Estimating Effects of Uncertainty on the Turkish Economy[1]

Belirsizliğin Türkiye Ekonomisine Etkilerinin Tahmin Edilmesi

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Abstract

In this paper, an uncertainty measure for Turkey is developed through principal component analysis based on a number of uncertainty proxies from three main financial markets and the Expectations Survey. Then, using this measure, a vector autoregression model is constructed to estimate the effects of uncertainty shocks on the Turkish economy. The results present evidence that uncertainty shocks are associated with a fall in industrial production, worsening consumer confidence, and rises in unemployment, inflation and credit interest rates. Uncertainty shocks seem similar to supply shocks, which cause economic activity to fall and inflation to rise.

Keywords: *Principal component analysis, Turkish economy, uncertainty, vector autoregression*

Jel Codes: *E30, E32, E37, E44*

Öz

Bu çalışmada, Türkiye için temel bileşen analizi yöntemi aracılığıyla, üç ana finansal piyasadan ve Belirsizlik Anketi'nden belirsizliği temsil eden bir dizi değişken kullanılarak bir belirsizlik ölçütü oluşturulmuştur. Ardından, bu ölçütü kullanılarak, belirsizlik şoklarının Türkiye ekonomisi üzerindeki etkilerini tahmin etmek için bir vektör otoregresyon modeli kurulmuştur. Sonuçlar, belirsizlik şoklarının sanayi üretimdeki düşüş, tüketici güveninde bozulma ve işsizlik, enflasyon ve kredi faiz oranlarındaki artış ile ilişkili olduğuna dair kanıtlar sunmaktadır. Belirsizlik şoklarının etkileri, ekonomik aktivitede düşüşe enflasyonda ise yükselişe neden olan arz şoklarına benzer görünmektedir.

Anahtar Kelimeler: *Temel bileşen analizi, Türkiye ekonomisi, belirsizlik, vektör otoregresyon*

Jel Kodları: *E30, E32, E37, E44*

Introduction

The 2008/2009 global financial crisis reminded that the world is surrounded by complexity and uncertainty. The several aspects of the crisis drew attention to the uncertainty that stems from 'unknown risk' that is not measurable because of: (i) lack of accurate information about the amount and

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location of risks (ii) inability to precisely assess the value of assets (iii) lack of thorough information about the current state of the economy, and (iv) absence of precise information about how policy actions, particularly unconventional ones, would affect the economy. Accordingly, uncertainty has been highlighted as one of the drivers of global financial crisis and causes of slow recovery afterwards.

Against this backdrop, the empirical literature on the measures of uncertainty and its impacts on the economy have witnessed a rapid growth in the wake of the global crisis. Measuring uncertainty is not a straightforward exercise because of its unobservable nature and varying sources. Accordingly, researchers have relied on proxies of uncertainty and/or constructed uncertainty measures through statistical techniques. These proxies and/or measures have been utilized to analyse the impacts of uncertainty on the macroeconomy.

Studies have shown that uncertainty affects an economy through several channels both from the demand side and the supply side. It can have an effect on the level of demand for goods and services in the economy through consumption and investment decisions. On the supply side, uncertainty can influence the economy via its impact on productivity and credit provision. Uncertainty can also have a negative impact on the economy through rising premia, which in turn dampen asset prices and the wealth of investors holding these assets in their portfolios. Since uncertainty raises the possibility of default, banks can also demand higher interest rates, resulting in an increase in the cost of debt financing. As a result, in both cases the rising cost of finance would derail investment and consumption, and hence economic activity.

The breadth and magnitude of 2008/2009 global crisis, which have financial origins, has brought the role of financial markets in particular to the attention of business cycle analysts. The developments in the financial markets during the global crisis highlighted the importance of credit markets, leverage, and asset prices in understanding business cycle fluctuations. In this context, various aspects of the relationship between financial variables and the business cycle are well documented in the recent literature. Moreover, as Gilchrist et al. (2014) underline the rise in asset price volatility and the credit spreads during the crisis have led to a growing literature that suggests financial market frictions as an additional channel through which fluctuations in uncertainty can transmit macroeconomic outcomes.

Despite the increasing interest in uncertainty and its effects, the number of studies that form uncertainty measures and estimate the effects of uncertainty on the Turkish economy has remained limited. In this context, the contribution of this paper is twofold. First, a novel uncertainty measure

for Turkey is formed through principal component analysis (PCA) using implied and realized volatilities of financial indicators as well as survey-based data.

Second, the macroeconomic impacts of uncertainty on the Turkish economy are estimated for the period of June 2005-August 2015 via a VAR analysis using this novel uncertainty measure. In the case of emerging economies such as Turkey, where uncertainty and its effects can be much higher than in advanced economies, ignoring uncertainty may significantly increase the probability of making policy errors. The analyses in this paper would help policymakers to have a better understanding of the level of prevailing uncertainty and design the appropriate policy in response to uncertainty shocks.

The findings suggest that elevated uncertainty has a negative impact on output and unemployment in Turkey. The impulse responses show that the maximum effects on industrial production and unemployment take place in six months and eight months after the shock, respectively. In response to an uncertainty shock consumer confidence bottoms out in two months and credit interest rates reach their peak in three months. On the other hand, CPI slightly increases following an uncertainty shock. The impulse responses of industrial production and CPI may jointly imply that uncertainty shocks operate via the aggregate supply channel in Turkey, tending to depress economic activity while increasing inflation.

The remainder of the paper is organized as follows. Section 1 surveys the literatures both on measures of uncertainty and estimating effects of uncertainty on an economy. Section 2 describes the methodologies in the formation of an uncertainty measure for Turkey and in estimating impacts of uncertainty on its economy. Section 3 documents and discusses results of the analysis, and the last section offers a conclusion.

1. Literature Review

1.1. Measuring Uncertainty

Measuring uncertainty is a challenging exercise given its unobservable nature. As a result, studies rely on proxies. In the literature, uncertainty measures are obtained in four ways:

One common approach is using volatility (either realized or implied) of economic and financial indicators. This method is used by Leahy and Whited (1996), Bloom (2009), Basu and Bundick (2012), Bloom et al. (2013), Caggiano et al. (2014), Leduc and Liu (2015), Popp and Zhang (2015) and Knotek II and Khan (2011), among many others. Generalized autoregressive conditional heteroskedasticity (GARCH) models are also utilized in order to

obtain the variance series that are regarded as uncertainty measures (Asteriou and Price, 2005; Berument et al., 2007; Bloom et al., 2014).

Another popular approach is using survey-based measures that show economic agents' perceived uncertainty about their future economic situation. In this strand, uncertainty is measured using forecast disagreements, that is dispersion of the point forecasts which can be estimated by variance or standard deviation (Baker et al. 2013; Bloom et al., 2014; Bachmann et al., 2013), forecast errors, that is variance of the difference between the forecast and realization (Bachmann et al., 2013; Arslan et al., 2011; Rossi and Sekhposyan, 2015) and utilizing responses to questions with direct references to uncertainty (Leduc and Liu, 2015).

Some studies rely on news-based keywords to construct economic policy uncertainty (Baker et al., 2013; Alexopolous and Cohen, 2009), which is supposed to capture uncertainty about policy actions or inactions and their effects. The number of uncertainty-related keywords in newspapers is counted on the basis that the unpredictability of future policy actions and their impacts constitutes one of the sources of uncertainty.

Measuring common variability across a number of indicators through statistical techniques such as PCA is also widely employed in construction of uncertainty proxies (ECB, 2013; Hadow and Hare, 2013; IMF, 2012; Creal and Wu, 2014; Jurado et al., 2015). PCA reveals the hidden structures that underlie the different uncertainty indicators. PCA summarizes underlying common information within several indicators that leads to a more succinct representation of uncertainty. This avoids dependency on a small number of observable variables.

1.2. Macroeconomic Effects of Uncertainty

The literature on the macroeconomic effects of uncertainty documents that uncertainty shocks can be significant sources of economic fluctuations. There are a number of channels through which an unexpected uncertainty shock may affect macroeconomic aggregates. One of the channels emphasizes the irreversible nature and real option feature of investments. High uncertainty weighs negatively on investment decisions through the "wait and see" approach (Bernanke, 1983; Dixit and Pindyck, 1994). In the face of heightened uncertainty, firms postpone investment decisions because they are costly to reverse.

The response of households to high uncertainty is found to be similar to that of firms. Households in the US increase their precautionary savings (Romer, 1990; Carroll, 1996) as they wait for new information that will increase certainty. Such behaviour reduces consumption spending (Knotek II and Khan, 2011) or increases their income, which will cause higher labour supply. Over time, when uncertainty dissipates, a temporary rise in the

spending may appear as the households see that they have fewer big ticket items than the optimal level.

The effects of uncertainty on the labor market are also examined in the literature. Firms in the US delay their hiring and firing plans in the presence of elevated uncertainty due to costly adjustment of inputs (Bloom, 2009). Caggiano et al. (2014) examine the effects of uncertainty shocks on unemployment dynamics during post-world war II U.S. recessions with a Smooth-Transition VAR framework. Their findings show that uncertainty shocks have larger impacts on unemployment during recessions.

Some recent studies suggest that the financial channel also plays an important role in transmission of uncertainty shocks (Arellano et al., 2012; Gilchrist et al., 2014; Popp and Zhang, 2015; Bonciani and Roye, 2015; Alfaro et al., 2018). Some of these studies assert that uncertainty may raise the risk premium in financial markets, leading to a rise in the cost of capital and, hence, depressed growth. Others provide evidence that frictions intensify the original effects of uncertainty shocks on the economic activity and generate more persistent shocks. Alfaro et al. (2018) report that higher uncertainty, together with financial frictions, generates the real options effect on investment and hiring, but also increases cash holdings of firms, further reducing investment and hiring. Jermann and Quadrini (2012) develop a model with financial frictions incorporating the pecking order theory of debt and equity financing to explore the impacts of financial shocks on the US economy. They find that shocks to firms' ability to borrow, together with rigidities in the capital structure adjustment, has an important role in generating business cycle fluctuations. They also show that the tightening of firms' financing conditions contributed notably to the fall in output and labour in 2008-2009. Lopez-Salido et al. (2016) study the role of credit-market sentiment as a driver of the business cycle and provide evidence that investor sentiment can help explain fluctuations in the economic activity. They claim that elevated credit-market sentiment forecasts a change in the composition of external finance whereby net debt issuance declines and net equity issuance rises. They argue that credit-market sentiment seems to forecast a fall in credit supply, which is likely to be responsible for some of the fall in activity. Caldara et al. (2016) discriminate the effects of financial and uncertainty shocks on the business cycle through the penalty function approach. Their results suggest that financial shocks have an adverse impact on the economy and uncertainty shocks have negative effects when they cause tightening of financial conditions. Moreover, the combination of financial and uncertainty shocks fully accounts for the contraction in the industrial output and the stock market during the Great Recession. Fernandez-Villaverde et al. (2011) investigate effects of volatility in borrowing rates for four emerging economies (Argentina, Ecuador, Venezuela, and Brazil) on output, consumption, investment, and hours worked. They find that a rise in interest

rate volatility generates a fall in output, consumption, investment, and hours worked, and a noteworthy change in the current account. They argue that following an uncertainty shock, households with precautionary behaviour adjust their holdings of foreign debt to diminish fluctuations in future marginal utility.

On the other hand, more recent studies explore the role of financial uncertainty in business cycle fluctuations. In this strand, Ludvigson et al. (2018) claim that the financial market uncertainty is a likely source of output fluctuations, while macro uncertainty increases endogenously in response to output shocks. Moreover, Dlugoszek (2018) shows that an increase in the financial uncertainty raises the risk premium and leads to a decline in output, consumption, investment and hours worked mainly due to an endogenous tightening of the financial constraint. He provides evidence that households provide less funding to financial intermediaries because of an increase in financial uncertainty and this triggers the financial accelerator mechanism. Choi et al. (2018) compare the effects of financial uncertainty shocks with policy uncertainty shocks on six emerging economies (Brazil, Chile, China, India, Korea, and Russia). Their results suggest that financial uncertainty shocks have a larger impact on output than policy uncertainty shocks, except in China where the government has control over financial market activity.

International transmission of uncertainty shocks is also examined by a set of papers. These mainly aim to identify level of spillovers, their exporters/importers, and their dynamics. Spillovers are mostly examined in the context of transmission among developed economies (Colombo, 2013; Klossner and Sekkel, 2014; Mumtaz and Theodoridis, 2012) and from developed economies (or global shocks) to emerging economies (Gauvin et al., 2014; Carriere-Swallow and Cespedes, 2013).

In the recent literature the VAR system is frequently used to estimate the effects of uncertainty on an economy. The VAR system is particularly useful when the dynamic relationships between variables are analysed. The studies use different VAR specifications to estimate the impacts of uncertainty. The system has been used to identify the effects of uncertainty on the US economy by Bloom (2009), Baker et al. (2013), Alexopoulos and Cohen (2009), Knotek II and Khan (2011), Rossi and Sekhposyan (2015) and on the UK economy by Denis and Kannan (2013) and Haddow and Hare (2013).

Bloom (2009) estimates a series of VAR models to quantify the impact of uncertainty on economic outcomes in the US from June 1962 to June 2008. The complete set of variables are the S&P 500 stock market index (as a control variable), a stock-market volatility indicator, the Fed funds rate, hourly earnings, the consumer price index, employment, and industrial production. According to his findings, there is a strong countercyclical relation between economic activity and uncertainty. Impulse responses show that an

uncertainty shock initially depresses employment and output, and then leads to recovery and overshoot.

Baker et al. (2013) estimate VAR models to quantify the impact of policy uncertainty on economic outcomes. Their findings indicate that the increase in policy uncertainty in the US had significant negative effects on industrial production and on employment. Effects on industrial production and employment peak at about 10 and 18 months, respectively.

Alexopoulos and Cohen (2009) construct bi-variate and multi-variate VAR models with monthly data for the period of 1962-2008 in order to examine the impact of two measures of uncertainty. They present evidence that an unanticipated rise in uncertainty leads to sharp and short-lived recessions. Industrial production, employment, productivity, consumption and investment fall, while unemployment rises in response to uncertainty shocks.

Quantifying the economic impact of uncertainty shocks in the UK through a VAR analysis for the recent Great Recession period, Denis and Kannan (2013) find that uncertainty shocks have a significant impact on economic activity in the UK, depressing industrial production and GDP. Contrasting with the general view, their results also show that unemployment is unresponsive to uncertainty shocks.

2. Methodology

2.1. Forming an Uncertainty Measure for Turkey

What is meant by uncertainty in this paper has two main aspects. The first relates to its nature. It is unquantifiable and unobservable. The second involves its substance. Uncertainty originates from diverse sources and has different components. To reflect these aspects, a PCA is performed in the formation of an uncertainty measure for Turkey using a number of proxies from three main financial markets and the Expectations Survey. The PCA enables summarisation of the information content of these proxies within the extracted principal components and in turn, provides a more complete picture. In doing so, the uncertainty measure encapsulates both economic uncertainty and policy uncertainty. The underlying idea is to identify unobserved common elements in a summary statistic.

As a first step in the formation of an uncertainty measure for Turkey, variables that reflect realized (or historical) volatility, implied volatility and dispersion of expectations (survey based) are chosen as proxies of uncertainty. Indicators chosen include the BIST 100 stock index, implied exchange rate volatility, the benchmark interest rate, the cross currency swap rate, the forward implied yield, the interest rate swap rate, inflation expectations and EMBI-Turkey (Table 1.). These indicators are presumed to reveal the

conditions in the three main markets i.e. bond market, foreign exchange market and equity market. Including all the main markets should avoid catching distress that takes place only in a specific segment of the financial markets. In addition, survey based data ensures that the analysis includes views of respondents about future economic conditions.
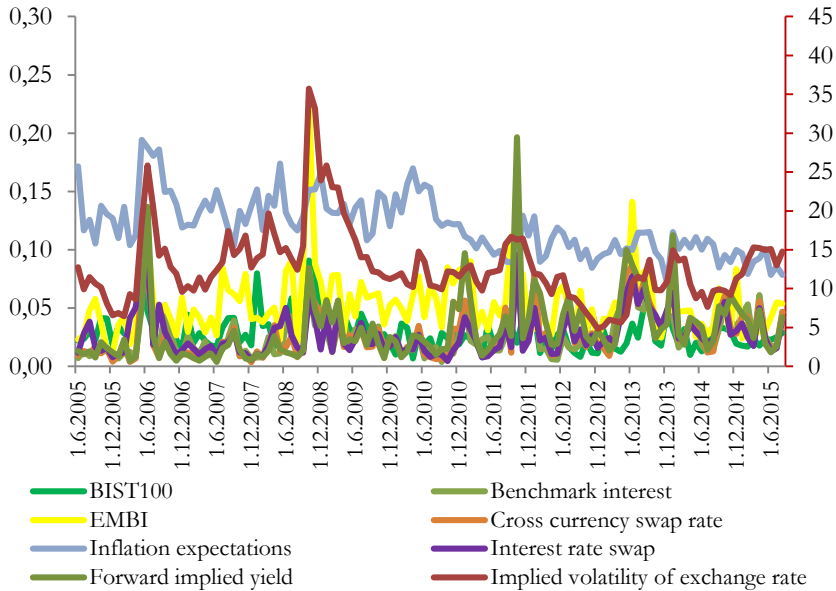
Table 1. Variables Used in PCA

Variable	Definition	Source
The BIST 100 Index	The main index for Borsa İstanbul Equity Market that includes 100 companies' stocks.	Bloomberg
Implied exchange rate volatility	A measure of market expected future volatility of a currency exchange rate, TRY/USD	Bloomberg
The benchmark interest rate	The annual interest rate of Treasury bills, 2 year	Bloomberg
The cross currency swap rate	The TRY/USD fixed vs floating swap, 1 year	Bloomberg
EMBI-Turkey	Turkey's sovereign spread	Bloomberg
The forward implied yield	The annualized interest rate derived from covered interest rate parity theorem, 3 month	Bloomberg
The interest rate swap rate	The Turkish lira fixed vs floating swap	Bloomberg
Inflation expectations	Expected CPI over the next 12 months	Central Bank of Turkey - Survey of Expectations

Note: Volatilities of series are used in the PCA.

In order to calculate monthly volatility of the series, daily coefficient of variations is calculated by using 21-trading days (or one-month) moving averages. Then, the frequency of the dataset is converted from daily to monthly by picking end of month values. The analyses cover the period of June 2005-August 2015 given the constraints on data availability before 2005. Prior to applying PCA to these series, a visual inspection is carried out in order to determine whether PCA is in fact a meaningful procedure for the data set. A visual inspection of all the variables in Figure 1. reveals that while there is some variation among the different proxies of uncertainty for Turkey, they tend to move together, pointing to the existence of an uncertainty component common to all measures. This suggests that PCA is suitable to analyse

the patterns in the data. The sampling adequacy is also assessed by examining the Kaiser-Meyer-Olkin (KMO) measure. The overall KMO value (0.78) supports the conclusion that the data set is suitable to perform PCA[3].

Figure 1. Volatility of Variables

After the identification of unobserved common factors and examining the KMO measures, a PCA is carried out using eight variables. Results of the PCA show that 50% of the total variance of the underlying series is explained by the first principal component. Thus, the derived factor explains a satisfactory amount of the common variation in underlying uncertainty of the sample. Since the eigenvalue of the first principal component is greater than 1.0, it explains more variance than a single variable, specifically 4.02 times as much. Accordingly, the uncertainty measure for Turkey (Figure 2.) is obtained by extracting the first PCs.

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[3] The OECD (2008) states that a KMO overall should be 0.6 or higher to proceed with the factor analysis.
Appendix A presents the KMO values for each variable in the data set.

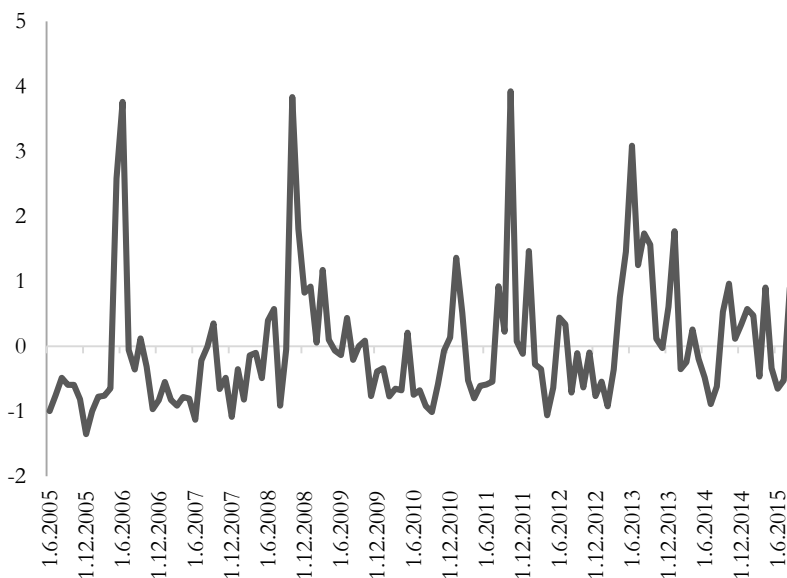**Figure 2. The Uncertainty Measure for Turkey (Monthly, 8-variable)**

Figure 2. illustrates that uncertainty appears to spike in response to significant events such as domestic economic and political issues in May 2006, collapse of the Lehman Brothers in October 2008, the Europe crisis in 2011, and the taper tantrum[4], which coincided with domestic political events (Gezi events) in the summer of 2013. This suggests that the sources of spikes in uncertainty seem widespread, and are both domestic and international.

The rise in uncertainty in May 2006 reflects concerns about the independence of key institutions, further progress in structural reforms and some emerging political tensions within Turkey (OECD, 2006). Accordingly, its origins are domestic. On the other hand, the increase in uncertainty in October 2008 originated from international sources. The concurrent spread of the effects of failure of the Lehman Brothers in September 2008 to the financial markets of a number of countries led to the widespread belief that there was a contagion effect. As Kazi and Wagan (2014) argue, the presence of herding behaviour among international investors and correlated trading across large institutional investors in the face of rising uncertainty resulted in contagion and exacerbated the conditions in emerging financial markets. Turkish financial markets faced sharp movements after the collapse of Lehman Brothers.

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[4] The taper tantrum is the reaction of financial markets in emerging countries, including Turkey, to the announcement of the Fed's intention to conclude its quantitative easing program.

The rise in the uncertainty measure for Turkey in the summer of 2013 originated from a combination of domestic and international sources. Following statements by Fed Chairman Ben Bernanke[5], expectations grew that the Fed would soon start lessening the amount of monetary stimulus it was providing to the economy through its unconventional monetary policies. However, the timing and pace of this tapering was uncertain. There were sharp movements in U.S. and global financial markets, including a large sell-off emerging assets by international investors, resulting in depreciations of currencies, and a rise in bond yields and EMBI and CDS spreads, as well as falls in equity markets (Shagil et al., 2015). Turkish financial markets were not immune from the global sell-off and the uncertainty was compounded by domestic events took place.

2.2. Estimating Effects of Uncertainty on the Turkish Economy

A seven-variable VAR model is constructed to estimate the impact of uncertainty shocks on the Turkish economy. Monthly data is used for the time span of June 2005-August 2015. The variables included in the VAR model are the uncertainty measure, the economic conditions index, the unemployment rate, the industrial production index, CPI, the credit interest rates, and the consumer confidence index. An economic conditions index is included in the data set to control for the impact of the general outlook. Periods of worsening outlook and increased uncertainty may take place simultaneously. Uncertainty increases when the future looks bleaker, so the results may reflect the impact of worsening in the outlook, rather than uncertainty shocks. Using a control variable helps to minimize the possibility that the uncertainty measure is simply grasping a deterioration of the outlook.

The industrial production index, the consumer price index and the consumer confidence index are used in log levels. The credit interest rates and the unemployment rate are included in percent. All variables are seasonally adjusted.

Before setting up the VAR model, all variables are HP detrended[6], except the economic conditions index and the uncertainty measure. Use of an HP filter renders variables stationary[7]. Augmented Dickey Fuller (ADF), Dickey-

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[5] In his testimony to Congress on May 22, 2013, Bernanke stated that the Fed was likely to start slowing, that is tapering, the pace of its bond purchases later in the year, conditional on continuing good economic news. At his press conference on June 19, 2013, Bernanke described economic conditions optimistically and again suggested that asset purchases might be reduced later in 2013.

[6] Bloom (2009), Alexopoulos and Cohen (2009), Knotek II and Khan (2011) and Denis and Kannan (2013) also use HP filter.

[7] The filter separates the trend from the cyclical component of a time series.

Fuller-GLS (DF-GLS) and Phillips Perron (PP) tests are performed in order to confirm that the series have no unit roots[8].

Shocks are identified with a Cholesky decomposition of the variance–covariance matrix of the residuals. The Cholesky decomposition involves recursive contemporaneous ordering among variables. This means that no variable depends contemporaneously on the variables ordered subsequently.

Following the recent literature, uncertainty is ordered first[9]. Subsequent ordering of the variables also complies with the common practices in the literature. It is based on the assumptions that prices can respond to these shocks immediately but quantities respond in a longer time, similar to Bloom (2009) and Alexopoulos and Cohen (2009). Accordingly, the variables are ordered as follows suggesting that that shocks quickly influence economic conditions and the consumer confidence, then prices (CPI and credit interest rates), and finally quantities (industrial production, unemployment):

(1) Uncertainty measure (U), (2) Economic conditions index (ECI), (3) Consumer confidence index (CCI), (4) Consumer price index (CPI), (5) Credit interest rate (INT), (6) Industrial production index (IP), and (7) Unemployment rate (UNP).

The Cholesky ordering in which the uncertainty measure is ordered first implies that the impulse responses to uncertainty shocks have already been purged from the effects of other shocks. That is to say, uncertainty does not respond to macroeconomic shocks in the impact period, but economic conditions, consumer confidence, inflation, the credit interest rate, industrial production and unemployment are allowed to respond to an uncertainty shock.

The set of (seven) equations in the model are depicted below. The appropriate lag length is determined as three[10]. The current values of each variable (at time t), on the left-hand side, depends on the first three lags of itself and all other variables (observed values at time t–1, t–2 and t-3), plus a contemporaneous shock, ε_t:

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[8] According to the results reported in Appendix B, all of the series are stationary in levels.

[9] Baker et al. (2011; 2013; 2015), Denis and Kannan (2013) and Alexopoulos and Cohen (2009), Jurado et al. (2015) and Bachmann et al. (2013) also ordered uncertainty measures first.

[10] Schwarz information criterion (SC) and final prediction error (FPE) suggest a model with one and two lags, while sequential modified LR test statistic and Akaike information criterion (AIC) select a model with twelve lags. Appendix C shows the optimum lag structure for the VAR. The proper lag length is chosen as 3 because it is the minimum lag sufficient to eliminate serial correlation and heteroskedasticity in the residuals. The results reported in Appendix D and Appendix E reveal that the residuals do not display any serial correlation, and are homoscedastic.

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\begin{bmatrix} U_t \\ ECI_t \\ CCI_t \\ CPI_t \\ INT_t \\ IP_t \\ UNP_t \end{bmatrix} = \begin{bmatrix} A_{01} \\ A_{02} \\ A_{03} \\ A_{04} \\ A_{05} \\ A_{06} \\ A_{07} \end{bmatrix} + \begin{bmatrix} A1_{11} & A1_{12} & A1_{13} & A1_{14} & A1_{15} & A1_{16} & A1_{17} \\ A1_{21} & A1_{22} & A1_{23} & A1_{24} & A1_{25} & A1_{26} & A1_{27} \\ A1_{31} & A1_{32} & A1_{33} & A1_{34} & A1_{35} & A1_{36} & A1_{37} \\ A1_{41} & A1_{42} & A1_{43} & A1_{44} & A1_{45} & A1_{46} & A1_{47} \\ A1_{51} & A1_{52} & A1_{53} & A1_{54} & A1_{55} & A1_{56} & A1_{57} \\ A1_{61} & A1_{62} & A1_{63} & A1_{64} & A1_{65} & A1_{66} & A1_{67} \\ A1_{71} & A1_{72} & A1_{73} & A1_{74} & A1_{75} & A1_{76} & A1_{77} \end{bmatrix} \begin{bmatrix} U_{t-1} \\ ECI_{t-1} \\ CCI_{t-1} \\ CPI_{t-1} \\ INT_{t-1} \\ IP_{t-1} \\ UNP_{t-1} \end{bmatrix}
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+ \begin{bmatrix} A2_{11} & A2_{12} & A2_{13} & A2_{14} & A2_{15} & A2_{16} & A2_{17} \\ A2_{21} & A2_{22} & A2_{23} & A2_{24} & A2_{25} & A2_{26} & A2_{27} \\ A2_{31} & A2_{32} & A2_{33} & A2_{34} & A2_{35} & A2_{36} & A2_{37} \\ A2_{41} & A2_{42} & A2_{43} & A2_{44} & A2_{45} & A2_{46} & A2_{47} \\ A2_{51} & A2_{52} & A2_{53} & A2_{54} & A2_{55} & A2_{56} & A2_{57} \\ A2_{61} & A2_{62} & A2_{63} & A2_{64} & A2_{65} & A2_{66} & A2_{67} \\ A2_{71} & A2_{72} & A2_{73} & A2_{74} & A2_{75} & A2_{76} & A2_{77} \end{bmatrix} \begin{bmatrix} U_{t-2} \\ ECI_{t-2} \\ CCI_{t-2} \\ CPI_{t-2} \\ INT_{t-2} \\ IP_{t-2} \\ UNP_{t-2} \end{bmatrix}
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+ \begin{bmatrix} A3_{11} & A3_{12} & A3_{13} & A3_{14} & A3_{15} & A3_{16} & A3_{17} \\ A3_{21} & A3_{22} & A3_{23} & A3_{24} & A3_{25} & A3_{26} & A3_{27} \\ A3_{31} & A3_{32} & A3_{33} & A3_{34} & A3_{35} & A3_{36} & A3_{37} \\ A3_{41} & A3_{42} & A3_{43} & A3_{44} & A3_{45} & A3_{46} & A3_{47} \\ A3_{51} & A3_{52} & A3_{53} & A3_{54} & A3_{55} & A3_{56} & A3_{57} \\ A3_{61} & A3_{62} & A3_{63} & A3_{64} & A3_{65} & A3_{66} & A3_{67} \\ A3_{71} & A3_{72} & A3_{73} & A3_{74} & A3_{75} & A3_{76} & A3_{77} \end{bmatrix} \begin{bmatrix} U_{t-3} \\ ECI_{t-3} \\ CCI_{t-3} \\ CPI_{t-3} \\ INT_{t-3} \\ IP_{t-3} \\ UNP_{t-3} \end{bmatrix} + \begin{bmatrix} \varepsilon_{t1} \\ \varepsilon_{t2} \\ \varepsilon_{t3} \\ \varepsilon_{t4} \\ \varepsilon_{t5} \\ \varepsilon_{t6} \\ \varepsilon_{t7} \end{bmatrix}
$$

where A_0 is a (7×1) vector of constants, A_1, A_2 and A_3 are (7×7) coefficient matrices and ε_t denotes a (7×1) vector of noise residuals.

3. Empirical Results and Discussion of Key Findings

The VAR model for Turkey confirms most of the stylized facts in the literature concerning the macroeconomic implications of uncertainty shocks. Country specific results emerge from the model as well. The results are robust to a series of checks with respect to different ordering of variables, excluding control variable, and shortening the time period to cover the post-global crisis period.

Figure 3 plots impulse response functions of variables to a one standard deviation uncertainty shock along with error bands. While the magnitudes of impulse responses are not large, the results appear broadly consistent with a view that the impact of uncertainty on industrial production and unemployment occurs through a "wait and see" mechanism. The findings present evidence that when the bout of uncertainty subsides, firms cautiously increase the pace of production and hiring to meet the recovering demand. Surges in uncertainty have relatively quick and persistent effects on production and employment, consistent with the findings in the literature. The peak impact on industrial production occurs six months after the shock and the effect unwinds after about eighteen months. This response path is similar to that of the UK as described by Dennis and Kannan (2013). The
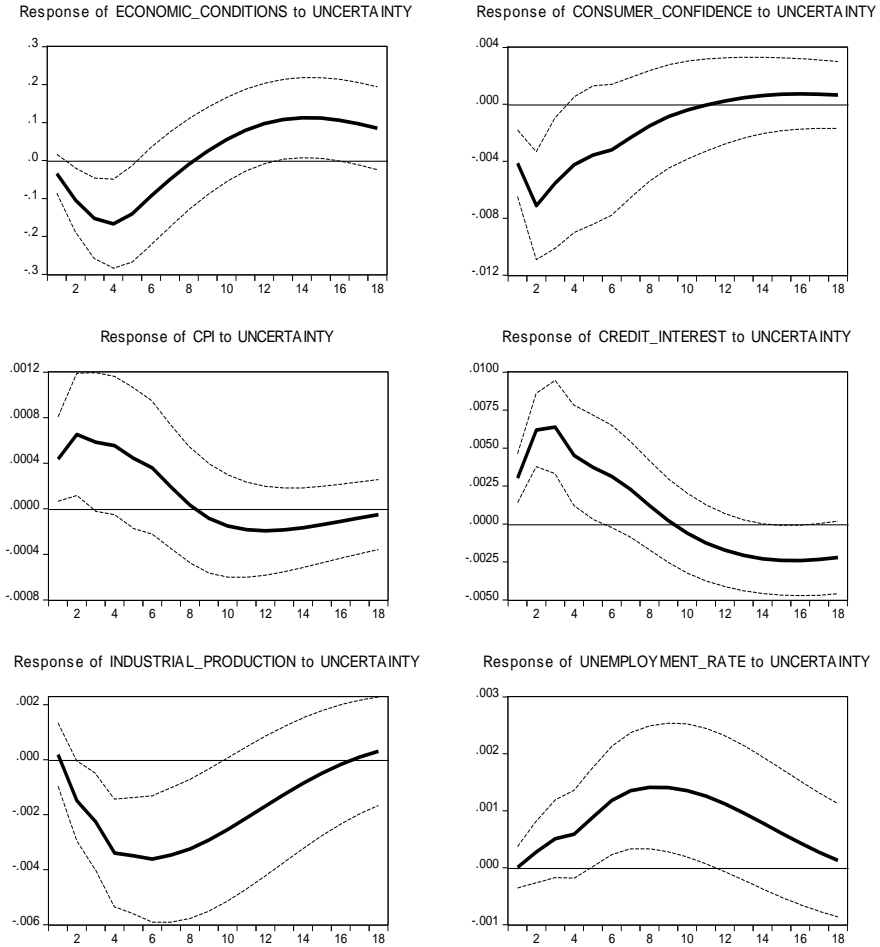
maximum impact on unemployment in Turkey takes place two months later than industrial production and the effect of the shock wanes after 20 months. One interesting result is that overshoot in the production is not observed. This suggests that on top of the "wait and see" mechanism, other channels of transmission may be at work in shaping the response of the economy to uncertainty shocks.

In the face of uncertainty, the financial frictions channel may manifest itself through a fall in the demand for or supply of credit, which may lead to a rise in the cost of borrowing. The worsening in consumer confidence could also affect the real economy through a reduction in consumption expenditures in line with the evidence provided in the literature (Karasoy and Yüncüler, 2015; Bram and Ludvigson, 1998; Dion, 2006; Acemoglu and Scott, 1994). This study finds some support for the operation of financial and confidence channels in the transmission of uncertainty shocks. The effects of such shocks on consumer confidence and the credit interest rate have a relatively sharp and short nature compared to their impact on industrial production and unemployment. In response to an uncertainty shock consumer confidence bottoms out in two months and the effect of the shock dissipates in twelve months. Credit interest rate reaches its peak in three months and the effect of the shock fades in nine months.

As shown in Figure 3. an uncertainty shock leads to a slight increase in inflation in two months. The duration of the response to the uncertainty shock lasts for 8 months. If this analysis were done for an advanced country, one might expect a positive uncertainty shock to act like a negative aggregate demand shock that leads to increases in unemployment and declines in inflation. For example, Leduc and Liu (2015) find that an uncertainty shock in the US leads to a rise in unemployment and a fall in inflation.

Figure 3. Impulse Responses to Uncertainty Shock

Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E.

The slight rise in inflation in Turkey following an uncertainty shock may be due to worsening in inflation expectations because of the past history of high and chronic inflation in Turkey. On the other hand, amid heightened uncertainty, countries with large external financing needs, such as Turkey, experience capital flight and currency depreciation. Therefore, another reason behind the increase in inflation in response to an uncertainty shocks may be capital reversal that may exert downward pressure on the Turkish lira.

In the case of Turkey, the effects of uncertainty shocks seem to be similar to those of a fall in aggregate supply. It is known that a fall in aggregate supply reduces economic activity and puts upward pressure on inflation.

Policymakers face a trade-off between output and price stability when dealing with supply side shocks, unlike demand shocks, which affect output and inflation in the same direction, thereby somewhat simplifying the policy response.

Conclusion

It is a challenge to measure uncertainty, given its unobservable nature and varying sources. Studies therefore rely on proxies, which can be divided into four categories: i) Measures based on volatility of indicators, ii) Measures based on surveys, iii) Measures based on frequency of keywords in newspapers and iv) Measures based on common variability of several indicators.

This paper develops an uncertainty measure based on indicators from three main financial markets and the Expectations Survey for Turkey, and examines the effects of uncertainty on the Turkish economy. These market indicators are chosen in order to capture the conditions in the three main markets: bonds, foreign exchange and equity market. The addition of survey-based data incorporates into the analysis the perceptions of respondents about future economic conditions. The uncertainty measure is estimated as the first principal component of eight variables, which suggests that uncertainty is a measure of common variation across these series. The first principal component from the PCA sufficiently captures the common variation of the underlying series, and hence could be regarded as an uncertainty measure for Turkey. The uncertainty measure for Turkey highlights four important incidents of uncertainty in the last decade, originating from domestic and international sources or both. These episodes occurred in May 2006 (domestic issues), October 2008 (collapse of Lehman Brothers), 2011 (Europe crisis), the summer of 2013 (taper tantrum coinciding with domestic events).

Overall, a seven-variable VAR model constructed with the novel measure of uncertainty obtained from PCA provides evidence that an uncertainty shock leads to a rise in unemployment, fall in industrial production, increases in inflation and credit interest rates together with a worsening in consumer confidence in Turkey. The maximum effect for industrial production takes place in six months after the uncertainty shock, while the response becomes statistically negligible after about eighteen months. The maximum impact on unemployment occurs two months later and the effect of the shock unwinds after twenty months. Credit interest rate and consumer confidence respond and return to trend faster than industrial production and unemployment. Uncertainty shocks put some upward pressure on the credit interest rate for three months, and the effect dies down in nine months. The response of consumer confidence bottoms out in two months and fades away in twelve months. An uncertainty shock leads to a slight increase in inflation in two

months. The duration of the response to the uncertainty shock lasts for eight months.

The impulse response magnitudes outlined above are moderate and their effects dissipate within six to twenty months. Still, taken together, the results indicate that the measure of uncertainty captures some of the features associated with firms', consumers' and financial institutions' cautious behaviour in times of uncertainty. More generally, the results suggests that policymakers should be vigilant to an increase in uncertainty even if they believe it does not reflect a deterioration in the macroeconomic fundamentals. In times of stress, delays in action, absence of transparency, and excessive steps that elevate the level of uncertainty in the economy could be damaging. A prompt and carefully calibrated response to emerging challenges together with clear communication would help to reduce the effects of uncertainty.

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Appendices

A. KMO Measures of Sampling Adequacy

BIST100	0.75
Implied volatility of exchange rate	0.75
Benchmark interest rate	0.85
EMBI-Turkey	0.82
Cross currency swap rate	0.70
Forward implied yield	0.73
Interest rate swap	0.89
Inflation expectations	0.67
Overall	0.78

B. Unit Root Tests

Tests		**Level**
Uncertainty	**ADF**	--5.608 (0)***
	DF-GLS	--3.166 (2) ***
	PP	-5.608 (0)***
Industrial production	**ADF**	-2.778 (2)*
	DF-GLS	-1.997 (2)**
	PP	-3.135 (2)**
Unemployment	**ADF**	2.645 (6)*
	DF-GLS	-2.197771 (6) **
	PP	-3.336 (6)**
Consumer price index	**ADF**	-5.417 (8)***
	DF-GLS	-5.241 (8)***
	PP	-3.742 (8)***
Credit interest rate	**ADF**	-4.644 (7)***
	DF-GLS	-4.573 (7)***
	PP	-23.921 (7)***
Consumer confidence index	**ADF**	-3.923 (1)***
	DF-GLS	-3.691891 (1)***
	PP	-4.041 (1)***
Economic conditions index	**ADF**	-3.921 (1)***
	DF-GLS	-3.840289 (1)***
	PP	-3.947 (1)***

Notes:

1. *, **, and *** denote stationary at 10%, 5% and 1%, respectively. Critical values are taken from MacKinnon (1996).

2. Max lag level is 12, which is calculated using formula [12 * (number of observations / 100)$^{1/4}$] proposed by Schwert (1989, p.151).

3. Optimal lag is determined by Akaike information criterion and shown in parenthesis.

C. VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1508.194	NA	4.22e-21	-27.04855	-26.87768	-26.97923
1	2047.648	1001.149	6.15e-25	-35.88556	-34.51859*	-35.33102*
2	2108.911	105.9684	4.98e-25*	-36.10651	-33.54344	-35.06675
3	2131.215	35.76622	8.26e-25	-35.62550	-31.86633	-34.10051
4	2169.165	56.06995	1.06e-24	-35.42639	-30.47113	-33.41619
5	2198.029	39.00503	1.65e-24	-35.06358	-28.91221	-32.56815
6	2237.136	47.91537	2.25e-24	-34.88533	-27.53787	-31.90468
7	2301.271	70.49018	2.07e-24	-35.15803	-26.61446	-31.69216
8	2362.292	59.37229	2.18e-24	-35.37463	-25.63497	-31.42354
9	2437.985	64.10053	1.96e-24	-35.85559	-24.91983	-31.41927
10	2499.397	44.26049	2.63e-24	-36.07922	-23.94736	-31.15768
11	2554.699	32.88270	4.87e-24	-36.19278	-22.86482	-30.78602
12	2705.547	70.66725*	2.20e-24	-38.02787*	-23.50381	-32.13589

Note: * indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

D. VAR Residual Serial Correlation LM Tests

Lags	LM-Stat	Prob
1	49.87698	0.4383
2	35.90528	0.9184
3	45.93547	0.5981
4	43.70857	0.6869
5	55.76227	0.2356
6	38.94544	0.8476

Note: Null Hypothesis: no serial correlation at lag order h
Probs from chi-square with 49 df.

E. VAR Residual Heteroskedasticity Tests

Joint test:

Chi-sq	Df	Prob.
1208.668	1176	0.2479

Note: No Cross Terms only levels and squares