohe (2017) as the share of government consumption is countercyclical in rich countries, but acyclical in emerging and poor countries. The government purchases have no consistent procyclical and countercyclical pattern (Table 6). This finding is in line with that of Kydland and Prescott (1990).

Table 7. Serial correlations of Turkey and the average across countries.

Business-Cycle	Turkey	South Africa	Japan	USA	World average
corr(y_t , y_{t-1})	0.78	0.81	0.78	0.87	0.71
corr(c_t , c_{t-1})	0.85	0.82	0.62	0.87	0.66
corr(i_t , i_{t-1})	0.85	0.84	0.83	0.90	0.56
corr(g_t , g_{t-1})	0.73	0.24	0.69	0.84	0.76
corr(x_t , x_{t-1})	0.80	0.26	0.76	0.69	0.68
corr(m_t , m_{t-1})	0.85	0.73	0.82	0.78	0.61
corr(o_t , o_{t-1})	0.88	0.37	0.74	0.51	36.5

o = (x + m)/y to determine whether or not the economy is open.

Persistence of economic variables in Turkey compared with across countries

All components of demand (*c, g, i, x*) and supply (*y, m*) are positively serially correlated in Turkey, South Africa, Japan, USA as well as across countries (Table 7). The economy of Turkey, South Africa, Japan and USA are more open compared to the average of world economy. Turkey and Japan economy is highly open as compared to USA and South Africa (Table 7).

Conclusion

The Turkish macroeconomic variables such as import, investment, and export are more volatile followed by government spending; while consumption and real GDP are less volatile. Generally, the Turkish economy is more volatile than South Africa, Japan and USA. Price in Turkey is highly volatile which is about four times as volatile as the average price volatility of South Africa, Japan, and USA. Output, consumption and investment in Turkey are twice as volatile as the average volatility of South Africa, Japan and USA. Import and export are more volatile in emerging economies as compared to the developed countries.

Volatility increases in moving from the quarterly frequency of observations to annual frequency of observation. This confirms that business cycle fluctuation is better expressed with the quarterly frequency compared to the annual frequency of observations. The trend component of annual frequency using the smoothing parameter of $\lambda_{annual} = 6.25$ is practically identical with the trend component of the quarterly data using $\lambda_{quarterly} = 1600$; whereas, the parameter value of $\lambda_{annual} = 25,\ 100,\ and\ 400$ lead to more deviation from the trend component of quarterly data. Hence the parameter $\lambda_{annual} = 6.25$ is more preferable to $\lambda_{annual} = 25,\ 100,\ and\ 400$ in detrending the annual frequency observations.

In Turkish economy, investment, consumption, import, export, and government are procyclical; price and inflation are countercyclical; whereas, the share of government consumption in output is acyclical. The components of aggregate demand (consumption, government spending, investment, and export) and aggregate supply (output and import) are all positively serially correlated in Turkey, South Africa, Japan, and USA; and their economies are more open compared to the economies across countries.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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