MACROECONOMIC EFFECTS OF UNCONVENTIONAL MONETARY POLICY IN THE UNITED STATES

A Master's Thesis

by

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Ankara
August 2022

To my family

MACROECONOMIC EFFECTS OF UNCONVENTIONAL MONETARY POLICY IN THE UNITED STATES

The Graduate School of Economics and Social Sciences
of
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by

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By Münip Kutay Sümbül

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

Burçin Kısacıkoğlu
Advisor

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

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Examining Committee Member

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Director

ABSTRACT

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August 2022

This thesis examines the macroeconomic effects of unconventional policy with smooth local projections in the United States. Unconventional monetary policy is identified using Swanson (2021)'s methodology. I find that the most effective policy tool is the target factor for unemployment and industrial production; however, its effect is not persistent as other tools. For instance, large scale asset purchases (LSAP) induce a significant and persistent impact on industrial production and forward guidance for unemployment. LSAP is the most successful instrument for inflation in the short run, but inflation responds more persistently to forward guidance. Therefore, a mix in which all three tools are used to manage a successful monetary policy can solve short-term and long-term problems for each macroeconomic variable. The findings here are consistent with the previous literature, and they are even supportive.

Keywords: Unconventional monetary policy, Smooth local projections, Forward guidance, Quantitative easing, Zero lower bound

ÖZET

GELENEKSEL OLMAYAN PARA POLİTİKALARININ AMERİKA BİRLEŞİK DEVLETLERİN'DEKİ MAKROEKONOMİK ETKİLERİ

MÜNİP KUTAY SÜMBÜL

Yüksek Lisans, İktisat Bölümü

Tez Danışmanı: Dr. Öğr. Üyesi Burçin Kısacıkoğlu

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Bu tez geleneksel olmayan para politikalarının ABD için makroekonomik etkilerini incelemektedir. Geleneksel olmayan para politikası unsurlarının tanımlanmasında Swanson (2021) takip edilmiş, bu unsurların makroekonomik etkilerinin incelenmesinde ise Barnichon ve Brownlees (2019) tarafından geliştirilen düzleştirilmiş yerel projeksiyon yöntemi kullanılmıştır. İşsizlik ve sanayi üretiminin en fazla beklenmeyen politika faizi değişikliklerine tepki verdiği fakat bu etkinin diğer politika unsurlarının etkileri kadar kalıcı olmadığı gösterilmiştir. İşsizlik için en kalıcı etki, beklenmeyen sözlü yönlendirme değişiklikleri, sanayi üretimi için ise varlık alımlarındaki beklenmeyen değişiklikler olduğu vurgulanmıştır. Bununla beraber, enflasyon için kısa vadede en etkili politika aracının varlık alımları olduğu, fakat en kalıcı etkinin sözlü yönlendirme tarafından sağlandığı belirtilmiştir. Sonuç olarak, para politikasının etkinliği için her unsurun kullanıldığı bir politika çerçevesinin makroekonomik değişkenler için kısa ve uzun vadede etkili olabileceği vurgulanmıştır.

Anahtar Kelimeler: Geleneksel olmayan para politikaları, Düzleştirilmiş yerel projeksiyon, Sözlü yönlendirme, Parasal genişleme, Varlık alımı, Sıfır alt sınırı

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My main objective has always been to achieve academic success so that I might bring honor to my family, Erdal Sümbül and Zekiye Sümbül. In light of this, completing my thesis is a dedication to my family, who have sacrificed their comforts to ensure that I can pursue my education.

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TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The dramatic events surrounding the subprime mortgage market in late 2008 heightened the likelihood of a severe recession. In many countries, fiscal and monetary authorities took various conventional and unconventional measures to mitigate the impact of the resulting global financial crisis on financial stability and the real economy. For instance, Federal Reserve set policy rates to their effective lower bound (ELB) in December 2008 and pursued unconventional monetary policies to decrease longer-term interest rates and stimulate the economy.

In this study, I investigate the macroeconomic effects of these unconventional monetary policies in the United States. To investigate the macroeconomic effects of monetary policy instruments separately, I measure the impact of these instruments on the financial market by following Swanson's methodology. In this paper, I use smooth local projections to analyze the macroeconomic effects of unconventional monetary policy. Following Swanson (2021), I use a high-frequency (30-minute) response of asset prices to FOMC announcements to identify components of unconventional monetary policy. Subsequently, I employ SLP to measure the macroeconomic effects of monetary policy components by treating unexpected changes in monetary policy as structural shocks. This

research contributes to the fast-expanding macroeconomic literature by employing LP to estimate structural impulse responses. Furthermore, my findings are in line with the previous literature in terms of both the sign and magnitude of each monetary policy element.

I find that for unemployment and industrial production, unexpected changes in fed funds target induce a more significant effect; however, its effect is not persistent as other tools. The LSAPs have a persistent impact on industrial production and forward guidance for unemployment. Additionally, inflation responds to LSAP shocks in the short run, but target changes and forward guidance have more persistent effects. Therefore, a mix in which all three tools are used together to manage aggregate demand can solve short-term and long-term problems for each macroeconomic variable. Also, the long-run impact of LSAPs is in line with prior research, as Swanson (2021) expects it.

Conventionally, central banks would adjust their policy interest rate to accomplish their economic objectives. After reaching the zero lower bound constraint during the 2008 financial crisis, they adopted unconventional tools, such as forward guidance and large scale asset purchases. The purpose of forward guidance is to manage expectations. The Fed guides market participants and the broader public about the anticipated future path of the policy interest rate and other areas of monetary policy through policy statements and speeches made by the chair and governors. Large scale asset purchases, on the other hand, involve the outright purchase of longer-term Treasury and mortgage-backed securities by the central bank. Both tools aim to influence the yield curve but through different channels: forward guidance (FG) is via expectations (Filardo and Hofmann (2014)) while large scale asset purchases (LSAPs) through term premium (Gagnon et al. (2010)).

Regardless of how they affect interest rates, it is essential to comprehend the consequences of unconventional monetary policy and why they appear. For ex-

ample Reifschneider and Williams (2000) show that when the central bank's ability to boost the economy during recessions is restricted by the zero lower bound, the unconventional policy may not be sufficient to stimulate the economy. Their results justify additional policy tools (such as LSAPs) to be used during severe downturns. Relatedly, Eggertsson and Woodford (2003) find that during the period in which monetary policy is constrained by the zero lower bound, the key to dealing with this situation is careful management of expectations for the future conduct of policy (forward guidance), however, their results indicate that large scale asset purchases would be neutral.

Contrary to Eggertsson and Woodford (2003) results, in practice, LSAPs are found to be effective. After the first round of LSAPs (commonly referred to as LSAP1), Gagnon et al. (2011) show a reduction in Treasury yields and yields on mortgage-backed securities of roughly 90 and 110 basis points, respectively, relying on event studies of LSAP announcements. Additionally, they find that the decrease in long-term interest rates reflects the decline in risk premiums brought about by these purchases, primarily due to the reduction of duration risk.

Similarly, Vayanos and Vila (2021) show that preferred habitat is in effect when LSAPs are conducted (Bauer and Rudebusch (2014)). In this model, a reduction in the supply of the particular security of interest to the preferred habitat investors creates a shortage that increases its price. As a result, arbitrageurs sell the scarce security and rebalance their portfolio towards other bonds that are now relatively underpriced and convertible. As the markets approach a new equilibrium, arbitrageurs distribute the scarcity produced by the central bank in a specific bond over several maturities and other bonds with similar features.

Krishnamurthy and Vissing-Jorgensen (2011) investigate the first and second rounds of Fed purchases using an event study methodology. They discover evidence of a significant decrease in interest rates in the first program. In contrast,

they do not get in the second (though this may reflect that the markets had already priced in much of the expected impact before the second program was announced). However, Swanson (2011) demonstrates that the second round of purchases resulted in a 15 basis point reduction in longer-term Treasury yields.

It is challenging to distinguish the effects of monetary policy instruments since many FOMC announcements simultaneously contain information about all dimensions of policy. Gürkaynak et al. (2004)'s paper can be considered one of the cornerstones of this quest. By extending the event study methodology, the authors show that monetary policy is multidimensional. In particular, they show that asset prices are affected by two separate policy components: unexpected policy rate changes (Kuttner (2001)) and revisions to expectations of short rate, namely, path factor (forward guidance). However, they are silent on the effects of quantitative easing (QE) since QE was not implemented in their sample.

To extend the analysis to the large scale asset purchases, Swanson (2021) expanded the Gürkaynak et al. (2004) strategy. The study demonstrates that three factors are necessary to explain U.S. monetary policy around FOMC announcements; information regarding target factor, forward guidance, and LSAPs.

Most studies on the effects of unconventional monetary tools have centered on financial market variables. The response of financial markets is a natural indicator of the effectiveness of the unconventional policy. However, fewer studies attempt to analyze the macroeconomic impacts of unconventional monetary policy measures. For example, Lenza et al. (2010) show that the considerable reduction in money market spreads indicates that unconventional policies successfully decrease financial market stress. These policies also significantly impact output and inflation, with a lag.

Weale and Wieladek (2016) study the effects of LSAPs on real GDP and the CPI in the UK and the US using a Bayesian VAR approach. They show that real GDP and the CPI always increase in reaction to an asset purchasing shock, and asset purchases successfully support GDP after the financial crisis in both the UK and the US. Additionally, Kim et al. (2020) show that dramatic increases in the Federal Reserve's asset holdings have a significant expansionary impact on the macroeconomy as a consequence of the shock by using a proxy structural VAR methodology. Gambacorta et al. (2014) evaluate the macroeconomic effects of unconventional monetary policy by utilizing a VAR. Using monthly data, they conclude that an exogenous increase in central bank balance sheets causes a brief boost in economic activity and consumer prices.

We frequently encounter VAR-based applications and traditional identification schemes to estimate the macroeconomic effects of monetary policy. For two reasons; 1) VAR properties are well understood, 2) Identifying restrictions are somewhat easy to implement. It is also well understood that Cholesky based identification is particularly flumed. Hence Mertens and Ravn (2013) propose using IV based VAR techniques. This method is used by Gertler and Karadi (2015) to identify monetary policy shocks by evaluating asset market responses during a short window before monetary policy announcements, hence, using monetary policy surprises as instruments to monetary policy shocks.

Jordà (2005) proposes a new alternative called local projections, to structural VARs. This study introduces ways to estimate impulse responses (which is revealed by Sims (1980)) without specifying or estimating the underlying multivariate dynamic system. Local projections have advantages such as they can be estimated by simple regression technique, are more impervious to misspecification, and analytic inference is straightforward. These strategies have complementary features: the VAR is more successful when the model is well defined, whereas the LP approach is less efficient but more robust to model misspeci-

fication even though they are asymptotically equivalent (Plagborg-Møller and Wolf (2021)).

Barnichon and Brownlees (2019) strike a balance between these two techniques leveraging their beneficial aspects and call it smooth local projections (hereafter SLP). SLP can vastly improve precision while conserving the conventional LP's versatility. Significant enhancements in IR estimating accuracy over LP are confirmed through a simulation study.

In light of my results, a contractionary shock in the target can reduce industrial production by 0.9 percent at the peak. As expected, unemployment jump after the negative shock and increase is 1.5 percent at its maximum, and inflation drops 0.4 percent. The"price puzzle" is a part of the response to inflation, but the effect is insignificant. A negative forward guidance shock dropped the industrial by 0.75 percent and unemployment increased by 1 percent at maximum. We observe a 0.4 percent decrease in inflation. On the LSAP part, we observe that the negative shock behavior of LSAP is very consistent and long-lasting, which is parallel to the literature. The reduction in industrial production is 0.5 percent. For unemployment, the maximum effect is 0.9 percent. In contrast to previous instruments, inflation is not increasing at the beginning, and the peak effect of LSAP is a 0.28 percent decrease in inflation. The forward guidance results are consistent with previous literature. For inflation and unemployment, the peak effects can be observable between 16 to 24 months, and for industrial production, the maximum effect of forward guidance is more significant than LSAPs; however, the impact of LSAPs is more effective.

The remaining sections of the paper are as follows. In Section 2, I describe the data set. In Section 3, I identify the unconventional monetary policy surprises separately. In section 4, I estimated the macroeconomic effects of these monetary policy surprises. In section 5, I discuss the findings. Finally, in section 6, I will conclude.

CHAPTER 2

DATA

This section provides detailed information about the data used for the analysis. Two distinct data sets are used. The first data set consists of financial variables that allow us to identify monetary policy components such as the target factor, forward guidance, and asset purchases. The second data set composed of macro variables, allowing for analyzing the macroeconomic effects of unconventional monetary policy.

To identify monetary policy components, I directly follow the Gürkaynak et al. (2004) approach. However, the version of the data set used here is extended by Swanson (2021) until October 2015 from July 1991. To do so, they collected all dates and exact times of monetary policy announcements. There are 214 FOMC announcements between July 1991 and October 2015. Specifically, the asset prices include federal funds futures (the current-month contract rate and the contract rates for each of the next six months) and euro-dollar futures (the current quarter contract rate and the contract rates for each of the next eight quarters). By using intraday data, we can be assured that no other economic news was released within this tight window, thus, clearly isolating the response of asset prices to monetary policy announcements. More specifically, the

changes in monetary policy could be a reaction to the movement in asset prices that occurred earlier in the month or quarter or responses to critical economic data that was announced earlier in the period. To overcome this problem, intraday data have played a significant role in ensuring that the FOMC decision was not impacted by asset price changes or other macroeconomic news over that period. Precisely, the intraday data measure the response of asset prices to monetary policy announcements by beginning ten minutes before the announcement and ending twenty minutes after the announcement; by doing so, we can practically guarantee that no other economic news was published during such a short period. Hence, all variations can be attributed to the monetary policy decision.

For analysis of macroeconomic effects, the monthly inflation, the monthly industrial production index (IND), and the monthly unemployment level data are considered. All data are taken from the Federal Reserve Economic Data website.

CHAPTER 3

IDENTIFYING UNCONVENTIONAL POLICY SURPRISES

Adhering to the Gürkaynak et al. (2004) (hereafter GSS) model, the first data set includes the asset price changes around FOMC announcements that have been gathered into a $T \times n$ matrix X where $T = 214$ is the sample size, and $n = 8$ is the number of assets. As in Swanson (2021), the data matrix X includes the first and third federal funds futures contracts, the second, third, and fourth Eurodollar futures contracts, and the two, five, and ten year treasury yields to concentrate on the assets most closely associated with monetary policy and minimize sample variability. I use financial market data on FOMC announcements to capture the effects of monetary policy components. The data are represented in a factor model as below:

$$\underset{T\times n}{\mathrm{X}} = \underset{T\times k}{\mathrm{F}} \times \underset{k\times n}{\lambda} + \underset{T\times n}{\epsilon} \tag{1}$$

where

X = Asset price changes

F = Unobserved factors, containing $k < n$ unobserved factors

λ = The loading matrix of asset price changes on the factors

ϵ = White noise residuals

Directly following the logic of both GSS and Swanson (2021), I took the result of the Cragg-Donald rank test as given, $k = 3$. The Cragg-Donald rank test aims to understand how many factors could explain sufficiently the data set X. So, by taking $k = 3$ as given, I assume that three-factor could explain the data set adequately. To determine the unobserved factor matrix F, the principal component analysis (PCA) should apply to the data matrix. The PCA is a technique for reducing the dimensionality of large data sets that consists of splitting a large collection of variables into a smaller set that retains the majority of the information in the larger set. This process divides the matrix X into a set of orthogonal vectors. This set (F matrix) consecutively contains the vectors with the most explanatory power for the residual of X. Consequently, since it is taken directly from Swanson (2021) that $k = 3$, the first three vectors have a maximum fraction of the variance of X explained but do not have any structural interpretation. In particular, there is no reason why any factor should correspond to specific monetary policy components. To give them a structural interpretation, I rotate factors in a way that preserves their orthogonality and explanatory power on X. The crucial point here is that the structural interpretations of the columns in our new rotated matrix, $\widetilde{F}$, is the result of a rotation matrix, U, which is a 3×3 orthogonal matrix:

$$\underset{T\times k}{\widetilde{\mathrm{F}}} = \underset{T\times k}{\mathrm{F}} \times \underset{3\times 3}{\mathrm{U}} \tag{2}$$

$$\underset{k\times n}{\widetilde{\lambda}} = \underset{3\times 3}{\mathrm{U}'} \times \underset{k\times n}{\lambda} \tag{3}$$

where

$k = 3$

$U =$ Rotation matrix

Specifically, to give a structural interpretation to the new matrix, first, one should impose identifying restrictions on the matrix U.

The first identifying restriction is that the LSAP announcements should not impact the federal funds rate. Mathematically, the third row of $\widetilde{\lambda}$ matrix has no impact on the first column, i.e., $\widetilde{\lambda_{31}} = 0$. The second identifying restriction is that the current federal funds rate is unaffected by changes in forward guidance; thereby, $\widetilde{\lambda_{21}} = 0$. The last restriction is that throughout the pre-ZLB period, from 1991 to 2008, the LSAP factor should not be there, implying that it has a minimal variance. Since FOMC announcements taken before the ZLB do not substantially impact the LSAP, the LSAP factor should be negligible during this time. When all these three restrictions are applied together, the U matrix could be particularly designated.

Restriction 1 and 2

$$\widetilde{\lambda_{31}} = 0$$

$$\widetilde{\lambda_{21}} = 0$$

Restriction 3

$$\min_{\{u_{13},u_{23}\}} [u_{13}\ u_{23}\ 1](F_{pre})'F_{pre}[u_{13}\ u_{23}\ 1]'$$

subject to

$$(\ \widetilde{\lambda_1})'[u_{13}\ u_{23}\ 1]' = 0$$

The rotating factors can be utilized to measure the effects of each monetary policy independently. So, I refer to $\widetilde{F}_1$, $\widetilde{F}_2$, and $\widetilde{F}_3$ as the "target" factor, the "forward guidance" factor, and the "LSAP" factor, respectively.

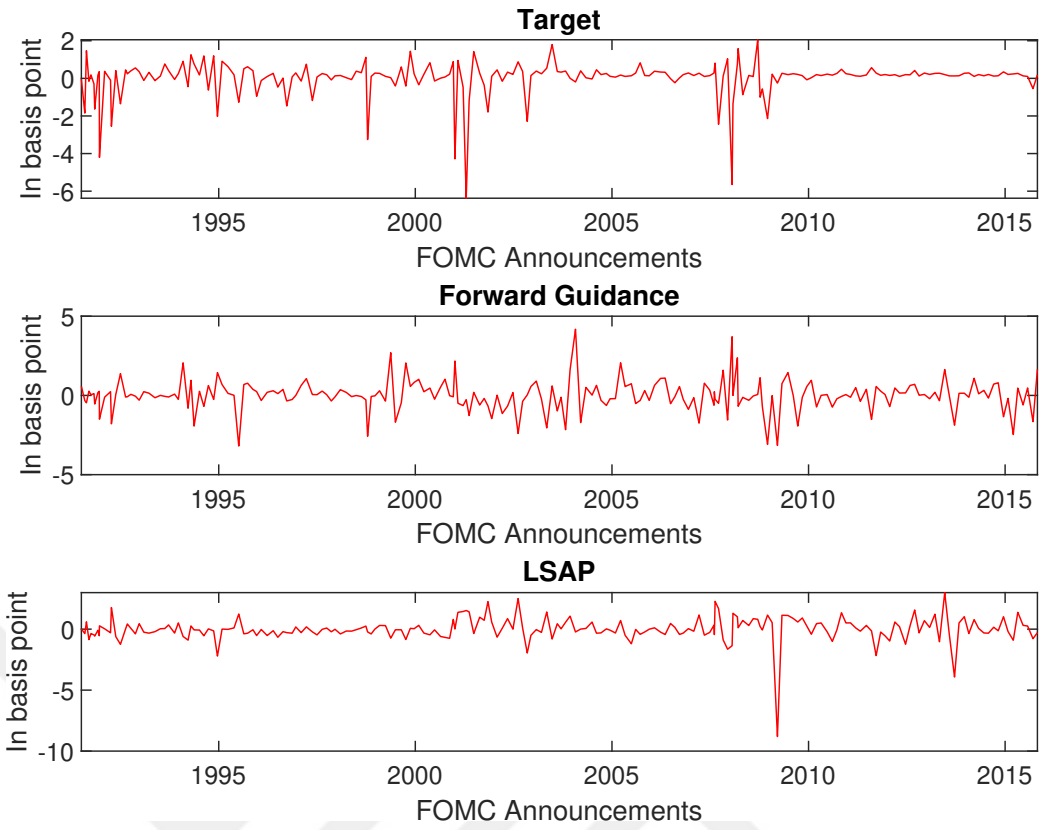

Figure 1: Monetary policy surprises from 1991 to 2015. In Figure 1, the target factor estimates are plotted in the top panel, the forward guidance factor estimates in the middle panel, and the LSAP factor estimates in the bottom.

CHAPTER 4

ESTIMATION OF MACROECONOMIC EFFECTS

An essential tool for quantifying the dynamic effects of structural shocks on macroeconomic variables is the impulse response (IR) function, which explains how the variable of interest changes over a specific time after a structural shock. Vector autoregression (VAR) has traditionally been implemented (Sims (1980)) to identify structural shocks and concurrently recover the corresponding IRs. Identification in VARs has two steps: estimating the model and then inverting its estimates to find the impulse response. The VAR approach could generate an accurate parameter estimate if the model is well stated, albeit it is prone to misspecification. A standard VAR specification can be given as:

VAR

$$\begin{bmatrix} y_{t+h} \\ x_{t+h} \end{bmatrix} = A^h \begin{bmatrix} y_t \\ x_t \end{bmatrix} + u_{(h)t+h} \tag{4}$$

where A is a 2×2 matrix and $u_{(h)t+h}$ is the h-step ahead innovation. Thus, the dynamic multiplier of y_{t+h} with respect to x_t keeping y_t constant is the (1,2) element of the matrix $[A^h]$. In analogy to the forecasting literature, we refer to this technique as "iterated" since the multiplier of interest is obtained by

iterating the dynamic system forward.

Alternative to VAR, Jordà (2005) introduced a new approach to computing impulse responses that do not require specifying and estimating the underlying multivariate dynamic system. The local projections (hereafter LP) model performs a series of predictive regressions of a variable of interest to a structural shock for various prediction horizons. The sequence of structural shock regression coefficients is defined as the IR. Simple regression techniques can estimate local projections because LP retains linearity with respect to the parameters. Moreover, this method's non-parametric IR estimation nature provides many advantages when compared with VARs. Jordà (2005) demonstrates that local projection is more robust to model misspecification than VAR impulse responses. Also, it has been shown that iterations needed to compute IRs in a VAR setting exacerbate the mistakes caused by misspecification as a function of the horizon. Additionally, in contrast to VARs, the LP approach does not impose any underlying dynamics on the system's variables, which can potentially solve the dimensionality issues that VARs suffer from and consequently handle nonlinearities. Even though LP's practically is what made this useful, an important caveat is its data-intensive nature. Extending the impulse response horizons shrinks the sample that may be used for the estimate. Moreover, since the LP approach is non-parametric, the IRs are overly noisy. Standard LP specifications can be given as:

Standard LP

$$y_{t+h} = \alpha_{(h)} + \beta_{(h)} x_t + \sum_{i=1}^{p} \gamma_{i(h)} w_{it} + u_{(h)t+h} \tag{5}$$

In the classic LP framework (equation (5)), our primary focus is to estimate y_{t+h} according to the change in x_t and it would be calculated by running a series of regressions, where $\beta_{(h)}$ is the regression coefficient, and it could capture the causal effect of the structural shock u_t.

The smooth local projections (SLP) method is utilized to overcome the deficiencies of both models. Barnichon and Brownlees (2019) improve the efficiency of LP while striking a balance between VAR and LP approaches. When the smooth local projection is applied, we still operate within the LP framework, but the main difference is that SLP has an extra assumption that the IR is a smooth function of the forecast horizon.

In the aftermath of this smoothness assumption, semi-parametric estimate methods are employed, particularly penalized B-splines (Eilers and Marx (1996)), to conclude the model in (5). The B-splines basis functions are utilized to approximate the unknown function of interest and estimate the parameters using a shrinkage estimator that penalizes the LP coefficients' non-smooth behavior.

Thus SLP can increase precision substantially when we compare it with LP. Therefore, the SLP approach is significantly preferable for macroeconomic analysis. Specification for SLP used in this paper is:

Smoothed LP

$$y_{t+h} \approx \sum_{k=1}^{K} \alpha_{(h)} B_{k(h)} + \sum_{k=1}^{K} b_k B_{k(h)} x_t + \sum_{i=1}^{p} \sum_{k=1}^{K} c_{ik} B_{k(h)} w_{it} + u_{(h)t+h} \tag{6}$$

where

$\beta_{(h)}$ $= \sum_{k=1}^{K} b_k B_{k(h)}$

b_k = Set of scalar parameters

w_{it} = RHS variables and include lagged values y_t and x_t

$B_{k(h)}$ = Stands for linear B-splines basis function expansion

$u_{(h)t+h}$ = Prediction error term

For obtain the IRs, we will use this regression:

$$y_{t+h} - y_t = \alpha_{(h)} + \beta_{(h)} x_t + \sum_{i=1}^{4} \gamma_{i(h)} w_{it} + u_{(h)t+h}, \;\; h = 0, 1, ..., 24 \tag{7}$$

where $u_{(h)t+h}$ is a prediction error term with $\text{Var}(u_{(h)t+h}) = \sigma^2_{(h)}$, w_{it} include

control variables (4 lagged values of y_t and x_t). The parameter of interest is the $\beta_{(h)}$, the effect of month t shock at $t+h$.

Making inferences about the dynamic impacts of structural shocks is one of the fundamental objectives of macroeconomic analysis. We define y_t as an endogenous variable and are trying to estimate its response to a structural shock u_t. Structural shock is defined as a variable that is exogenous to the system. It is uncorrelated with other shocks and indicates either unexpected changes in external variables or information about potential changes in exogenous variables in the future.

For estimating macro effects, monthly data of inflation, industrial production index, and unemployment level were chosen as interest variables for this study. The monthly data of macro variables are chosen to be the same as the time interval of monetary policy data. Since FOMC announcements are not declared monthly, I sum up surprises in a given month. For instance, I aggregate all the effects if there are multiple announcements for a given month.

The y_{t+h} stands for variables of interest (endogenous variables), x_t represents monetary policy surprises and ϵ_t means the structural shock as explained by Ramey (2016). So, the structural IR of y_t to a structural shock ϵ_t is then defined as:

$$IR(h,\delta) = E(y_{t+h} \mid \epsilon_t = \delta) - E(y_{t+h} \mid \epsilon_t = 0) \tag{8}$$

Endogenous variables and the LHS of regression are log of industrial production ind_t, unemployment $unemp_t$ and inflation cpi_t. Shocks are used to be identified surprises. The goal is to estimate the macro variables' IRs in response to monetary policy shocks. So by setting $y_{t+h} = ind_{t+h}$, $x_t = mp_t$ and $w_t' = (ind_{t-1}, unemp_{t-1}, cpi_{t-1}, mp_{t-1}, ..., ind_{t-4}, unemp_{t-4}, cpi_{t-4}, mp_{t-4})'$ we can calculate the impulse responses of industrial production to monetary policy shock. Effects are estimated for 24 months.

Be aware that the contemporary impact of the shocks on the system is subject to typical timing restrictions. The IRs have calculated to a one-standard-deviation negative monetary shock (contractionary shock).

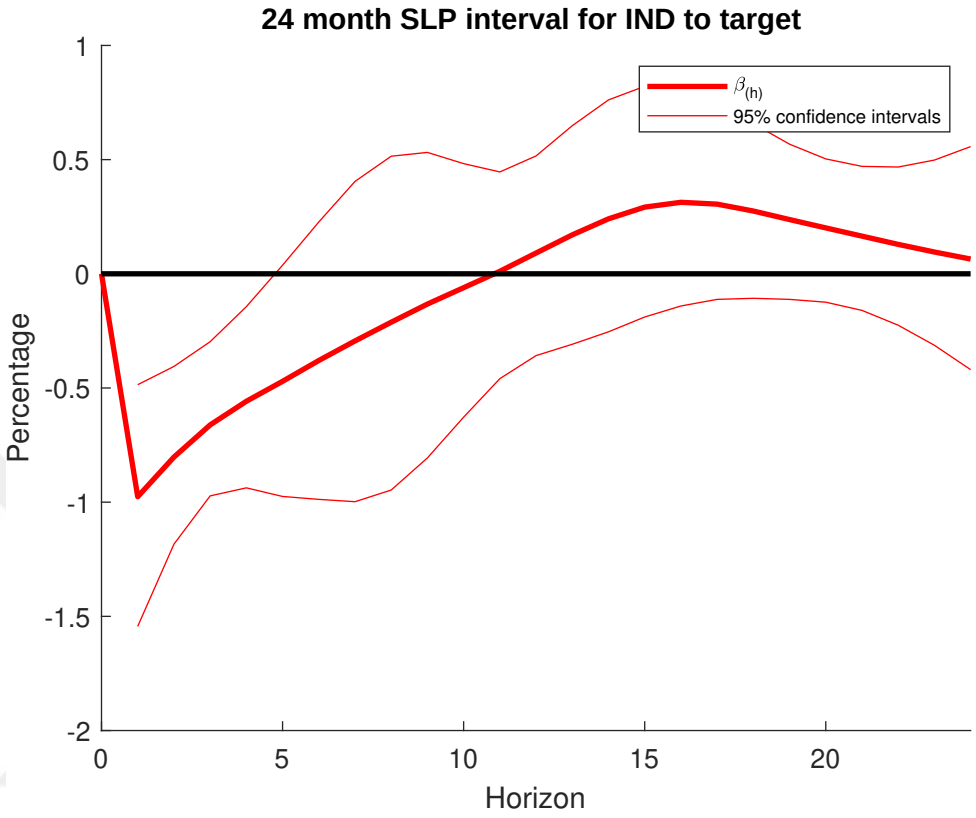

Figure 2: The figure displays the IR of industrial production to the target factor shock.

Figure 2 plots the IRs of industrial production to one-standard-deviation target factor shock. Following a contractionary shock, industrial production falls, as previously found in numerous studies. The peak effect occurs immediately, at the time of the shock, which is a 0.9 percent decrease. The decline lasts for 12 months, however, the effect is not statistically significant after 18 months.

In Figure 3, the IRs of unemployment to the target factor shock are shown. A contractionary shock causes a persistent increase in unemployment. The maximum effect of the target factor is observed in the 12th month at 1.5 percent. The target factor has a very long-lasting effect; the rise in unemployment persists for more than six quarters.

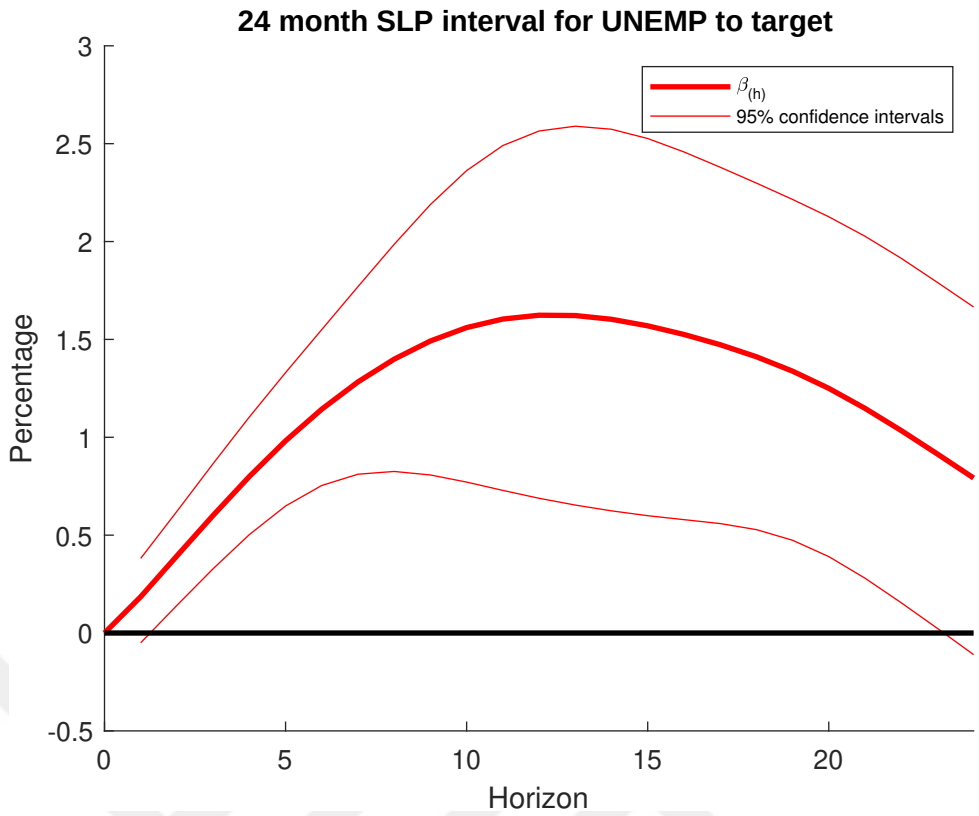

Figure 3: The figure displays the IR of unemployment to the target factor shock.

Figure 4 demonstrates the IRs of inflation to the target factor shock. A negative shock causes an increase in inflation at the time of the shock; however, after four months, inflation starts decreasing. The "price puzzle" is a part of the response; however, the impact is insignificant. The maximal effect of the target factor is observed at the end of the horizon, which is 0.4 percent. The target factor has a very long-lasting (almost permanent) impact on inflation. The decline occurs in two stages, with the first stage being the fastest.

Figure 5 illustrates the IRs of industrial production to forward guidance shock. A shock causes a similar trend to the target factor; the decline starts immediately, and the peak effect occurs in the sixth month with 0.75 percent. Again, an increase is observed after the twelfth month, which is relatively small. However, differently from the target factor, the effects occur late as expected, and the magnitudes are small and do not last long.

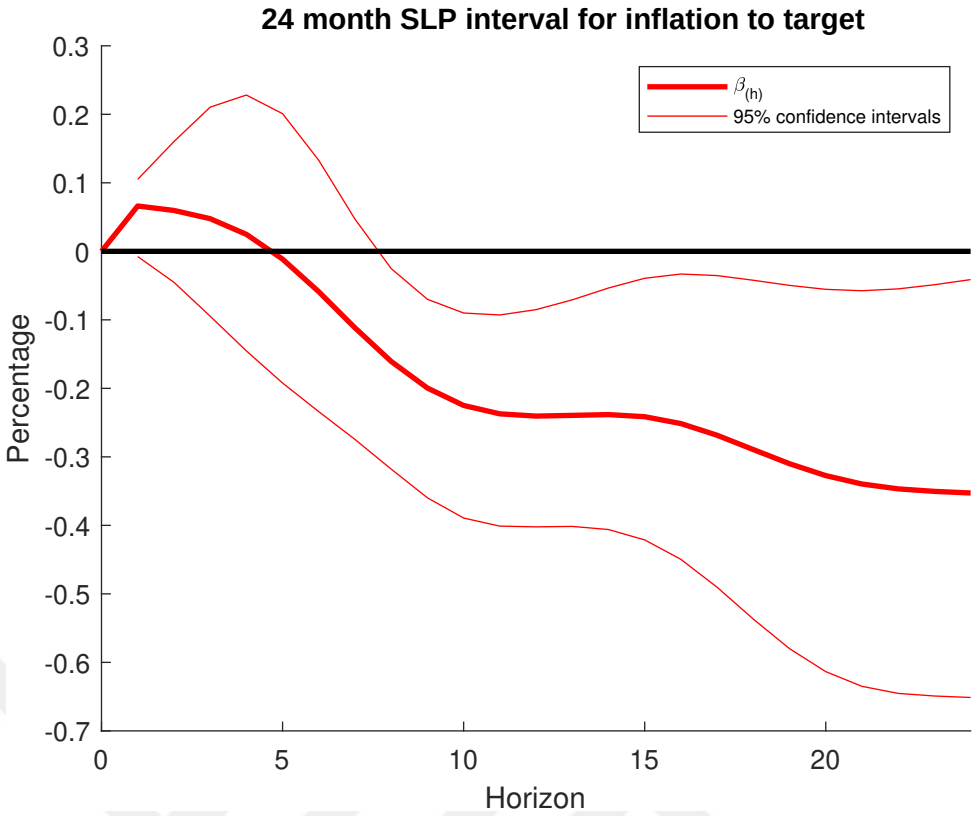

Figure 4: The figure displays the IR of inflation to the target factor shock.

Figure 6 depicts the IRs of unemployment to forward guidance shock. A minor increment exists for the first three months, followed by a steady decrease that persists until the horizon's end. Unlike the target factor, the forward guidance top effect occurs in the 24th month with a 1 percent decrease. The impact of forward guidance seems persistent, without statistical significance.

Figure 7 exhibits the IRs of inflation to forward guidance shock. Similar to the target factor, the "price puzzle" is a part of the responses for forward guidance, and the two-stage decrease exists. According to prior research, the impact of forward guidance and the target factor is similar, although the influence of the target factor is more significant than forward guidance. Once more, the maximum effect of forward guidance is observed late than the target factor, at the 24th month, and the magnitude is akin to the target; 0.4 percent decrease.

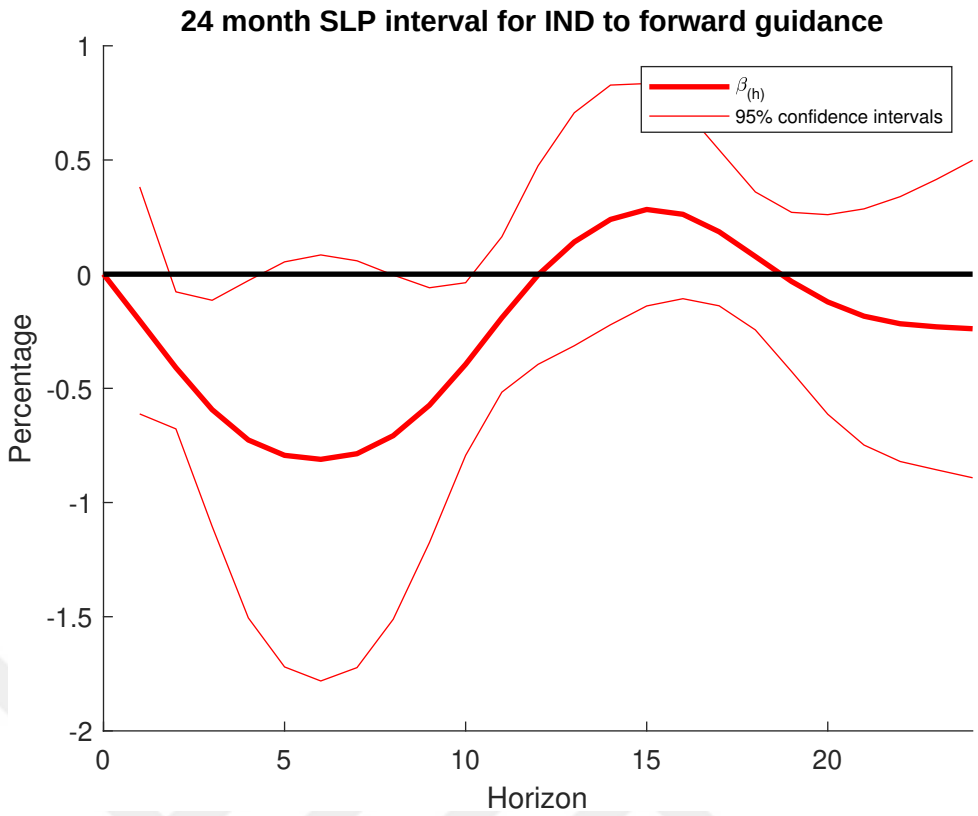

Figure 5: The figure displays the IR of industrial production to forward guidance shock.

Figure 8 shows the IRs of the industrial production to LSAP shock. Industrial production falls immediately after the LSAP shock, and the decline is very persistent. I can say that this decline in industrial production is more persistent than other monetary policy instruments. It is observed that the peak effect of LSAP is 0.5 percent. As before, there is a two-stage decline here too, and the first stage is more potent while the second stage's effects fade away faster.

Figure 9 shows the IRs of the unemployment to LSAP shock. The effects of LSAP are similar to forward guidance; both are persistent; however, there is no drop at the beginning, LSAP's impact realizes after one month, and the maximum impact does not occur at the end of the horizon. Instead, it appears in the 17th month with a 0.9 percent increase. After LSAP reaches its most significant effect, there is a halt in its rise, which lasts until the end of the horizon.

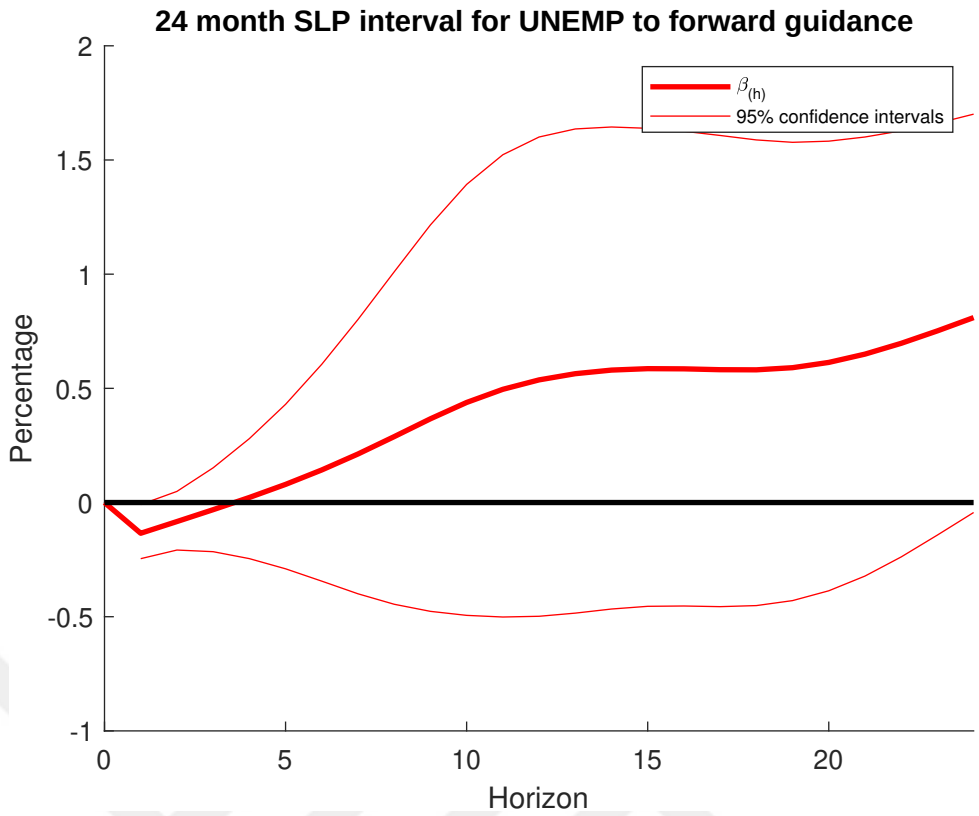

Figure 6: The figure displays the IR of unemployment to forward guidance shock.

In Figure 10, the IRs of inflation to LSAP shock are displayed. In contrast to previous instruments, inflation does not increase initially. First, it declines by 1.75 percent in the 5th month; then, the second drop arises in the 11th month with a 0.28 percent decrease. Similar to other monetary policy tools, the effect of LSAP on inflation is persistent. The critical difference between LSAP and other tools is that LSAP can decrease inflation soon after the shock.

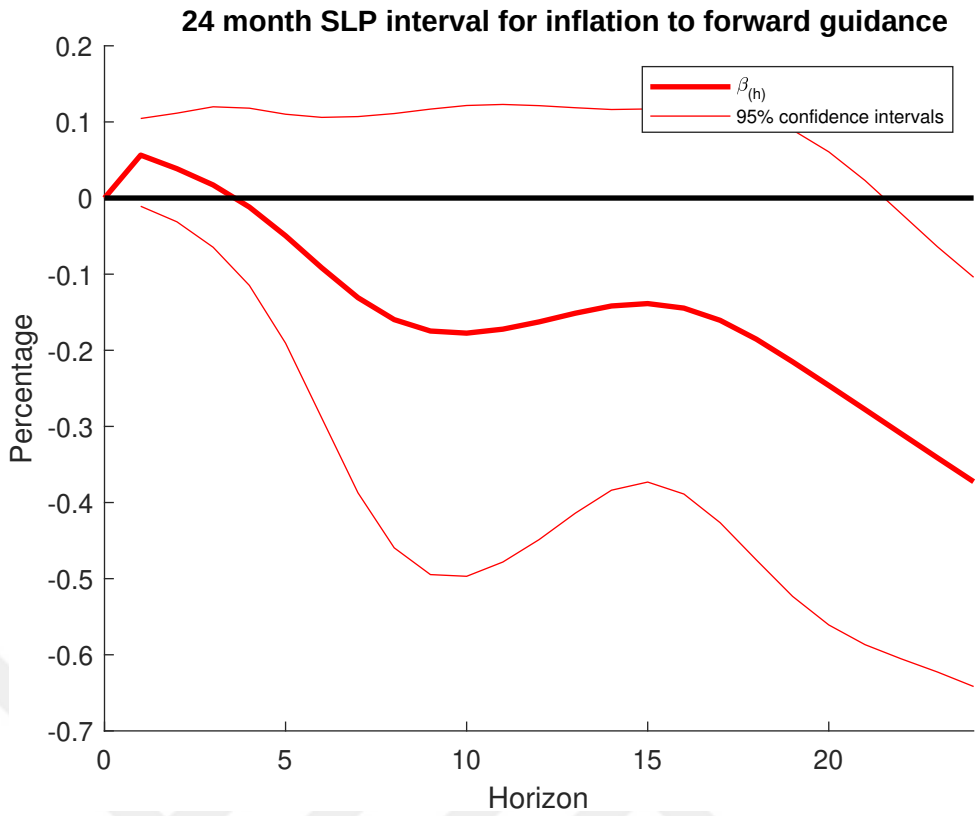

Figure 7: The figure displays the IR of inflation to forward guidance shock.

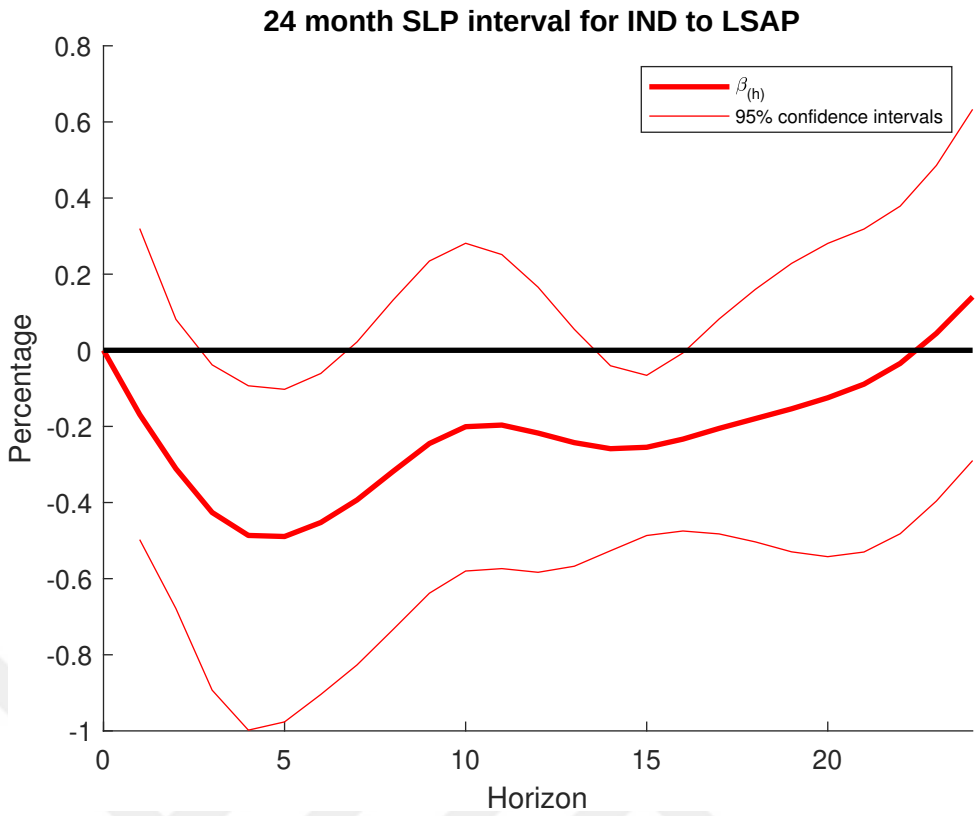

Figure 8: The figure displays the IR of industrial production to LSAP shock.

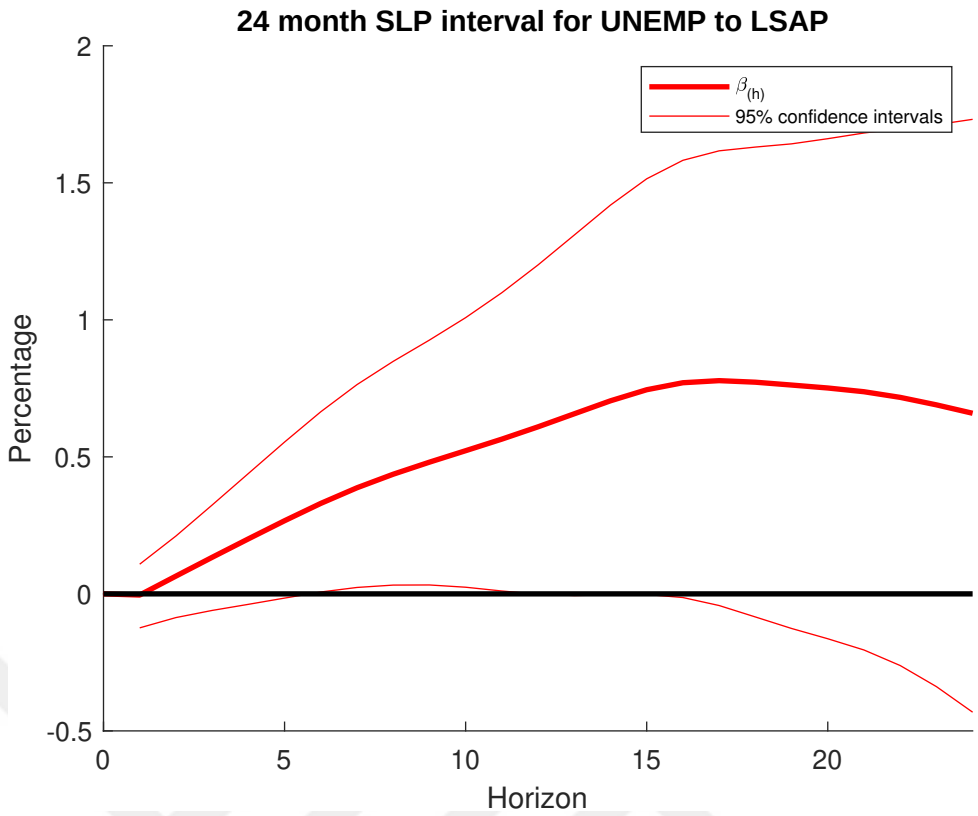

Figure 9: The figure displays the IR of unemployment to LSAP shock.

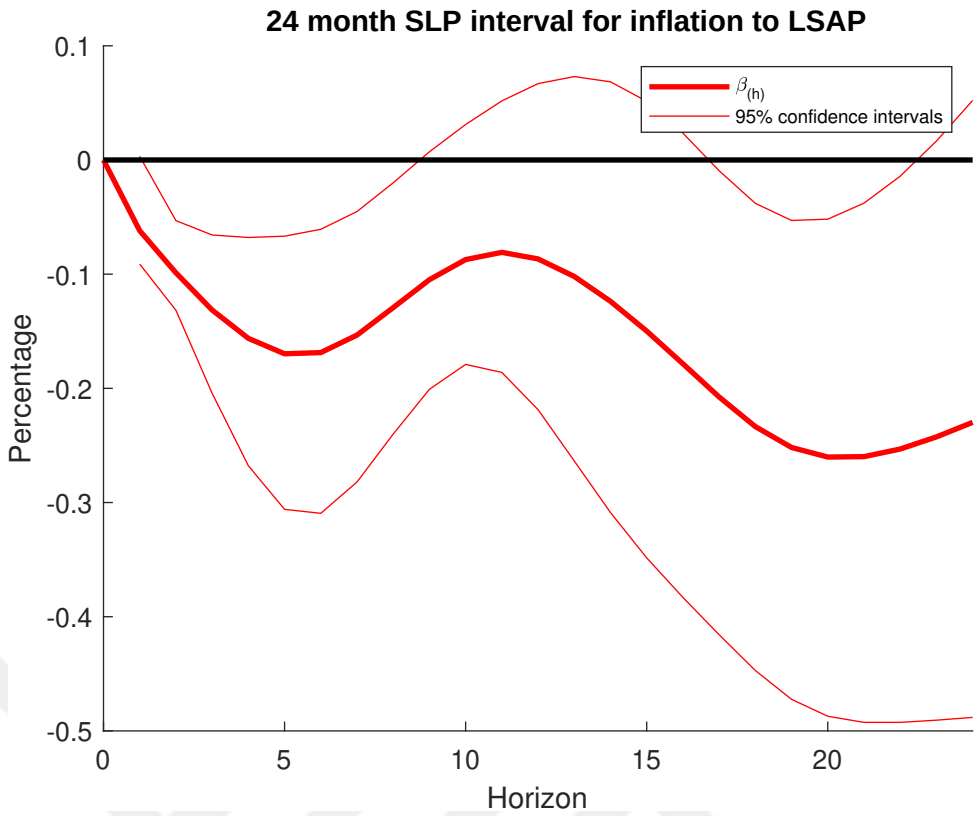

Figure 10: The figure displays the IR of inflation to LSAP shock.

CHAPTER 5

RESULTS AND DISCUSSION

Conventional monetary policy influences the economy primarily via its effects on interest rates. Changing the target federal funds rate affects long-term interest rates by altering future monetary policy expectations. Long-term interest rates, such as those on vehicle loans and mortgages, are most relevant to the spending decisions of households. Through this channel, a decrease in the target federal funds rate can boost spending in the economy and consequently create pricing pressures for firms as they begin to employ resources more intensely to fulfill the increased demand, thereby impacting the real economy.

The goals of unconventional monetary policy are identical to those of conventional monetary policy. Especially at the zero lower bound, it can reduce interest rates more than adjustments to the policy interest rate alone can. Lower interest rates reduce the cost of borrowing, which increases investment spending and private consumption spending through the substitution effect. Additionally, financial stability is supported by unconventional policy initiatives that supply liquidity to stressed financial markets. Therefore, it is quite normal for unconventional monetary policy to have effects like conventional policy. For instance, Smith and Becker (2015) show that forward guidance, as prac-

ticed by the FOMC since 2008, has had a similar impact on the economy as past changes in the target federal funds rate. In addition, Gertler and Karadi (2018) show that similar to conventional monetary policy, LSAPs stimulate the economy by reducing the cost of credit. Consequently, the transmission to real output and inflation is very similar to that occurring under the conventional policy.

It is thought that forward guidance operates through a similar to interest rate channel but does not require a change in the current federal funds target rate. Statements by the FOMC indicating policy rates would remain abnormally low in the future would decrease term premia and the expected future path of interest rates. This sort of policy guidance minimizes the term premium by lowering the risk of unanticipated increases in future policy rates. Therefore, investors purchasing a long-term bond will require a lower-term premium. A lower term premium can stimulate the economy by reducing the credit premium on private debt, hence reducing corporate and consumer borrowing costs.

Therefore, my results are consistent with previous literature and theory; the effects of the target factor and forward guidance are similar. The key differences between them are that the effects of forward guidance occur later than the target factor, and the magnitudes of the target factor are more significant than forward guidance. As shown in the literature, forward guidance has a much more significant impact on longer-term assets, while the target factor has a greater effect on shorter-term. Thus, the peak effects of forward guidance could occur later than the target factor. In addition, since the target factor directly affects short and medium-term credit costs (while forward guidance has a complicated transmission mechanism), it is logical that the macroeconomic impact of the target factor is greater than forward guidance.

For LSAPs, there are several channels through which central bank asset purchases may affect long-term interest rates. One channel works through the

portfolio balance effects. Central bank asset purchases reduce the overall supply of longer-term securities available to investors, as a result, a fall in the stock of long-term securities held by the private sector pushes up the price of these securities, decreases the term premium required to compensate investors to hold them, and hence lower long-term interest rates, but also spillover into the yields on other assets.

The second channel involves favorable market effects that asset purchases can have in times of stress by providing market liquidity. The greater involvement of a central bank in the market may improve market functioning and reduce the extra compensation "liquidity premium") that investors demand for buying assets that risk being more difficult to sell in the future.

Lastly, asset purchase announcements may have signaling effects about the central bank's perception of economic conditions and about how it might be likely to react to future developments. Alternatively, LSAPs may serve as a signal that the future path of short-term risk-free interest rates would remain low. The signal is thought to be more credible since a premature quantitative tightening would make the central bank incur losses. Such an expectation of lower future short-term interest rates will lower long-term rates.

So again, my results are consistent with previous literature and theory; the key differences between them are that the effects of LSAPs emerge later than the target factor, LSAPs persist more, and the magnitudes of the target factor are greater than LSAPs. By its nature, LSAPs have a much more significant impact on the financial market for longer-term assets. Similar to forward guidance, the maximum effects of LSAPs could occur later than the target factor. Also, in terms of magnitudes, LSAPs and forward guidance are similar when we compare them with the target factor. Furthermore, the spillover and portfolio-balancing (via term premiums) effects make LSAPs more persistent than the target factor and forward guidance.

Using a sample from 2008-2014, Smith and Becker (2015) discovered that forward guidance shocks had a peak effect on payroll changes and inflation between 18 to 24 months. Forward guidance influences expectations over a significantly longer horizon than conventional monetary policy instruments do. In fact, forward guidance is supposed to move financial market expectations of the future path of short-term interest rates. In addition, Zhang (2018) shows that an easing forward guidance announcement lowers Treasury yields at all maturities, with a peak effect at maturity of about 20 months; in contrast, easing LSAP will reduce medium-term and long-term yields, with the peak effect on the longest maturities. Thus, my forward guidance results are consistent with previous literature. For inflation and unemployment, the peak effects can be observable between 16 to 24 months, and for all variables, the effects can be observable after the shocks. Even, the industrial production's peak effect occurred six months after the shock.

Campbell et al. (2012) show that a positive shock of forward guidance is associated with decreases in unemployment forecasts for the upcoming three quarters and increases in CPI inflation forecasts for the current and subsequent three quarters. Furthermore, Campbell et al. (2017)'s GDP forecasts carry the effect of forward guidance shock for four quarters, and the same pattern is valid for the unemployment forecasts. Therefore, my findings look consistent with these results. For unemployment and inflation, the effects of shock last for six quarters. For industrial production, the peak effect occurs earlier than other variables; however, the impact fades away in three quarters, which is in line with previous literature.

Swanson (2021) illustrates that forward guidance is more powerful than LSAPs in influencing shorter-term Treasury yields, while LSAPs are more effective in longer-term Treasury yields, corporate bonds, and interest rate uncertainty. In addition, LSAPs were more effective at reducing interest rate uncertainty,

which may also help to stimulate the real economy (Bloom (2009)). Thus, for the industrial production case, my results are consistent. The peak effect of forward guidance is more significant than LSAPs; however, the impact of LSAPs is persistent and overall is more effective, while the forward guidance effect fades away after one year.

Glick and Leduc (2012) show that U.S. asset purchase announcements reduce the ten-year U.S. Treasury yield and depreciate the dollar on days of LSAP announcements. Wu (2014)'s empirical findings indicate that the LSAP has effectively decreased long-term Treasury bond yields via both "signaling" and "portfolio balance" channels. Also, Gertler and Karadi (2018) demonstrate that LSAPs reduce long-term rates by decreasing inefficiently large-term premia, and by following Chen et al. (2011), they suppose that the purchases are kept at the peak for two years and are gradually phased out. Therefore, my findings about LSAPs' effects are consistent with previous literature regarding the peak effects of unemployment and inflation that occurred nearly the twentieth month. However, the impact of LSAP on inflation is relatively small compared with other studies such as Weale and Wieladek (2016). Probably, it stems from the fact that their research uses the data set which covers March 2009 to May 2014.

In general, the findings here are consistent with the previous literature, and it is even supportive. For instance, LSAP induces the most persistent responses. Therefore, in terms of policy recommendations, we can say that the most effective tool for cooling unemployment and industrial production is the target factor; however, its effects are not long-lasting for industrial production. For inflation, it seems that the behavior of forward guidance and target factor are similar; however, for observing a more persistent effect on inflation, the usage of forward guidance rather than LSAP makes sense because the peak effect of LSAP occurs nearly at the end of the horizon.

CHAPTER 6

CONCLUSION

In this paper, I directly followed the Gürkaynak et al. (2004) and Swanson (2021) methods to separately identify the monetary policy components in each FOMC statement from January 2009 through October 2015. I evaluate the impacts of all policies on macro variables, such as industrial production, unemployment, and inflation.

Target factor and forward guidance effect trends are roughly the same at moving inflation. However, the forward guidance is more persistent while the target is more effective. For industrial production and employment, in the short run, the forward guidance's magnitude was smaller nearly for all variables, and the effect of the target factor was observed more rapidly than forward guidance. In addition, forward guidance was essentially more persistent than the target factor, but the most persistent component of monetary policy is LSAPs. I observe the long-run impact of LSAPs in line with prior research. As expected by Swanson (2021), LSAPs were more successful than forward guidance for unemployment and industrial production. The target factor is the most effective instrument for industrial production and unemployment, but the most persistent is LSAP for industrial production and forward guidance for unemployment.

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