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The Transmission Mechanism and Effectiveness Of the Fed's Operation Twist

Abstract: The Fed's Operation Twist (OT) is a variation of conventional open-market operations. However, as an innovation in both theory and practice, its transmission mechanism and effectiveness need further exploration. In this paper, a macro-economic system is set up, which not only includes the central bank, commercial banks, and enterprises, but also covers a range of credit markets, bond markets and commodity markets. In order to analyze the transmission mechanisms of Operation Twist, the limit solution of nonhomogeneous linear equations is introduced. The impact of Operation Twist on the U.S. and world economies is studied quantitatively by selecting 24 non-equal frequency series of variables belonging to 7 categories: Treasury yield, quantity of loans of commercial banks, unemployment rate, inflation rate, GDP, exchange rate and trade. The TRAMO/SEATS technique is used to identify the structural change points of these series and make predictions. Results show that, in general, the effects of Operation Twist are not quiet ideal. Since Operation Twist is a policy designed to "fine-tune" the economy, the macroeconomic regulators should establish an organic system integrating monetary as well as fiscal policies, strengthening its coordination of interests between different nations so as to ensure better regulation on the macro-economy.

Key words: operation twist; monetary policy; transmission mechanism; effect analysis
JEL Classification: E52, E58

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1. Introduction

The Operation Twist is an operation undertaken by a country's central bank that involves the sale (or purchase) of short-term Treasury bonds and the simultaneous purchase (or sale) of same amount of relatively long-term Treasury bonds in an attempt to extend (or shorten) the overall maturity of treasuries held by it. This kind of operation will drive up (or down) short-term bond yields and bring down (or up) long-term bond yields. Seen from the trend of Treasury yield curve, this operation is equivalent to bending (or lifting) the far end of the curve.

OT is an unconventional monetary policy, the essence of which is a variation of conventional open-market operations, i.e. the simultaneous buying and selling of bonds. Before the implementation of Operation Twist, the U.S. had already conducted two rounds of Quantitative Easing (QE): in the first round, from November, 2008 to June, 2010, the Federal Reserve bought approximately USD1.35 trillion of government bonds, mortgage-backed securities, and other toxic assets; in the second round, from June, 2010 to June, 2011, the Federal Reserve once more bought up to USD0.6 trillion of long-term government bonds. The essence of QE is the increase of the monetary base in the market achieved by the central bank through its purchase of Treasury bonds. In the early stage of its implementation, QE achieved some positive effects, but they were unsustainable. In the meantime, it brought in a huge impact on the size and structure of the assets on the Federal Reserve's balance sheet. The Federal Reserve launched Operation Twist when the effects of QE became fatigued and feeble.

On September 22, 2011, the U.S. Federal Open Market Committee (FOMC) announced it would purchase USD400 billion Treasury bonds with maturities of 6~30 years and simultaneously sell the same amount of

Treasury bonds with maturities of 3 years or shorter. By doing this FOMC was trying to drive down long-term interest rates; this way it could lower the long-term financing costs of enterprises, and thus boost the economy. On June 21, 2012, the Federal Reserve decided to extend the implementation of Operation Twist, which was expired by that point, until the end of this year, with an additional amount increase to approximately USD267 billion. Through the sale of short-term bonds and the purchase of long-term bonds, the Fed tried to cut down long-term interest rates and raise short-term interest rates while keeping aggregate supply of monetary base unchanged. This was done so capital could be led into areas such as long-term loans, inducing and promoting the growth of the economy.

Scholarly attention has been drawn to the Federal Reserve's unconventional monetary policies, such as QE and OT, especially the controversial effect of Operation Twist. After the launch of OT1 in October 2011, U.S. building permits, new home sales and existing home sales demonstrated a short-term uptrend. Most of the indicators, however, began to drop after February 2012. Thus it can be seen that OT is effective, but its effects may be relatively short-lived. Compared with OT1, the scale of OT2 is much smaller, which is 2, 670 trillion dollars. So what kind of effects will OT2 bring? The current 30-year U.S. Treasury yield is just around 2%. How much room is still there for OT to lower the long-term yield? Could it then be possible to encourage long-term investments and promote economic growth by introducing a lower cost of long-term capital? Furthermore, given the fact that the U.S. dollar serves as a key international settlement currency in the world economy, will the Fed's implementation of Operation Twist targeted at Treasury bonds lead to international capital flow and exert an impact on the world economy? The above questions suggest it is of great theoretic and realistic significance to make a scientific and rational evaluation on the transmission mechanisms and effectiveness of Operation Twist.

Given its relative novelty, Operation Twist has a short history. At present, related research is rare and no unified conclusion has yet been reached on the effects of OT. J. Gagnon et al. (2010) studied the impact of the Fed's large-scale purchase of long-term assets on the US economy after its implementation of traditional monetary policy. They found that, through its purchase of long-term assets, the Fed managed to boost the supply of market liquidity. However, with the increase of market liquidity, the amount of risky assets available in the market also increased. S. D. Amico (2010) examined the stock and flow effects of the large-scale purchases of Treasury bonds. He argued that such large-scale Treasury bond transactions exerted significant influence on short-term Treasury yields, but its effects on the medium and long-term Treasury yields were less prominent. On the contrary, A. Krishnamurthy and A. V. Jorgensenu (2011) discovered that the Fed's large-scale purchase of long-term Treasuries was followed by sharp decline in the nominal interest rates of other long-term assets. A. Palacio-Vera (2011) explored the influence of the term structure of Treasuries held by U.S. government on the Treasury yield curve. He concluded that the variations in the term structure of Treasuries held by U.S. government during 1990~2007 was adequate enough to reflect the variations in long-term and short-term interest rates. Torsten Ehlers (2012) carried out an assessment of the Federal Reserve's Operation Twist. He discovered that the announcement effect of adjustments on the Treasuries' term structure was comparatively outstanding.

Michael Joyce et al (2012) argued that it was particularly challenging to quantify the wider macroeconomic effects of OT, since central banks' policy easing was accompanied by the fiscal authorities' attempt of stimulating demand. Additionally, the spillover effects from other countries, which were taking similar measures, might further increase the difficulties of quantification. Moreover, he pointed out, the possible long and variable lags in the wider macroeconomic effects of OT led to a need for extra control over a host of additional factors. Nearly all scholars take the effects of OT as limited rather than ideal. Myron H.Ross (1966) showed that the influence of OT in 1961 was weak. Furthermore, given the fact that it failed in both compressing long-term interest rates and stimulating economic growth, the implementation of OT in 1961 might actually be considered an obvious mistake. Eric T. Swanson (2011) pointed out that OT had a significant impact on Treasury yields, but it left credit almost unaffected. Andrea Ferrero (2011) thought that government's large-scale purchase of assets played a limited role in promoting GDP growth, and its contribution to the reduction of inflation rate was even less. In addition, M. Hashem Pesaran (2012) found that GDP would increase by 1% for every doubling in quantitative easing. Unfortunately, as the intensity of quantitative easing increased, the effects of this monetary policy became less prominent.

The above scholars' research findings are notable. However, there are several deficiencies in their analysis. Firstly, most of the scholars examined the effects of Operation Twist from an empirical perspective; they lacked an analysis of the transmission mechanism of Operation Twist. Secondly, while exploring the effects of the Federal Reserve's Operation Twist on the U.S. economy, they focused primarily on a single factor, such as Treasury yield, GDP, or inflation rate, ignoring the status of the U.S. dollar as a major settlement currency in international trade. In this way they failed to comprehensively assess the impact of the Fed's monetary policy on the U.S. economy, and the world economy in the meantime. Moreover, in empirical analyses, some scholars used the qualitative analysis method, which combines the event-study methodology and statistical description together, while others have resorted to conventional VAR and SVAR to verify the correlation of Operation Twist and economic growth. However, due to the fact that the non-equal frequency data series can't be processed directly, the data series needs to be smoothed. Unfortunately, after smoothing, the characteristics of data series are distorted, thus its conclusion

based on the data series is not convincing.

This paper makes improvements based on the above scholars' studies. We focus on three aspects: first, examining the transmission mechanism of Operation Twist by establishing a mathematical model; second, comprehensively assessing the implementation effects of this monetary policy by taking into account the effects of OT on both the U.S. economy and the world economy; finally, by using the TRAMO/SEATS technique, a quantitative analysis of the effects of the Fed's Operation Twist is conducted without changing the characteristics of non-equal frequency data series.

2. Model

2.1 Economic System

Enterprise is the core part that connects upstream financing sources with downstream investments and outputs. It also determines the commodity market equilibrium. Therefore, our analysis starts with enterprise. Under the premise of established commodity price, we assume that the output of enterprise depends on its financing costs: the higher the financing cost is, the lower the outputs will be, and vice versa. This inverse proportion is presented in equation (1):

$$output = \frac{k}{c_{fund}} \tag{1}$$

where k is a positive parameter, $output$ refers to the enterprise outputs and c_{fund} is the financing cost.

We assume that enterprise raises its capital from two sources: loans obtained through financial intermediaries, such as commercial banks; the other source is the issuance of bonds, which is accomplished through the capital market based on the future expected market interest rates. Thus, the enterprise financing costs also consist of two parts: the bank financing cost and the market bond issuance cost. Enterprise will choose specific financing modes in accordance with the market conditions.

The more sufficient the loans provided by the commercial banks, the lower the financing cost for the enterprises; the lower the loans provided by the commercial banks, the higher the financing cost for enterprises. The higher the future expected bond yields are, the more the enterprise will have to pay for raising the same amount of funds; the lower the expected bond yields become, the lower the cost will be for enterprise financing through the issuance of bonds. Thus, we have the following equation:

$$c_{fund} = \frac{m}{M_{loan}} + nEy \tag{2}$$

where m and n are constant coefficients greater than 0, M_{loan} is loan amount provided by commercial banks to the market, and Ey is the expected bond yields.

In this model, the monetary policy variable is the central bank's Operation Twist targeted at the Treasury bonds. We assume the amount of long-term bonds held by the central bank is B_{long}, the amount of short-term bonds held by the central bank is B_{short}, then the quotient R of the two is a proper measure of the OT as is shown in equation (3)

$$R = \frac{B_{long}}{B_{short}} \tag{3}$$

Apparently, the bigger (or smaller) R is, the more long-term bonds the central bank is buying (or selling) and the more short-term bonds the central bank is selling (or buying).

The central bank adjusts the bond structure in the market through OT. As we are more concerned with the influence of the OT on the price and yield of long-term bonds[1], equation (4) is drawn to represent the long-term bond demand. The market price and the central bank monetary policy together determine the long-term bond demand. The greater (or smaller) the intensity of the OT is, the higher (or lower) the demand for the long-term bond will be. In this paper, the common right downward-sloping demand curve is used to present the relations of the two, where $c < 0$ and $u > 0$:

$$Q_d = b + cp + uR \tag{4}$$

The supply of long-term bonds is mainly determined by market price, thus we have equation (5) where $h > 0$

[1] Actually, if the variable subscript is properly adjusted, we can smoothly extend the conclusion to the analysis of short-term bonds; for the sake of avoiding repetition in the article, a detailed description has been omitted, because the processes are the same,.

$$Q_s = g + hp \tag{5}$$

What we want to investigate is: if a disturbance of monetary policy occurs at the beginning of the period, will there be a steady state in the economy at the end of the period? If the answer to the former question is positive, then we try to identify the steady state. For this purpose, we will introduce time variables and take a bond as a type of commodity. In the classical macroeconomic supply and demand analysis, it is generally assumed that the rate of change of commodity price and the excess demand are in direct proportion as shown in equation (6), where q is a positive constant:

$$\frac{dp}{dt} = q(Q_d - Q_s) \tag{6}$$

We also assume at the beginning, the price of long-term bonds is $p(0)$ as below:

$$p\big|_{t=0} = p(0) \tag{7}$$

Bond yield depends on two factors: one is the market transaction price of bonds. Investment theory points out that the bond yields and the market price of bonds are in inverse proportion, i.e. the lower (or higher) the market price of bonds, the higher (or lower) the bond yields. The other factor influencing bond yields is the expected bond yields. When investors anticipate a sharp rise in the future return rate of bonds (which means the risk of bonds increases, i.e. the default rate of bonds will surge in the future), they will position themselves for large sales of bonds. This leads to a fall in bond market price and a further surge of bond yields. In the 2010 European debt crisis, Greece's excessively high level of indebtedness was overburdening the government. Investors sold large amounts of Greek Treasury bonds in response to their overwhelming expectations that the default risk of the Greek Treasury bonds would soar in the future. This was reflected in the Treasury bond transaction market as a plunge of the market price and the soar of the yields of the Greek Treasury bonds. The above process can be represented by the following equation: [2]

$$Yield = l - ap + wEy \tag{8}$$

The first two items on the right side of the equation show the inverse proportion of the yields and the price of bonds; the third item on the right represents the direct proportion of the yields and the expected yields of bonds. In the equation, $Yield$ is the bond yield and the l, a and w are all constant parameters larger than 0, since the expected yields only partially, but not completely determine the yields, $w < 1$.

The formation of expected bond yield is a relatively complex process, because it involves the psychological expectation factors of rational man. At the beginning, investors have a priori expected bond yields. The future expected bond yields are adjusted periodically, according to the current real bond yield level. Thus, for investors, the current bond yields are a signal based on which they can make adjustments to the final value of expected bond yield. This is a typical Bayesian Process. When the bond yields are greater than their expected yields, investors anticipate that those bond yields will continue to rise in the future; when investors find that the bond yields are smaller than their expected yields, they expect those bond yields to fall in the future. All is shown in equation (9) where j is a parameter larger than 0.

$$E\left(Ey\middle|Yield\right) = \frac{dEy}{dt} = j(Yield - Ey) \tag{9}$$

Also we assume a priori bond expected yield $Ey(0)$ at the beginning, as below:

$$Ey\big|_{t=0} = Ey(0) \tag{10}$$

The 10 equations above are integrated into the following equation system. The first and second equation in the system are financing costs and output of the enterprise; the third is the OT monetary policy; the fourth, fifth, sixth and seventh are the supply and demand relations of bonds; the last three equations are the bond yields and their expected yields.

[2] To simplify the discussion, equation (8) and (9) in this part are actually taking the Treasury bonds and the enterprise bonds as one study object. There are plenty of articles (as most recently Krishnamurthy. A and A. Vissing-Jorgensen (2011), and Swanson. E (2011)) proving that the interest rate of the Treasury bonds has a guiding function to the market interest rate and these two kinds of rates have a strong correlation and respond consistently to the monetary policy. So, although during the analysis, the price and yield of Treasury bonds and the enterprise bonds should be molded separately and then be connected using constant coefficients; considering the equation structures of these two are completely the same and are of positive correlation, this paper only presents one equation to avoid unnecessary complication in the deduction.

$$\begin{cases} c_{fund} = \dfrac{m}{M_{loan}} + nEy \\ output = \dfrac{k}{c_{fund}} \\ R = \dfrac{B_{long}}{B_{short}} \\ Q_d = b + cp + uR \\ Q_s = g + hp \\ \dfrac{dp}{dt} = q(Q_d - Q_s) \\ p\big|_{t=0} = p(0) \\ Yield = l - ap + wEy \\ \dfrac{dEy}{dt} = j(Yield - Ey) \\ Ey\big|_{t=0} = Ey(0) \end{cases}$$

2.2 Transmission Mechanism of Monetary Policy

Substituting equation (4) and (5) into (6), we have:

$$\frac{dp}{dt} = (qc - qh)p + q(b - g + uR) \tag{11}$$

Solving this non-homogeneous linear differential equation with a constant coefficient, we get the general solution of the variation trend of bond price under the intervention of monetary policy over time:

$$p = C\exp[q(c-h)t] + \frac{b-g+uR}{h-c} \tag{12}$$

Substituting equation (7) into (12), we have its particular solution:

$$p = \left(p(0) + \frac{b-g+uR}{c-h}\right)\exp[q(c-h)t] + \frac{b-g+uR}{h-c} \tag{13}$$

Studying equation (13), assuming a monetary policy disturbance at the beginning of adjustment, under certain monetary policies, as $\left(p(0) + \dfrac{b-g+uR}{c-h}\right)$ is a constant, and $(c-h)$ is a negative number; when t tends to be a long term, the bond price tends to be a definite value. All as follows:

$$\lim_{t\to+\infty} p = \lim_{t\to+\infty}\left(p(0) + \frac{b-g+uR}{c-h}\right)\exp[q(c-h)t] + \frac{b-g+uR}{h-c} = \frac{b-g+uR}{h-c} \tag{14}$$

In the equation, when $\left(p(0) + \dfrac{b-g+uR}{c-h}\right) > 0$, p tends from the positive direction to be $\dfrac{b-g+uR}{h-c}$, otherwise, p tends from the negative direction to be $\dfrac{b-g+uR}{h-c}$. Since b, c, g, h, u are constants, we find:

Proposition 1: The price of long-term bonds relies on monetary policy.

Reconsidering the numerical relationship between the price of long-term bonds and OT, because:

$$\frac{\partial p}{\partial R} = \frac{u}{h-c} > 0 \tag{15}$$

Therefore, the bond price and OT are in direct proportion, i.e. the more (or less) intense OT is, the more long-term bonds the central bank is buying (or selling). As a result, the market bond price will rise (or fall).

Substituting (14) into (8) and then substituting equation (9) in the result, we have:

$$\frac{dEy}{dt} = j\left(l - ap + (w-1)Ey\right) = j(w-1)Ey + j\left(l - \frac{a(b-g+uR)}{h-c}\right) \quad (16)$$

Solving this non-homogeneous linear differential equation, and substituting (10) based on the general solution, we get:

$$Ey = \left(Ey(0) + \frac{l(h-c) - a(b-g+uR)}{(h-c)(w-1)}\right)\exp\left(j(w-1)t\right) + \frac{a(b-g+uR) - l(h-c)}{(h-c)(w-1)} \quad (17)$$

Thus when t tends to be a long term, we have;

$$\lim_{t\to+\infty} Ey = \frac{a(b-g+uR) - l(h-c)}{(h-c)(w-1)} \quad (18)$$

All terms in (18) are constants except R, thus we get:

Proposition 2: The expected yields of long-term bonds depend on monetary policy.

Using R to get the partial derivative of Ey, we have:

$$\frac{\partial Ey}{\partial R} = \frac{au}{(h-c)(w-1)} < 0 \quad (19)$$

This equation implies that after the implementation of OT, with the enhancing (or weakening) of the intensity in buying long-term bonds, the price of long-term bonds in the market will rise (or fall), and the long-term bond yields will fall (or rise). This conclusion is consistent with our economic intuition and prior assumptions.

Since OT only acts on the bonds as well as the bond market fluctuations, it will not directly lead to changes in loans from the commercial banks. Using R to get the derivative of equation (1) and combining equation (19), we get:

$$\frac{dc_{fund}}{dR} = n\frac{dEy}{dR} < 0 \quad (20)$$

The economic implication of this equation can be expressed as:

Proposition 3: Strengthening (or weakening) the intensity of OT monetary policy will cause the fall (or rise) of enterprise long-term financing cost.

Using R to get the derivative of equation (2), and substituting (20), we get:

$$\frac{doutput}{dR} = \frac{-k}{c_{fund}^2} \cdot \frac{dc_{fund}}{dR} > 0 \quad (21)$$

Thus we have:

Proposition 4: Strengthening (or weakening) the intensity of OT monetary policy will lead to the rise (or fall) of the enterprise long-term outputs.

The monetary policy transmission mechanism constructed above starts with bonds. Next we introduce psychological expectations, and prove that the adjustment of the OT will influence the enterprise long-term financing costs by changing the expected bond yields. Ultimately, this adjustment will change the equilibrium in the commodity market. Theoretically speaking, the transmission mechanism of the OT exists; unfortunately, its transmission effects are under the influence of many factors. Taking the long-term bond yields as an example, equation (18) indicates that in the long run, the yield variable indeed relies on monetary policy. However, in the meantime, the formation of specific numerical values also depends on variables like a, b, g, u, l, h, c, w. Thus, from the perspective of actual operations, the pursuit of a steady effect of OT is like walking on a "blade." The original designed purpose of the monetary authority is very difficult to complete. Thus, we have:

Proposition 5: Despite the fact that its transmission mechanism exists, the effects of Operation Twist are difficult to control.

3. The Impact of Operation Twist on the U.S. Economy

3.1 Data

In the above sections, we carry out modeling analysis on the transmission mechanism of the Operation Twist. In the following parts we are going to use the U.S. data to empirically test the conclusions of this paper.

Originally through its implementation of the Operation Twist targeted at Treasury bonds, by raising short-term interest rates and bringing down long-term interest rates, the Fed intends to boost long-term investments and thus to promote economic growth. Therefore, in this part, related series indexes are selected and TRAMO (Time Series Regression with ARIMA Noise, Missing Observations and Outliers) and SEATS (Signal

Extraction in ARIMA Time Series) are employed to analyze the changes in these series after the Federal Reserve's implementation of the OT in September 2011 so as to study the impact of the Operation Twist on the U.S. economy.

Variables are classified into five categories, namely, Treasury yield, growth rate of loans, unemployment rate, inflation rate and GDP, totaling 17 time series. Among them, Treasury yield has 10 data series, which separately are 1-month, 6-month, 1-year, 2-year, 3-year, 5-year, 7-year, 10-year, 20-year and 30-year series; the original data are daily data from January 2001 to August 2012; loan growth has 4 series: the commercial bank loan growth rate, the industrial and commercial enterprise loan growth rate, real estate loan growth rate, and the consumption loan growth rate, all of which are quarterly data from the 1st quarter of 2001 to the 2nd quarter of 2012; the series of unemployment rates are monthly data from January 2001 to August 2012; the series of inflation rates are monthly data from January 2001 to July 2012; the series of GDP are quarterly data from the 1st quarter of 2001 to the 2nd quarter of 2012. All the data above are from publicly available information on the Federal Reserve's website[3], except for the inflation data, which are from InflationData[4].

3.2 TRAMO Identification

We set parameter RSA as 3, and used TRAMO to identify the structural change points in the selected series from September 2011 to August 2012. Taking the monetary policy expectations into account, we also included the two months before September 2011 into the selected series' identification intervals, which fluctuated under the influence of OT. Specific results are shown in Table 1:

Table 1

Structural Change Points Extracted by Using TRAMO

Series		Structural Change Points			
		Corresponding to OT?	Position	Type	T-Value
Treasury Bonds (Yield)	1-month	Yes	2011/12	AO	-7.55
			2011/09	AO	-7.13
			2011/07	AO	3.52
	6-months	Yes	2011/09	AO	-7.85
			2012/02	LS	5.41
	1-year, 2-year, 3-year, 5-year, 7-year, 10-year, 20-year and 30-year	No			
Loan (Growth Rate)	Commercial Bank Loans, Industrial and Commercial Enterprise Loans, Real Estate Loans and Consumption Loans	No			
Marco Index	Unemployment Rate, Inflation Rate, GDP	No			

By conducting data verification we find that OT exerts considerable impact on short-term Treasury yields, while it has no significant influence on the medium and long-term Treasury yields. Its lack of significant influence on the medium and long-term Treasury yield may be due to the fact that the current medium and long-term Treasury yields in the U.S. are already extremely low[5], which means there is not much room left for the Fed to use the OT to bring an already extremely low yield further down. Relatively speaking, it might be easier to raise the short-term Treasury yield.

The data show that Operation Twist has no significant influence on the quantity of loans. That is because, more often than not, the Federal Reserve adjusts the structure and scale of loans by using monetary policy instruments, such as the interest rate. Yet Operation Twist is just a combination of selling and buying in the traditional open market operation. Although it adjusts the term structure of Treasury bonds, it makes no change in the total amount of money supply directly. Since the Fed's implementation of OT fails to sharply lower the long-term interest rate, the quantity of loans will not change significantly. In the meanwhile, OT also has no significant impact on the unemployment rates, inflation rates and the GDP. That is because, on the one hand,

[3] For more details please refer to www.federalreserve.gov.

[4] For more details please refer to inflationdata.com。

[5] In U.S. the current Treasury yield is 3% for 30-year bonds, 2.8% for 20-year bonds, 1.9% for 10-year bonds, 1.4% for 7-year bonds, 0.9% for 5-year bonds, 0.3% for 3-year bonds, 0.2% for 2-year bonds and 0.1% for 1-year bonds, all of which are at historically low levels.

monetary policy has some lag effects, and on the other hand, changes in the series of unemployment rates, inflation rates and the GDP are gradual rather than abrupt. Therefore, these three series have no structural change points. Figure 1 and Figure 2 represent the series of the 1-month Treasury bond yield and the 6-month Treasury bond yield. It is easy to discover the existence of obvious structural change points.

Figure1
Structural Change Points of the Treasury Yield (1-month)

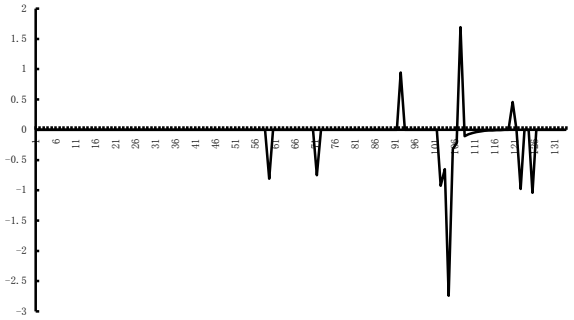
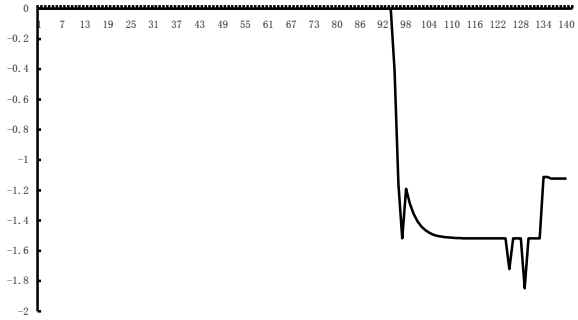


Figure2
Structural Change Points of the Treasury Yield (6-month)

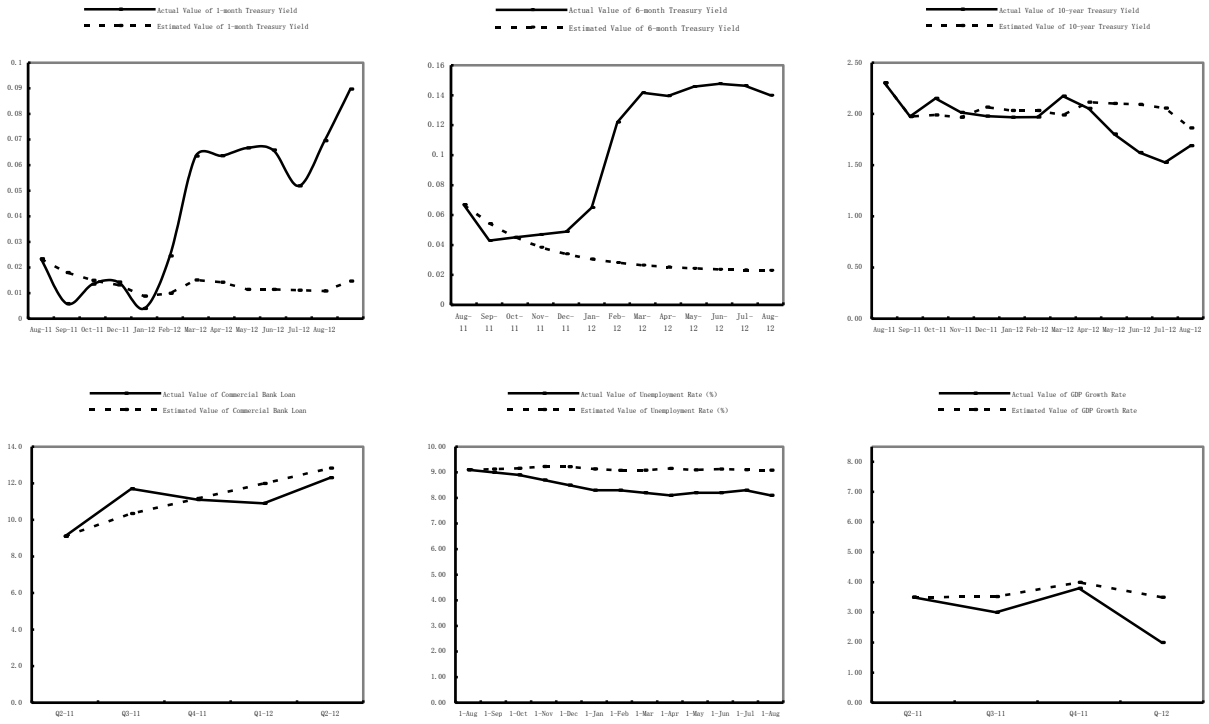


3.3 SEATS Prediction

In this section, based on the analytic results of TRAMO, we use SEATS to make predictions of the related series and carry out quantitative research regarding the impact of the Federal Reserve's OT on the U.S. Economy. Since there are too many series in this segment, we chose 6 of them: the 1-month Treasury yield, the 6-month Treasury yield, the 10-year Treasury yield, commercial bank loans, unemployment rate, and GDP to make predictions. We compared the actual values of the six series from September 2011 to August 2012 with the SEATS predicted values in order to study the impact of the Federal Reserve's OT on the U.S. Economy.

Figure 3

Actual Values and Estimated Values of Related series



The parameters $(p,d,q)(P,D,Q)$ of the model are automatically selected by the model calculation. The series of 1-month Treasury yield are $(0,1,1)(0,1,1)$; the series of 6-month Treasury yield are $(0,1,1)(0,1,1)$; the series of 10-year Treasury yield are $(0,1,1)(0,1,1)$; the series of commercial bank loans are $(0,1,0)(0,1,0)$; the unemployment rate series are $(0,1,1)(0,1,1)$ and the inflation rate series are $(0,1,1)(0,1,1)$. Figure 3 shows the

comparison of the predicted values obtained by using the TRAMO/SEATS method with the actual values of the six series from September 2011 to August 2012.

According to the results of the predictions, as for 1-month Treasury yield series and 6-month Treasury yield series, their actual values differ greatly from the predicted ones (as is shown in the 1st and 2nd graphs in Figure 3). In general, the actual values are significantly higher than the predicted ones. This proves the remarkable effect the Federal Reserve's implementation of OT in September 2011 has on raising the short-term interest rate. The difference between the actual values and the predicted values of the 10-year Treasury bonds yield series is very small (see the 3rd graph in Figure 3). This is consistent with the result of structural change points identified by TRAMO. It proves that OT has little effect on driving down the long-term yields of Treasury bonds. The actual values of the commercial bank loans growth series are relatively close to the predicted ones (see the 4th graph in Figure 3), which demonstrate that OT has a limited effect on the amounts of commercial bank loans. This agrees with the result of structural change points identified by TRAMO in Table 1. The actual values of the unemployment rate series are approximate to the predicted ones (see the 5th graph in Figure 3), which indicate that OT has a slight influence on reducing the unemployment rate. The actual values of the GDP series are all close to the estimated values except for the values in the 2nd quarter of 2012 (see the 6th graph in Figure 3), which is more or less in line with the result of the structural change points identified by TRAMO.

4. Impact of Operation Twist on the World Economy

4.1 Data

The primary purpose of the Operation Twist launched by the Federal Reserve is to bring down long-term Treasury yields and drive up short-term Treasury yields. But in the meantime, the change of the U.S. Treasury yields will affect the term structure and yields of the U.S. Treasury bonds held by foreign investors, thus affecting international capital inflow and outflow. This would lead to changes in the US dollar exchange rate; changes in US dollar exchange rate would further influence the international trade pattern. In this section, we focus on the analysis of the influences of the Federal Reserve's OT on the world economy. There are two types of variables (i.e. exchange rate and the trade) and 7 series. We've taken the 3 largest trade economies of U.S., i.e. EU, Japan and China, and we've taken 3 series as exchange rate variables, namely the USD/EUR series, the USD/CNY series, and the USD/JPY series. They are monthly data from January 2001 to August 2012, which come from the public information on Federal Reserve's website[6]. We've taken 4 series as trade variables, namely U.S. imports series, U.S. exports series, U.S. trade deficit series, and the Sino-US trade series; among them, the data of the first three series are the monthly data from January 2001 to July 2012, and the data of the last series consist of the annual data from 2001 to 2011, and the monthly data from January 2012 to June 2012. In this paper, we have doubled the total trade from January 2012 to June 2012, and used the results to represent the annual data of 2012. In this way we have changed the data of the Sino-US trade series into annual data from 2001 to 2012. The data of the four series came from the public information available on the website of the U.S. Department of Commerce[7].

4.2 TRAMO Identification

Table 2

Structural Change Points Extracted by Using TRAMO

Series		Structural Change Points			
		Corresponding to OT?	Position	Type	T Value
US Dollar Exchange Rate	USD/EUR	No			
	USD/CNY	Yes	2012/03	AO	5.02
			2011/08	LS	-6.42
			2012/06	LS	4.29
	USD/JPY	No			
U.S. foreign trade	Exports	No			
	Imports	Yes	2012/02	AO	-3.71
	Deficit	Yes	2012/02	AO	4.36
Sino-US Trade		No			

[6] For more information, please refer to www.federalreserve.gov
[7] For more information, please refer to http://www.bea.gov/

Table 2 shows the results of the structural change points in the selected series identified by TRAMO when RSA＝3. Results show that among the exchange rate series, structural change points appear in the USD/CNY series. That is because currently the US dollar assets take a large proportion in China's foreign exchange reserves; in the meanwhile, China serves as the biggest holder of U.S. Treasury bonds. As a result, the exchange rate of the RMB against the US dollar will fluctuate greatly when the U.S. Treasury yields change as a result of the OT. This, to some extent, reflects the unreasonable structure of China's current foreign exchange reserves. In this regard, China should optimize the structure of its foreign exchange reserve and try to lower the risk of its foreign exchange assets. In contrast, the OT does not affect the exchange rates of the Euro and the Japanese Yen against the US dollar. This may have something to do with the more dispersed structure of the foreign exchange assets held by the EU countries and Japan.

In terms of trade, we discovered structural change points in both U.S. imports and U.S. trade deficit in February 2012, i.e. a substantial decrease in imports and reduction in trade deficit. However, no structural change points can be found in the export trade, as well as in the Sino-US trade. The Federal Reserve's OT only has a significant impact on the exchange rate between the US dollar and the RMB, as for the exchange rates between the US dollar and other currencies, its effect becomes negligible. As a result, there is no significant change in the total amount of U.S. exports. Additionally, the decline in imports and the improvement in trade deficit might also be related to the series of economic policies launched at the end of 2011, before the U.S. general election. These economic policies are budget and deficit reduction, corporate income tax and personal income tax reform, and domestic employment promotion. The structural changes of the related data series are clearly shown in Figure 4, Figure 5, and Figure 6.

Figure 4
Structural Change of CNY/USD

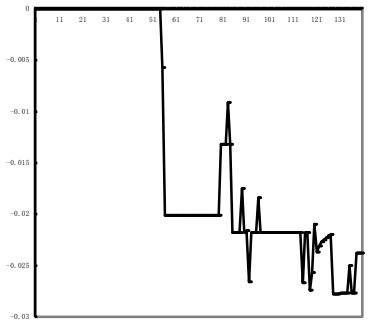


Figure 5
Structural Change of Imports

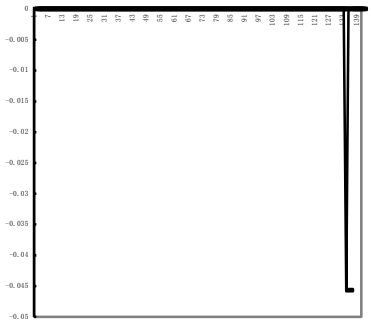
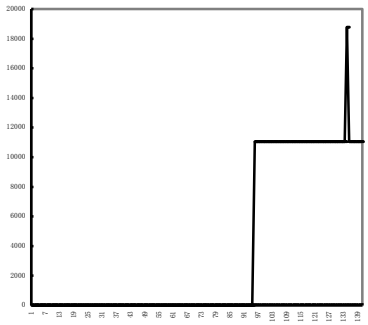


Figure 6
Structural Change of Trade Deficit

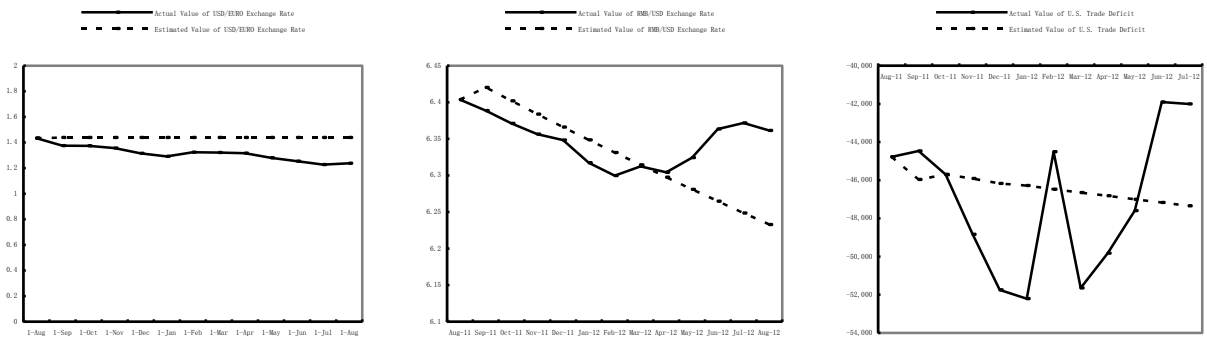


4.3 SEATS Prediction

Here, we have used SEATS to make predictions about the related series and compare the predicted values with real values so as to conduct further quantitative research on the impact of the Fed's OT.

Figure 7

Actual Values and Predicted Values of the Related Series



Parameters are selected automatically by the related series model: $(0,1,1)(0,0,0)$ for CNY/USD, $(0,1,1)(0,0,0)$ for USD/EUR and $(1,1,1)(0,0,0)$ for the U.S. trade deficit. The 1st graph in Figure 7 shows that despite the continuous appreciation of US dollar against the Euro ever since the implementation of the OT, changes in the exchange rate caused by the appreciation show no great fluctuations (in other words, there are no

structural change points). This is consistent with the result of structural change points identified by TRAMO. The 2nd graph in Figure 7 shows that there is an obvious structural fluctuation in the RMB exchange rate series. For instance, the actual value of the RMB exchange rate against the US dollar is 1.58% higher than the predicted value in June 2012. This might be related to some short-term fund outflow from China and the continuous decline for months in funds outstanding for foreign exchange in China, caused by OT. To some extent this helps maintain the strong currency status of the US dollar. The 3rd graph in Figure 7 shows that the actual value of the U.S. trade deficit series in February 2012 is 4.2% higher than the predicted value, indicating certain improvements in the deterioration of the U.S. trade deficit after OT.

5.Conclusions

The empirical results indicate that an objective and comprehensive assessment is required in studying the impact of the Federal Reserve's OT on the U.S. and world economies. On the one hand, as is shown from proposition 1 to proposition 4, the OT indeed has several impacts on Treasury price, Treasury yield and the fluctuations in real economy; however, on the other hand, as is pointed out in proposition 5, its transmission effect is under the influence of many factors. As a result, it is difficult to obtain steady effects of OT, taking into account all the difficulties in fulfilling the original designed purpose of the monetary authority and regulating the effects of OT policy.

In terms of adjustments in the Treasury yield, OT succeeds in driving up the short-term yields but fails to substantially bring down the medium and long-term Treasury yields. This is due to the fact that, at present, the yield of the long-term U.S. Treasury bond is already extremely low, which means there is little room for further compression. The OT has little effect on promoting loan growth, which indicates that OT, as a combination of conventional open market operations, plays no part in changing the currency structure and money supply. Cooperation with monetary policies, such as interest rate adjustment or reserve ratio adjustment is necessary if the government wants to effectively increase the loan amounts. In terms of unemployment and inflation rate reductions and the promotion of economic growth, the effects of OT are, at least for the time being, not significant. This may be because the changes in employment rates and commodity prices are gradual rather than abrupt, while a lag effect exists in OT's effects, which means economic output might change along with its original trend for some time before an increase takes place. Therefore, the late effects remain to be verified by further development of the real economy. Furthermore, the impact of OT on the world economy in general is not significant. In terms of exchange rates, OT only has inflicted a significant impact on the RMB exchange rate against the US dollar, but leaves the exchange rates of the Euro and the Japanese Yen against the US dollar nearly unaffected. This is the result of the unreasonable structure of China's foreign exchange reserves and the relatively independent economy of the EU countries and Japan. In terms of trade, large fluctuations are found in American import trade and trade deficits, but in import, the volatility is not obvious. Besides, judging from the series with structural changes after the Fed's implementation of OT, we can say that OT has an influence on the U.S. and world economies, but we still cannot rule out other factors that may lead to similar effects. For instance, both before and after the launch of George W. Bush's 700 billion dollar bailout in August 2008, the financial market fluctuated greatly in response to it. China's exchange rate reform in 2005 also led to structural changes in the RMB exchange rate. This shows that the factors influencing the economic operation are complex and diverse. Therefore, the authority should establish an organic system integrating monetary policies as well as fiscal policies, while at the same time strengthening its coordination of interests between different nations in order to ensure a better regulation on macro-economy.

From the perspective of actual operations under the current situation, as for the monetary policy-making in emerging market countries, the Federal Reserve's OT is not terribly significant. Take China as an example: first of all, China's economic environment is completely different from that of the U.S.: China, as an emerging market country, has its own unique basis for determining economic and financial operation modes and interest rates; second, they also differ in their monetary policy instruments and the transmission mechanisms: the U.S. is now implementing the monetary policy instruments which focus on interest rate adjustment, while China is implementing the monetary policy instruments which focus on reserve requirement ratio adjustments. Take the Treasury bonds transaction as an example; the Treasury bonds now in China are of a small scale and their term structure is unreasonable. China's capital market is relatively underdeveloped; therefore, China's central bank has not yet found the basis on which it can apply large-scale open market operations to change money supplies and regulate macroeconomic trends. Moreover, studies indicate that the effects of the Federal Reserve's OT as a whole is rather limited. Hence, we believe, the emerging market countries maybe need to think twice if they want to adopt similar policies.

Nevertheless, OT has enriched our ways of thinking in theoretical research. In the future it may help generate some new monetary policy implementation modes. The traditional theories generally believe that monetary policy is more effective at adjusting monetary aggregates than economic structure. However, OT allows us to see that monetary policy may also be effective at adjusting the economic structure. This marks the possible prelude to a

richer and more diverse monetary policy system in the future. Authorities can try to take advantage of this feature to fine-tune the macro-economy in a more efficient and more effective way.

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