The Original Operation Twist: The War Finance Corporation's War Bond Purchases, 1918 – 1920.

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In 1918 the United States Treasury delegated to the War Finance Corporation, a newly-created off-budget federal agency, the task of buying Liberty and later Victory bonds in an effort to stabilize prices. Bayesian vector autoregression analysis of the bond purchases indicate that the WFC purchases provided significant price support, and lowered bond yields while the program operated. Once WFC purchases ended, war bond yields increased substantially. However, since the war bond purchases were financed by the sale of short-term debt certificates, the bond purchases increased short rates while reducing long rates. The WFC's bond purchases twisted the yield curve.

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The United States federal government was almost debt free prior to World War I. In December, 1916, gross federal debt was 2.67% of GNP.[1] In order to finance the war efforts of the European Allies and of the United States, the U.S Treasury issued five war loans between June, 1917 and May, 1920. The four issues during the hostilities were Liberty Loans and the final issue following the war was the Victory Loan. By December 1919, gross debt peaked at 33.46% of GNP.

Marketing of the war loans emphasized the patriotic duty of citizens to buy bonds, and bonds were issued in small as well as large denominations to facilitate purchases by individuals with little financial wealth.[2] Although the bond issues were a success,[3] the market prices of both the Liberty and Victory bonds decreased shortly after they were issued. As the Treasury had aggressively marketed the bonds to the public, the ensuing price depreciation engendered considerable discontent.

When the federal government began borrowing heavily to finance the war effort, Treasury Secretary William McAdoo worried about the availability of funds for businesses essential to the war effort. In January 1918 McAdoo formed a Capital Issues Committee comprised of three members of the Federal Reserve Board.[4] The committee passed on proposed security issues, advising against those that it found to be unnecessary during the war. However, the committee's recommendations were advisory and not compulsory. McAdoo desired formal authority for the committee with the ability to penalize unnecessary security issues.

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[1] Federal debt data is from Board of Governors of the Federal Reserve System (1943). GNP data is from Balke and Gordon (1989).

[2] Kang and Rockoff (1996) investigate the impact of patriotism on war bond yields.

[3] The amount subscribed always exceeded the amount issued for all the five loans. (Gilbert, 1970).

[4] Willoughby (1934) provides a detailed account of the Capital Issues Committee and the War Finance Corporation.

In 1918 McAdoo proposed legislation creating a War Finance Corporation (WFC). The WFC legislation, passed on April 5, 1918, had two primary objectives: formalizing the Capital Issues Committee and providing financing for businesses deemed essential to the war effort.[5] In conjunction with the war financing provision, the WFC was also authorized to trade and deal in federal debt securities. The WFC was created as an off-budget agency. The Treasury provided capital of $500 million, and the WFC was authorized to sell an additional $3 billion of bonds as needed to fund its lending.

The WFC bill as passed created a formal Capital Issues Committee with seven members, but its recommendations remained advisory. The ability to penalize security issues deemed unnecessary to the war effort was removed from the final legislation.

The second provision of the legislation authorized the WFC to provide funding to essential industries otherwise unable to obtain financing. As the war ended in November 1918, the WFC lending to finance essential industries totaled only $301.5 million, of which $204.8 million was a 1919 loan to the United States Railroad Administration to assist with the federal operation of the railroads.[6] The WFC's wartime lending was limited.

The WFC was also authorized to deal in federal debt securities. Eugene Meyer, an original WFC director and later managing director, was responsible for the bond purchases. Meyer (1974, Box 180) recalled that McAdoo wanted to stabilize the market for war bonds to avoid a rate increase on the third Liberty Loan. In the two-year period that it purchased war bonds to support prices, the WFC purchased $1,461 million of bonds.[7]

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[5] Subsequent legislation authorized the WFC to provide funding for exports and to lend to banks and agricultural financing agencies during the agricultural crisis of 1921-1923.

[6] Details of all WFC operations are summarized in Secretary of Treasury (1943).

[7] This sum is obtained from War Finance Corporation (Box 114, Vol. 31). The Secretary of the Treasury (1943) reports that the WFC purchased a total par value of $1,912 million of bonds at a

This paper reports the results of an investigation of the WFC purchases of war bonds, to assess whether the purchases stabilized bond prices, and also to assess the impact of purchases on the yield curve. The next section provides a detailed description of the war bond issues and the WFC's bond purchases. The model and empirical methodology, Bayesian Structural Vector Autoregession (SVAR), are explained in section II. Section III describes the data used in the analysis. The findings are reported in section IV. Section V concludes the paper.

I. The Liberty Bonds and the WFC's Bond Purchases

The war placed tremendous financial burdens on the federal government. Federal expenditures increased from $734 million in fiscal year 1916 to $18,515 million in fiscal 1918.[8] Correspondingly, income tax rates and total tax revenue both increased dramatically. Income tax revenue was $125 million in fiscal 1916 and peaked at $3,945 million in fiscal 1920. Total receipts also peaked in fiscal 1920 at $6,695 million. Still, the majority of the increased spending was debt financed. The increases in gross debt totaled $24,259 million for fiscal years 1917-1919.

The Treasury sold five long-term bond issues (four Liberty loans and one Victory loan) between June 1917 and May 1919.[9] Between issues the Treasury sold short-term certificates of indebtedness to obtain temporary funding in anticipation of the war bond issues. Some certificates were also sold to be used to pay taxes.[10]

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total cost of $1,818 million. The WFC did make occasional purchases for the Treasury after the price support program ended.

[8] All data in this paragraph are from Board of Governors of the Federal Reserve System (1943).

[9] The maturity of the Victory Loan bonds ranged from 10 to 30 years, while the Liberty Loan bonds had a shorter four-year maturity.

[10] The use of certificates of indebtedness is explained by the Secretary of the Treasury (1919).

The First Liberty Loan Act, passed on April 24, 1917, authorized the Treasury to issue $5 billion worth of bonds at 3.5% interest.[11] The Treasury issued $2 billion of bonds on May 14, 1917, that were to mature in 1947. The denominations ranged from as low as $50 to over $250,000 and it was oversubscribed by 52% (Gilbert, 1970). The main attraction of the First Liberty Loan (LL) was probably its income tax exemption, as the top marginal income tax rate in 1917 was 67%.

There were two additional issues of the First LL, the first at 4%, starting on the week of December 21, 1917 and the second, at 4.25%, starting on the week of July 19, 1918. The bonds from the first issue at 3.5% were convertible into these later issues at the higher coupon rates.

The Second Liberty Loan Act, passed by Congress on September 24, 1917, authorized the Treasury to issue more than $7.5 billion of bonds maturing in 1942 at a 4% interest rate. Although the Second LL did not carry the tax-exemption privileges of the First LL, its final subscription still surpassed the total allotment by 54% (Gilbert, 1970).

By spring 1918, all the Liberty Loan bonds were selling below par. For instance, at the beginning of March 1918, the First LL at 3.5% was selling at 97.86 (and 97.08 for the First LL at 4%) while the Second LL was selling at 96.34. Both the Treasury and Congress were concerned by this decline in prices, as the Treasury was preparing to issue the Third LL. On May 9, 1918, the Treasury issued $3 billion of Third LL bonds at 4.25%, maturing in 1928. From the start, the Third LL was selling below par. The average price during the first trading week (*Commercial and Financial Chronicle*) was 98.4. In 1918 the Treasury was drowning in deficits. Gilbert (1970) reports

[11] The details on the chronology of bond issues and financial terms for each loan is based on Gilbert (1970) and the *Commercial and Financial Chronicle*, weekly issues.

that for July, 1918, the Treasury registered a deficit of over $1 billion.

On October 24, 1918, $6 billion of bonds of the Fourth LL were issued at 4.25%, maturing in 1938. In order to maintain its price at par, the Fourth LL included the tax-exempt provision. However, by the end of December 1918, the Fourth LL was selling below par at 94.

In a final attempt to raise government bond prices, the Victory Loan was issued on April 21, 1919, at 3.75% and 4.75%, maturing in 1922-1923. Just as for the Fourth LL, the Victory Loan included the important tax-exemption provisions on the income resulting from holding old LL bonds, for any amount not higher than $20,000 (Gilbert, 1970).

Because Liberty bonds were trading at a discount during the 1917-1918 winters, the Third Liberty Bond Act, passed on April 4, 1918, authorized the Treasury to purchase up to 5% annually of the outstanding amount of each war bond series,[12] except the First LL at 3.5% (Gilbert 1970). The initial tax-exemption provision of the First LL was probably the main driver behind its relatively higher prices (although still not at par) during the Liberty and Victory Loan Campaigns.

The Treasury delegated the bond purchases to the newly formed WFC. The WFC initiated operations in May 1918 and made its first bond purchases in June of the same year. WFC purchases of the various issues are depicted in Figure 1. Meyer's policy was to prevent war bond prices from falling more than a quarter of a point in a day, regardless of the amount traded.[13] The WFC purchased war bonds and sold them to the Treasury at the average price paid plus interest.

Figure 1 here.

[12] Section 15 of the Act authorized the bond purchases. The Act is reproduced in Secretary of the Treasury (1919).
[13] Meyer's policy is discussed by Pusey (1974).

The Third Liberty Bond Act authorized the Treasury to set aside un-appropriated funds to pay for the bond purchases. This provision proved to be ineffective, as discussed when the original sinking fund was replaced by a new fund created in conjunction with the Victory Loan legislation:

> The [Victory Liberty Loan] act of March 3, 1919, also repealed the old sinking-fund statutes which had proved unworkable and resulted in nothing more or less than a bookkeeping account. They did not retire the debt. The new law which takes the place of the provisions thus repealed can never descend to the state of uselessness which they occupied as long as the Government keeps faith with of investors in its obligations. … To make the plan effective, sinking-fund charges must be met out of revenues received from taxation. Any thought in the future of suspending operations of the cumulative sinking fund or of meeting its charges through the sale of securities would not only be unwise in the extreme … but would be a breach of faith with every subscriber to the Victory Liberty loan and with every holder of Liberty bonds. Whatever may be necessary in the future financing of the Government, nothing must be permitted to interfere with the effective operation of the cumulative sinking fund and the consequent gradual retirement of the war debt. (Secretary of the Treasury, 1920, 85-86)

In essence, the WFC bought war bonds to stabilize their prices. The bonds were resold to the Treasury, but due to the sizable deficits, the Treasury sold other debt, certificates of indebtedness, to pay for the retired war bonds. The financing of bond purchases with sales of short-term debt and the effect on interest rates was emphasized by Assistant Treasury Secretary Leffingwell in his April 16, 1920 letter to Meyer directing the WFC to cease bond purchases:

> The Treasury has been obliged to resume the issue of loan certificates and at increasing rates of interest. Under these circumstances, purchases of long-term obligations out of the proceeds of the sale of Treasury certificates will only add to the Treasury's difficulties and consequently cannot in the long run

> benefit the holders of bonds and notes or strengthen the market price of bonds and notes. (Leffingwell, 1961, reel 35)[14]

Treasury Secretary McAdoo noted that the bond purchases required issues of short-term debt: "By discontinuing purchases of Liberty Bonds for retirement under provisions of the existing law, the Treasury would be relieved of a large burden now reflected in the floating debt…" (New York Times, March 5, 1920, p. 1).

Federal finances had improved from a $13,363 million deficit in fiscal year 1919 to a $291 million surplus in fiscal year 1920 (Board of Governors of the Federal Reserve System, 1943). Thus, the WFC bond purchases had occurred during a period of sizable deficits followed by a small surplus. For the most part, WFC bond purchases did not reduce the debt, but merely retired long-term debt funded by short-term debt. While unintentional, this was the original Operation Twist, a precursor of the Federal Reserve's policies of 1961 and 2011-12.

This study investigates two questions. Did WFC bond purchases stabilize bond prices, avoiding further depreciation, or even increasing war bond prices? Secondly, did WFC bond purchases, funded by sales of short-term debt, increase short-term interest rates?

Prima facie support that the WFC purchases did stabilize prices is provided in Figures 2 and 3, for the Second and Fourth LL.[15] Upon receiving the directive, Meyer discontinued purchases during the week of April 23 1920, although he was given a deadline of June 30, 1920, to end the purchases.[16] The vertical line in each figure indicates the end of WFC purchases and the

[14] Pusey (1974) also recounts that Leffingwell felt too much money was spent on war bond purchases, and that he wanted to stop selling short-term debt at higher rates to fund the bond purchases.

[15] Figures A1 – A5 in the appendix display the bond purchase and yield data for the other issues. All follow the same pattern of timing for the yield increase.

[16] There were some purchases of the Fourth LL bonds in May 1920.

corresponding change in war bond yields. It is evident that the yield increases generally preceded the end of the purchases. Yields increased when the announcement was made, a week in advance of the actual termination of purchases. The announcement of the termination of the purchase program likely changed expectations regarding future war bond yields at the time of the announcement:

> Hereafter such purchases as the Treasury may have to make for the bond purchase fund of the sinking fund under the general program above announced will be occasional and not habitual. (New York Times, April 18, 1920, p. 15)

While the data in the figures suggest that WFC purchases stabilized prices, the impact of WFC purchases on war bond yields will be investigated econometrically.

Figures 2 and 3 here.

II. Methodology and Model

Doan, Litterman and Sims (1984), Litterman (1986) and Sims and Zha (1998) have demonstrated the usefulness of Bayesian inference techniques for macroeconomic modeling with vector autoregressions (Sims, 1980) and structural vector autoregressions (Bernanke, 1986) that make assumptions about contemporaneous relationships between variables. Bayesian inference involves the systematic incorporation of prior information into the modeling process while making probability statements about quantities of interest and testing the sensitivity of estimates (Hoogerheide, Van Dijk and Van Oest, 2009).[17]

A Bayesian structural vector autoregression (BSVAR) is constructed for

[17] A typical Bayesian prior belief is that lag coefficients go to zero as lag length increases.

each of seven war bonds as identified by its issue and its coupon rate of interest. For each type of bond, the following m-dimensional structural VAR model (in matrix notation) is constructed for a data sample of size T:[18]

$$\underset{1\times m}{y_t}\ \underset{m\times m}{A_0} = \sum_{l=1}^{p} \underset{1\times m}{y_{t-l}}\ \underset{m\times m}{A_l} + \underset{1\times m}{d} + \underset{1\times m}{\varepsilon_t}, \qquad t = 1,...,T \qquad (1)$$

where y_t is the vector of observations for m endogenous variables at time t, A_0 is the contemporaneous coefficient matrix for the structural model,[19] A_l is the coefficient matrix for the l^{th} lag, with the maximum number of lags p, d represents the vector of constant terms, and ε_t is the vector of i.i.d. shocks, assumed to be normal and structural with

$$E[\varepsilon_t \mid y_{t-s}, s>0] = 0, \qquad [\varepsilon'_t \varepsilon_t \mid y_{t-s}, s>0] = I$$

The reduced form version of the model (1) is

$$y_t = c + \sum_{l=1}^{p} y_{t-l} B_l + u_t, \quad t = 1,...,T \qquad (2)$$

where the connection with the structural simultaneous equation model (1) is given by

$$B_l = A_l A_0^{-1}, \quad u_t = \varepsilon_t A_0^{-1}.$$

By post-multiplying (1) by A_0^{-1}, the structural restrictions are incorporated in the residuals of the reduced form model as well as the dynamics of the system (Hamilton, 1994).

Model (1) is a dynamic simultaneous system of equations and thus the coefficients in the matrix A_l describe the dynamic impact of the past values on the current values of each endogenous variable, while the coefficients in A_0 describe the impact at time "0", or how the variables are interrelated to each other in each time period (each week). The structural

[18] A more detailed development of BSVARs is provided by Brandt and Freeman (2006).

[19] The matrix A_0 is assumed to be nonsingular and identified (Sims and Zha, 1998).

parameters are identified by imposing linear constraints on the contemporaneous matrix A_0 (zero restrictions correspond to a lack of contemporaneous feedback).

Bayesian estimation of model (1) requires the specification of a prior density that incorporates beliefs about the dynamic properties of the variables included in the model. For a detailed discussion about the choice of the parameter values entering the prior density (or the informative prior), see Litterman (1986), Sims and Zha (1998), Brandt and Freeman (2006, 2009). Therefore, the specification of the BSVAR models is done in two steps. First, the prior density parameters are specified for the reduced form model and second, the contemporaneous restrictions in the A_0 matrix are specified.

A. Prior Density Specifications

Table 1 reports the model specifications. For each of the seven war bond models, the prior density is specified using the Sims-Zha (1998) reference prior. The BSVAR models specified by (1) are estimated with the parameter values for the prior densities displayed in Table 1. The benchmark priors proposed by Sims and Zha (1998) are the values used for $\lambda_0 - \lambda_4$ in Table 1. These five priors specify, respectively, overall tightness around the error covariance matrix, tightness around the variance of the AR(1) coefficients, the relative weight of each variables own lags, the relative lag decay in the variance, and tightness around the variance of the intercepts. As there are no exogenous variables in the model, $\lambda_5 = 0$.

Table 1 here

The parameters are modified for unit roots and common trends. Beliefs about unit roots are allowed, by setting $\mu_5 = 2$, however, due to the short time span of the data, the specification rules out a common stochastic trend, by setting $\mu_6 = 0$. The Sims-Zha (1998) prior improves upon the previously popular "Minnesota prior" (Litterman, 1986) in that it is imposed on the entire system of equations, rather than equation-by-equation as was the case for the "Minnesota prior".

B. Contemporaneous Relationships

For each war bond, a four-equation BSVAR model that includes the following endogenous variables is constructed: the New York Federal Reserve's discount rate (NY), WFC bond purchases (WFC), Liberty/Victory bond yields (WBY), and the prime commercial paper interest rates (CPR). The (current) war bond yields are computed using the price data for Liberty and Victory Bonds.[20] WFC purchases are expressed in millions of US dollars.

Table 2 lists the restrictions on the contemporaneous matrix A_0. Zero restrictions imply the lack of contemporaneous responses. The commercial paper rate restrictions assume the Fed responds to changing rates (market conditions) by changing its discount rate. Commercial paper shocks affect war bond yields through the term structure. Changes in the discount rate affect the commercial paper rate during the same week. It is further assumed that WFC

[20] The current yields are obtained by using the following formula: WBY = (Coupon Rate/ Market Price)*100.

purchases do not respond within a week to changes in New York Fed's discount rate or commercial paper rate, while the commercial paper rate is assumed not to be affected by changes in war bond yields in the same week. The WFC responds to changes in war bond yields, or WFC purchases affect both short-term and long-term interest rates.

Table 2 here

III. Data

The data set is constructed at weekly frequency, covering the period November 1917 through December 1920. This sample period includes the entire period of WFC bond purchases, and also includes intervals with no WFC bond purchases at both the beginning and end of the sample.

Bond prices and commercial paper rates are obtained from the Commercial and Financial Chronicle (weekly issues, 1917-1921). WFC purchase data is collected from the WFC's (Record Group 154, Box 114, and Volume 31) Register on Purchases, Sales, Holdings, and Conversions of Liberty Loan Bonds, 1918-22, at the National Archives and Records Association II. The data for WFC purchases covers the June 1918 - June 1920 period. For comparability with the commercial paper rate, war bond current yields are used instead of bond prices. WFC purchases are measured in millions of dollars to obtain the same scale for all the variables in the VAR models. The New York Fed's weekly discount rates are computed from data available in Board of Governors of the Federal Reserve System (1943).

IV. Results

A. The Main Results of Impulse Response Functions

Median impulse response functions following a positive one standard error shock to WFC purchases and the New York Fed's discount rate are presented in figures 4-17, along with Bayesian shape 68% error bands around the mean response.[21] Sims and Zha (1999) argue that their approximate one standard deviation (68%) error bands provide a better indication of the range of uncertainty than 95% confidence intervals. The error bands trace the general trend and shape of the response functions and the densities of the bands account for serial correlation in the responses (Sims and Zha, 1999; Brandt and Freeman, 2006). The bands are not necessarily symmetrical, as is the case for some of the bands in figures 4 – 17.

The main results show that positive one standard error shocks to WFC purchases have a negative and statistically significant effect on war bond yields for all issues of war bonds.

Figures 4-17 here

The responses of commercial paper rates are mixed. Commercial paper rates are not statistically significant for the First LL at 4 and 4.25%. They show a positive and statistically significant change for the Second LL after four weeks, for the Third LL during the first two weeks and for the Fourth LL. The responses are negative for the Victory Loan yields.

A positive shock to the New York Fed's discount rate has a statistically significant and positive effect on commercial paper rates for the trading periods corresponding to the First LL at 4%, the Third LL, and the Victory

[21] Median responses are computed by cumulating the Markov Chain Monte Carlo samples pointwise, and then reporting the median response and confidence intervals (Brandt and Freemen, 2009).

Loans. For all the other war bonds the effects of discount rate shocks are not statistically significant. There is no clear pattern emerging from the effects of the discount rate shock on war bond yields.

B. Responses to WFC Bond Purchases Shock

All of the war bond yields decreased following a positive shock to WFC purchases. These results indicate that the war bond purchase program implemented by WFC was successful in stabilizing war bond prices. Table 3 shows the impact (first period effect) of positive shocks to WFC purchases on war bond yields, measured in percentage points (1.0 = 1%).

On impact, as displayed in table 3, an increase in WFC purchases causes all War Bond yields to fall. The decrease is approximately 3 basis points (bp) for the First and Second LL, 2 bp for the Third and Fourth LL, and 1 bp for the Victory L. Over time, after about 10 weeks following the shock, the effect dies out for most of the war bonds. The effects are still persistent after 10 weeks only for the Third and the Fourth LL. Since the price effects of the bond purchases were transitory, the WFC would have had to make purchases continuously to maintain prices, a result consistent with the facts.

Table 3 here

A one standard deviation shock to WFC purchases translates into an increase of purchases by $20,000 for the First LL at 4%, $30,000 for the First LL at 4.25%, $80,000 for the Second LL, $1.2 million for the Third LL, $950,000 for the Fourth LL, and $500,000 and $290,000 for the Victory L at 3.75% and at 4.75% respectively.

WFC purchases of the Second, Third and Fourth LL have a positive and significant effect on commercial paper rates, as shown by the impulse response functions displayed in figures 8, 10 and 12. The Third and Fourth bonds were the two issues that WFC purchased in the highest amounts. As discussed above, war bonds were subsequently sold to the Treasury, financed by Treasury sales of certificates of indebtedness. The increase in the supply of short-term certificates of indebtedness by the Treasury decreased prices and therefore drove up interest rates, while purchases by WFC of war bonds decreased long-term yields. Therefore, the positive effect on the commercial paper rate along with the negative effects on war bond yields indicates a twisting of the yield curve.

As is evident in figures 2 – 3 above, at the time of the announcement of the end of the WFC's war bond purchases, yields increased considerably. The trend line suggests a structural break at the time the end of the bond purchase program was announced, April 18, 1920 (New York Times, 1920). The trend break may be due to the fact that the program was effective. It may also reflect a change in expectations about future prices and yields, that upon completion of the sale of the final Victory Loan, the Treasury had no incentive nor interest in stabilizing the prices of its bonds.

C. Forecast Error Variance Decompositions

The Forecast Error Variance Decompositions are reported in the tables 4 to 17. WFC purchase shocks explain almost all of the forecasting uncertainty of future war bond yields, between 97 and 100% in the short-run (over a 10-week period). The contributions of the other variables are close to zero and are not statistically significant. It's noteworthy that relative contributions of WFC purchases do not change over time. They remain stable and close to 100%. This

result is consistent with impulse responses of War Bond yields following a shock to WFC purchases.

Tables 4 - 17 here

As shown in Figure 1 above, the WFC intervened heavily in the market for the Second, Third and the Fourth Liberty Loans, as well as the Victory Loan. The forecast error variance of a shock to commercial paper rates is explained in part by WFC purchases of these war bonds (all except the First LL purchases). The relative contribution of WFC purchases of the First LL on commercial paper rates is close to zero.

On impact, WFC purchases of Liberty and Victory Loans explain between 22% (Victory Loan at 4.75%) and 81% (Second LL) of the variance of a shock to the commercial paper rate, while shocks to the New York Fed's discount rate contributes between 0.4% (Second LL) and 64% (Victory Loan at 3.75%).[22] While the relative contribution of WFC purchases decreases over time, the discount rate's influence increases over time, explaining almost 74% (Victory Loan at 3.75%) of the forecast error variance of commercial paper rates after 10 weeks. These decompositions indicate that WFC purchases played a very significant role affecting bond yields and as a result twisted the yield curve, a result consistent with the impulse-response analysis.

V. Conclusion

The War Finance Corporation was created in 1918 to exert some influence on capital markets and to insure adequate funding for businesses deemed essential to

[22] The Victory Bonds had a shorter maturity than the Liberty bonds, which may account for the difference in the magnitude of the effects.

the war effort. These activities of the WFC were relatively limited.[23]

As the war required the Treasury to issue bonds in here-to-fore unimagined amounts, the Treasury had an incentive to stabilize prices to make the bonds attractive to bond holders. The general public was urged to purchase bonds as an act of patriotism, and war bonds were issued in small as well as large denominations to make the bonds attractive to citizens with limited financial wealth. However, after issue, the war bonds traded at discounts from par value, much to the dismay of many citizens who had purchased the bods. To placate the public, and to facilitate future bond issues, the Treasury had an incentive to stabilize its bonds' prices.

The Third Liberty Bond Act authorized the Treasury to repurchase up to 5% of the outstanding issues annually in order to stabilize bond prices. This act was passed at the same time the WFC legislation was approved, and the Treasury delegated the repurchase of war bonds to the WFC.

During a two-year period, the WFC purchased almost $2 billion of bonds that it sold to the Treasury. While the Third Liberty Bond Act had authorized the creation of a sinking fund from un-appropriated funds, there were during this period no un-appropriated funds, as there was a sizable budget deficit. Thus, the Treasury had to issue short-term debt to retire long-term debt.

This paper reports the results of an analysis of the WFC bond purchases, to assess the impact on both short-term and long-term yields. Bayesian structural vector autoregression models are estimated for each war bond issue. The results indicate a significant negative impact of WFC purchases on war bond yields for all issues purchased. This is true for both impulse-response functions and variance decompositions.

[23] Other than the war bond purchases, the most significant activity of the WFC was its lending to banks in an effort to relieve agricultural distress during the period 1921-24 (Secretary of the Treasury, 1943).

The results also indicate, for those bond issues purchased in greatest quantities, that the purchases had a significant positive impact on the short-term interest rate. Thus, however inadvertent, the WFC purchases of war bonds twisted the yield curve.

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Table 1: Sims-Zha Prior Density Hyperparameters for the Liberty and Victory Loan Models.

Parameters	λ_0	λ_1	λ_2	λ_3	λ_4	λ_5	μ_5	μ_6
Values	0.6	0.1	1	1	0.1	0	2	0
Range	[0,1]	>0	=1	>0	≥0	≥0	≥0	≥0

Table 2: The Structure of the Contemporaneous Matrix (A_0).

Variables	CPR	NY	WBY	WFC
CPR	*	*	0	*
NY	*	*	0	0
WBY	*	0	*	*
WFC	0	0	*	*

Note. The cells marked with * represent the contemporaneous relationships (or the "free" parameters) to be estimated, while the cells recording a 0 represent zero restrictions.

Table 3: Time Profiles of Median Responses in War Bond Yields Following a Positive Shock to WFC Purchases. (1.0 = 1%)

War Bonds/Weeks	1	2	3	4	5	6	7	8	9	10
First LL 4%	-0.03	-0.026	-0.023	-0.02	-0.018	-0.016	-0.014	-0.013	-0.012	-0.01
First LL 4.25%	-0.029	-0.023	-0.018	-0.014	-0.011	-0.009	-0.007	-0.006	-0.004	-0.004
Second LL 4%	-0.032	-0.025	-0.018	-0.014	-0.01	-0.007	-0.006	-0.004	-0.003	-0.003
Third LL 4.25%	-0.023	-0.016	-0.015	-0.014	-0.014	-0.013	-0.012	-0.012	-0.012	-0.012
Fourth LL 4.25%	-0.026	-0.02	-0.014	-0.009	-0.005	-0.001	0.002	0.004	0.008	0.011
Victory L 3.75%	-0.011	-0.009	-0.008	-0.006	-0.005	-0.004	-0.003	-0.002	-0.002	-0.001
Victory L 4.75%	-0.011	-0.009	-0.007	-0.005	-0.004	-0.002	-0.001	0	0	0

Table 4: Decomposition of Forecast Errors for the Commercial Paper Rates (First LL at 4%).

Horizon	Std. Error	CommPaper	NYrate	yields.first4	WFCfirst4
1	0.1	88.5	9.4	1.8	0.3
2	0.1	88.6	9.4	1.7	0.3
3	0.2	88.6	9.5	1.7	0.3
4	0.2	88.6	9.5	1.7	0.2
5	0.2	88.5	9.5	1.7	0.2
6	0.2	88.5	9.5	1.7	0.2
7	0.2	88.5	9.6	1.8	0.2
8	0.2	88.5	9.6	1.8	0.2
9	0.3	88.4	9.7	1.8	0.1
10	0.3	88.4	9.7	1.8	0.1

Table 5: Decomposition of Forecast Errors for the First LL Yields At 4%

Horizon	Std. Error	CommPaper	NYrate	yields.first4	WFCfirst4
1	0.1	0.0	0.0	0.0	99.9
2	0.1	0.1	0.0	0.1	99.8
3	0.2	0.2	0.0	0.1	99.7
4	0.2	0.3	0.0	0.1	99.5
5	0.2	0.4	0.1	0.2	99.3
6	0.2	0.6	0.2	0.2	99.0
7	0.2	0.7	0.4	0.3	98.6
8	0.2	1.0	0.6	0.4	98.1
9	0.2	1.2	0.8	0.5	97.5
10	0.2	1.4	1.1	0.6	96.9

Table 6: Decomposition of Forecast Errors for the Commercial Paper Rates (First LL at 4.25%)

Horizon	Std. Error	CommPaper	NYrate	yields.first4.25	WFCfirst425
1	0.1	94.4	0.9	3.8	0.9
2	0.1	94.4	1.0	3.8	0.8
3	0.2	94.5	1.0	3.9	0.6
4	0.2	94.6	1.0	3.9	0.5
5	0.2	94.6	1.0	3.9	0.5
6	0.2	94.6	1.1	3.9	0.4
7	0.2	94.6	1.1	3.9	0.3
8	0.3	94.6	1.1	4.0	0.3
9	0.3	94.6	1.1	4.0	0.3
10	0.3	94.6	1.1	4.0	0.2

Table 7: Decomposition of Forecast Errors for the First LL Yields at 4.25%

Horizon	Std. Error	CommPaper	NYrate	yields.first425	WFCfirst425
1	0.2	0.1	0.0	0.0	99.9
2	0.3	0.1	0.0	0.0	99.9
3	0.3	0.0	0.0	0.0	99.9
4	0.3	0.0	0.0	0.0	99.9
5	0.3	0.0	0.0	0.0	99.9
6	0.3	0.0	0.0	0.1	99.9
7	0.3	0.1	0.0	0.1	99.9
8	0.3	0.1	0.0	0.1	99.8
9	0.3	0.1	0.0	0.1	99.8
10	0.3	0.1	0.0	0.1	99.7

Table 8: Decomposition of Forecast Errors for the Commercial Paper Rates (Second LL at 4%)

Horizon	Std. Error	CommPaper	NYrate	yields.second	WFCsecond
1	0.1	11.9	0.4	6.5	81.1
2	0.2	15.0	0.6	8.3	76.1
3	0.2	18.0	0.7	10.0	71.3
4	0.2	20.8	0.8	11.6	66.8
5	0.2	23.4	1.0	13.1	62.5
6	0.2	25.8	1.2	14.5	58.6
7	0.2	27.9	1.3	15.8	55.0
8	0.2	29.9	1.4	16.9	51.8
9	0.2	31.6	1.6	18.0	48.9
10	0.2	33.1	1.7	18.9	46.3

Table 9: Decomposition of Forecast Errors for the Second LL Yields at 4%

Horizon	Std. Error	CommPaper	NYrate	yields.second	WFCsecond
1	1.0	0.0	0.0	0.0	100.0
2	1.2	0.0	0.0	0.0	100.0
3	1.3	0.0	0.0	0.0	100.0
4	1.4	0.0	0.0	0.0	100.0
5	1.4	0.0	0.0	0.0	100.0
6	1.5	0.0	0.0	0.0	100.0
7	1.5	0.0	0.0	0.0	100.0
8	1.5	0.0	0.0	0.0	100.0
9	1.5	0.0	0.0	0.0	100.0
10	1.5	0.0	0.0	0.0	100.0

Table 10: Decomposition of Forecast Errors for the Commercial Paper Rates (Third LL at 4.25%)

Horizon	Std. Error	CommPaper	NYrate	yields.third	WFCthird
1	0.2	10.3	33.9	0.0	55.8
2	0.2	11.7	39.3	0.0	49.0
3	0.3	13.2	45.6	0.0	41.2
4	0.3	14.4	50.9	0.0	34.6
5	0.3	15.1	54.7	0.0	30.2
6	0.3	15.3	56.8	0.0	27.9
7	0.4	15.1	57.5	0.0	27.4
8	0.4	14.6	57.2	0.0	28.2
9	0.4	14.0	56.3	0.0	29.7
10	0.4	13.4	55.1	0.0	31.5

Table 11: Decomposition of Forecast Errors for the Third LL Yields at 4.25%

Horizon	Std. Error	CommPaper	NYrate	yields.third	WFCthird
1	1.9	0.0	0.0	0.0	100.0
2	2.3	0.0	0.0	0.0	100.0
3	2.6	0.0	0.0	0.0	100.0
4	2.8	0.0	0.0	0.0	99.9
5	2.9	0.0	0.0	0.0	99.9
6	3.0	0.0	0.0	0.0	99.9
7	3.0	0.0	0.0	0.1	99.9
8	3.1	0.0	0.0	0.1	99.9
9	3.1	0.0	0.0	0.1	99.9
10	3.1	0.0	0.0	0.1	99.9

Table 12: Decomposition of Forecast Errors for the Commercial Paper Rates (Fourth LL at 4.25%)

Horizon	Std. Error	CommPaper	NYrate	yields.fourth	WFCfourth
1	0.3	14.3	4.3	0.7	80.7
2	0.3	15.9	4.8	0.8	78.4
3	0.4	17.3	5.3	0.9	76.5
4	0.4	18.7	5.7	0.9	74.7
5	0.5	20.0	6.2	1.0	72.9
6	0.5	21.3	6.6	1.1	71.1
7	0.5	22.5	7.0	1.1	69.3
8	0.6	23.8	7.4	1.2	67.6
9	0.6	25.0	7.8	1.3	65.9
10	0.6	26.2	8.3	1.3	64.2

Table 13: Decomposition of Forecast Errors for the Fourth LL Yields at 4.25%

Horizon	Std. Error	CommPaper	NYrate	yields.fourth	WFCfourth
1	3.0	0.0	0.0	0.0	100.0
2	3.9	0.0	0.0	0.0	100.0
3	4.6	0.0	0.0	0.0	100.0
4	5.0	0.0	0.0	0.0	100.0
5	5.3	0.0	0.0	0.0	100.0
6	5.6	0.0	0.0	0.0	100.0
7	5.8	0.0	0.0	0.0	100.0
8	5.9	0.0	0.0	0.0	100.0
9	6.0	0.0	0.0	0.0	100.0
10	6.1	0.0	0.0	0.0	100.0

Table 14: Decomposition of Forecast Errors for the Commercial Paper Rates (Victory L at 3.75%)

Horizon	Std. Error	CommPaper	NYrate	yields.victory375	WFCv375
1	0.2	14.5	63.6	0.0	21.9
2	0.2	15.9	69.2	0.0	14.9
3	0.3	16.5	71.2	0.0	12.3
4	0.3	16.9	72.3	0.0	10.9
5	0.3	17.1	72.9	0.0	10.0
6	0.4	17.4	73.3	0.0	9.3
7	0.4	17.6	73.5	0.0	8.9
8	0.4	17.8	73.7	0.0	8.5
9	0.4	18.0	73.9	0.0	8.2
10	0.5	18.2	73.9	0.0	7.9

Table 15: Decomposition of Forecast Errors for the Victory L Yields at 3.75%

Horizon	Std. Error	CommPaper	NYrate	yields.victory375	WFCv375
1	1.1	0.0	0.2	0.0	99.8
2	1.5	0.1	0.2	0.0	99.8
3	1.7	0.1	0.2	0.0	99.7
4	1.9	0.1	0.2	0.0	99.7
5	2.0	0.1	0.3	0.0	99.6
6	2.1	0.1	0.3	0.0	99.5
7	2.2	0.2	0.4	0.0	99.4
8	2.2	0.2	0.4	0.0	99.4
9	2.2	0.3	0.4	0.0	99.3
10	2.3	0.3	0.5	0.0	99.2

Table 16: Decomposition of Forecast Errors for the Commercial Paper Rates (Victory L at 4.75%)

Horizon	Std. Error	CommPaper	NYrate	yields.victory475	WFCv475
1	0.3	10.6	1.8	0.0	87.6
2	0.4	11.6	2.0	0.0	86.3
3	0.4	12.9	2.3	0.0	84.8
4	0.5	14.3	2.5	0.0	83.2
5	0.5	15.7	2.8	0.0	81.5
6	0.5	17.2	3.1	0.0	79.7
7	0.5	18.8	3.4	0.0	77.9
8	0.6	20.3	3.6	0.0	76.1
9	0.6	21.8	3.9	0.0	74.3
10	0.6	23.3	4.2	0.0	72.5

Table 17: Decomposition of Forecast Errors for the Victory L Yields at 4.75%

Horizon	Std. Error	CommPaper	NYrate	yields.victory475	WFCv475
1	1.6	0.1	0.0	0.0	99.9
2	2.1	0.1	0.0	0.0	99.9
3	2.4	0.1	0.0	0.0	99.9
4	2.7	0.1	0.0	0.0	99.9
5	2.8	0.1	0.0	0.0	99.8
6	2.9	0.1	0.0	0.0	99.8
7	3.0	0.2	0.0	0.0	99.8
8	3.1	0.2	0.0	0.0	99.8
9	3.1	0.2	0.0	0.0	99.8
10	3.2	0.2	0.0	0.0	99.7

Figure 1: WFC Purchases of Liberty and Victory Bonds ($millions).

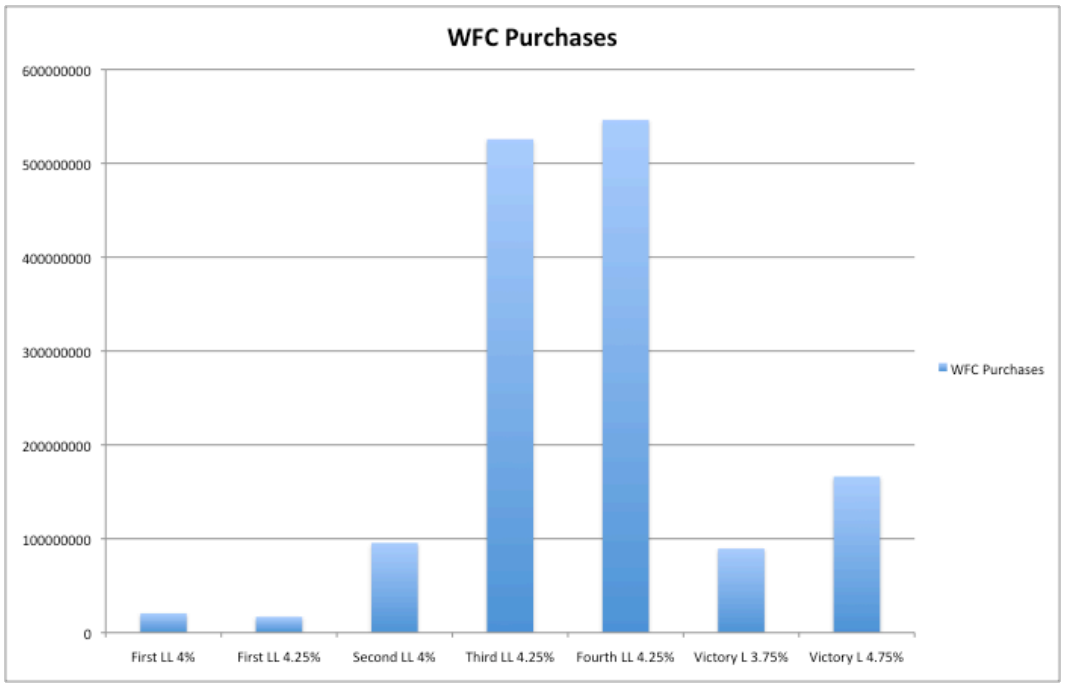


Figure 2:

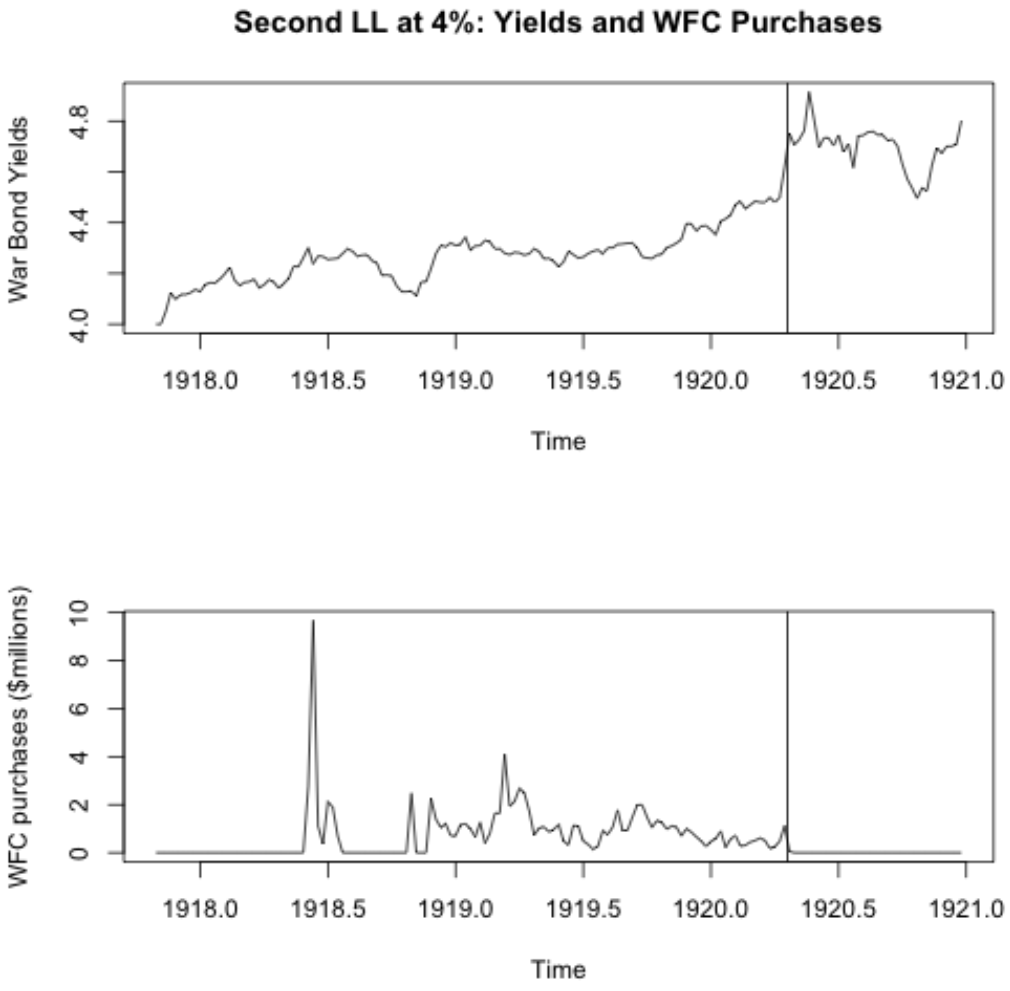

Second LL at 4%: Yields and WFC Purchases
War Bond Yields
4.0
4.4
4.8
1918.0
1918.5
1919.0
1919.5
1920.0
1920.5
1921.0
Time
WFC purchases ($millions)
0
2
4
6
8
10
1918.0
1918.5
1919.0
1919.5
1920.0
1920.5
1921.0
Time

Figure 3:

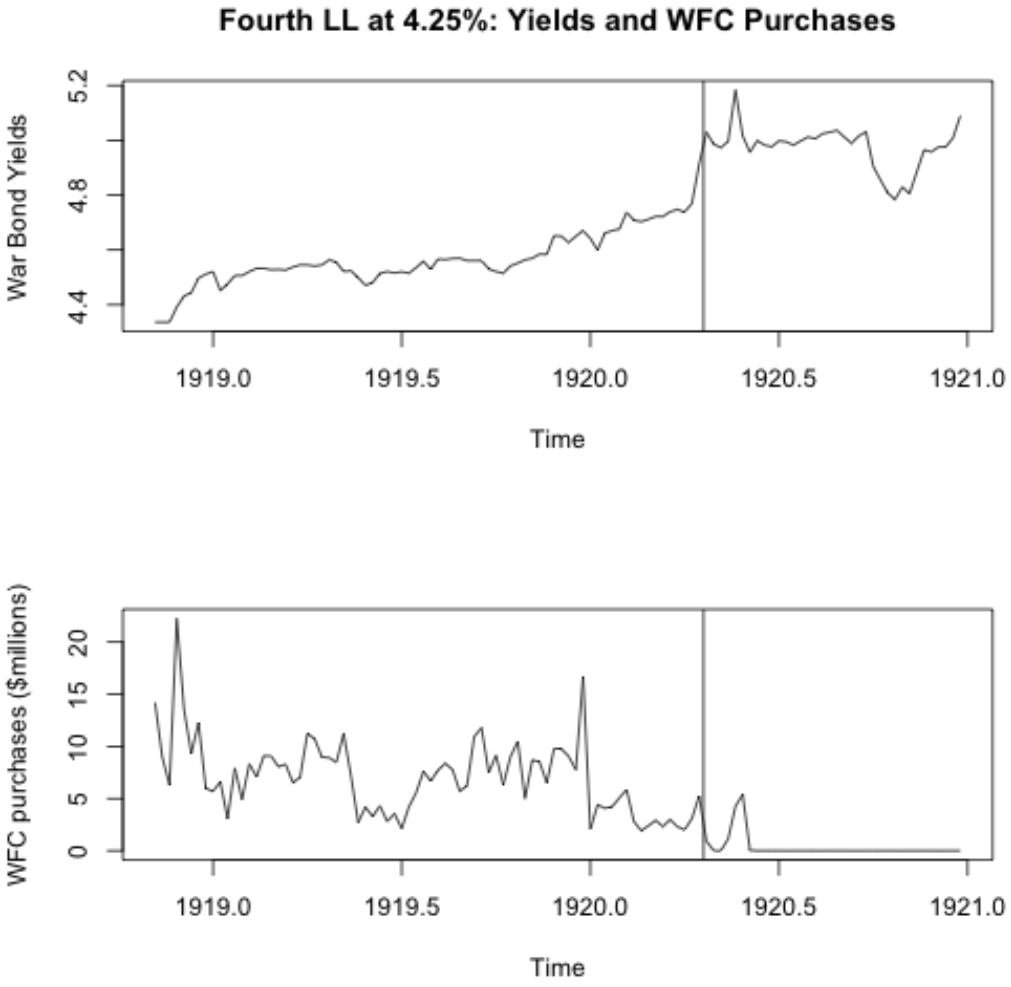

Fourth LL at 4.25%: Yields and WFC Purchases
War Bond Yields
4.4
4.8
5.2
1919.0
1919.5
1920.0
1920.5
1921.0
Time
WFC purchases ($millions)
0
5
10
15
20
1919.0
1919.5
1920.0
1920.5
1921.0
Time

Figure 4 - Impulse-Response Functions First Liberty Loan at 4%.

Response to WFC Purchases:

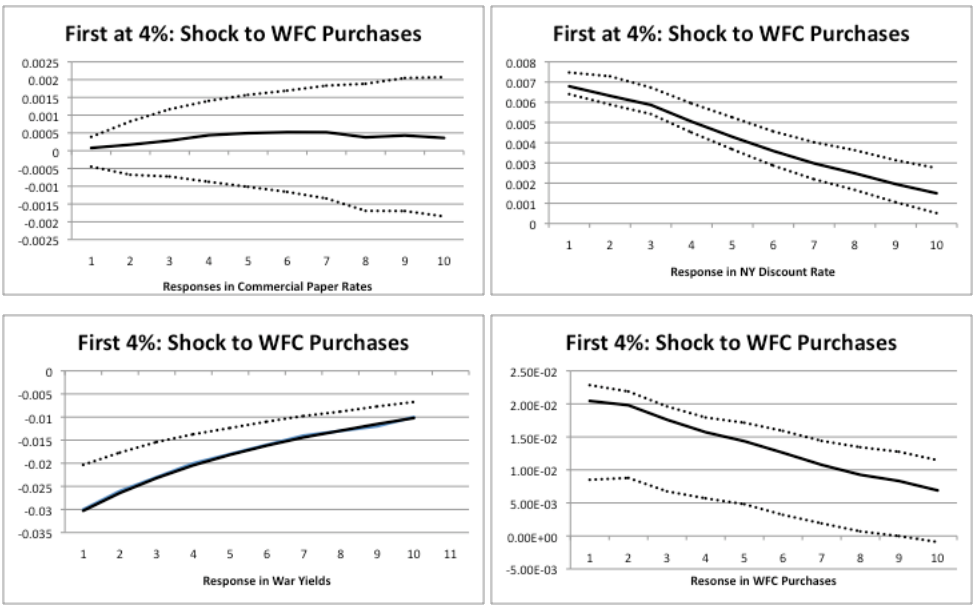


Figure 5 - Impulse-Response Functions First Liberty Loan at 4%.

Response to NY Fed Discount Rate:

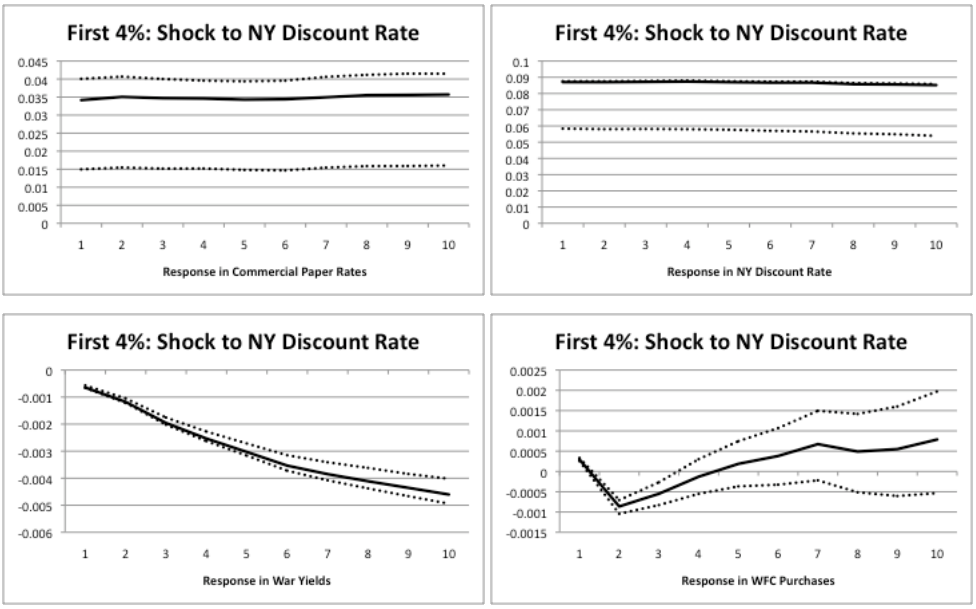


Figure 6 - Impulse-Response Functions First Liberty Loan at 4.25%. Response to WFC Purchases:

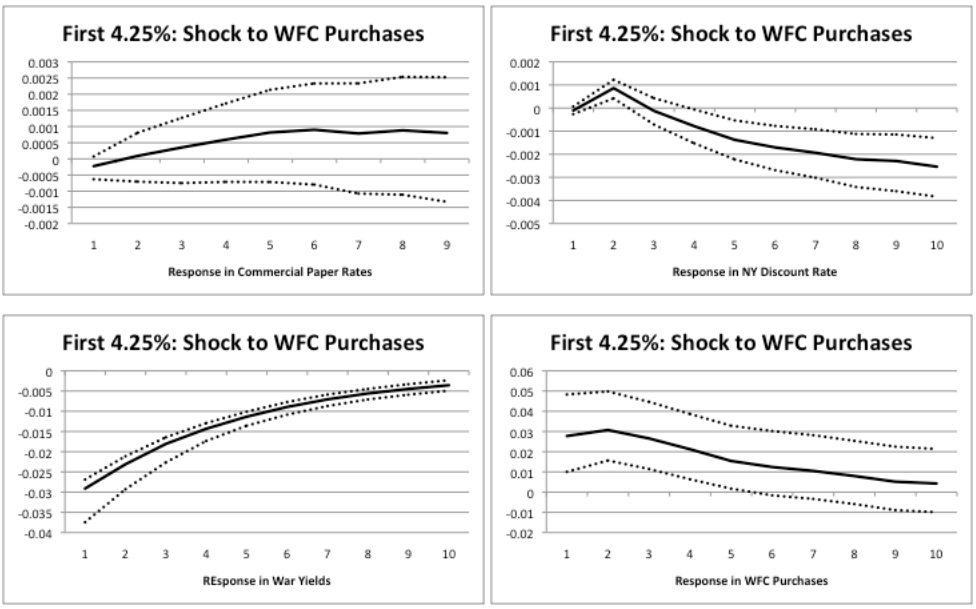


Figure 7 - Impulse-Response Functions First Liberty Loan at 4.25%. Response to NY Fed Discount Rate:

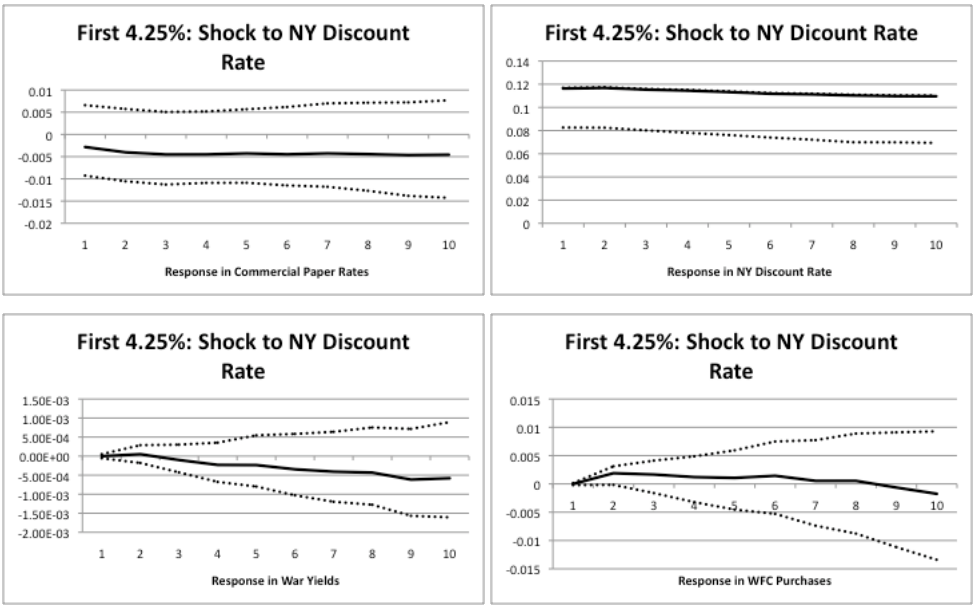


Figure 8 - Impulse-Response Functions Second Liberty Loan at 4%.

Response to WFC Purchases:

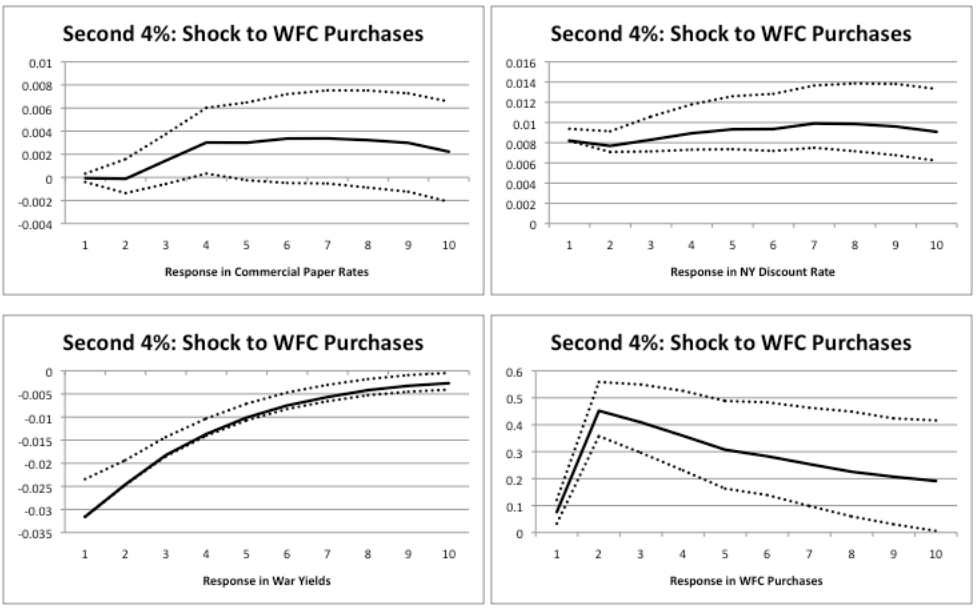


Figure 9 - Impulse-Response Functions Second Liberty Loan at 4%.

Response to NY Fed Discount Rate:

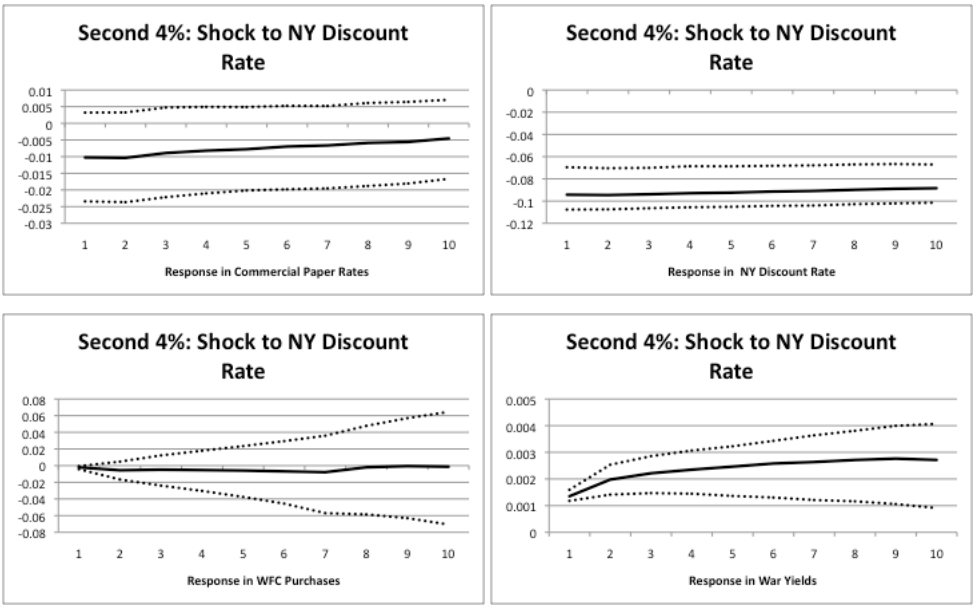


Figure 10 - Impulse-Response Functions Third Liberty Loan at 4.25%. Response to WFC Purchases:

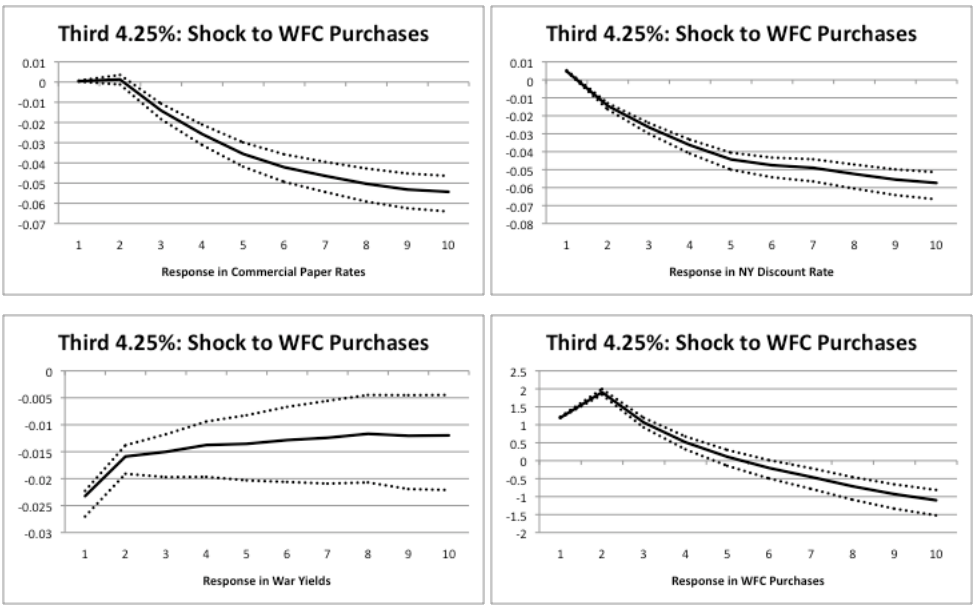


Figure 11 - Impulse-Response Functions Third Liberty Loan at 4.25%. Response to NY Fed Discount Rate:

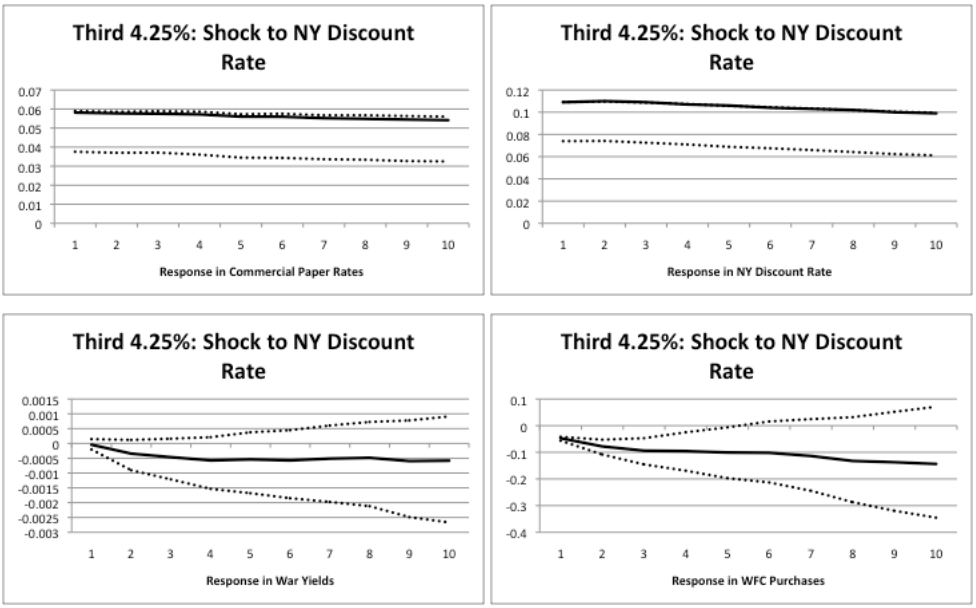


Figure 12 - Impulse-Response Functions Fourth Liberty Loan at 4.25%. Response to WFC Purchases:

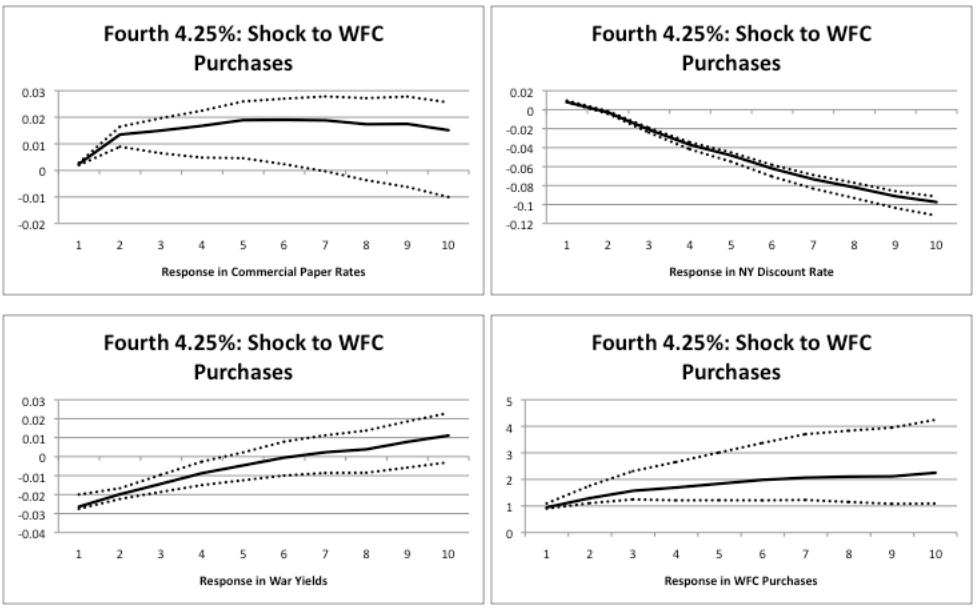


Figure 13 - Impulse-Response Functions Fourth Liberty Loan at 4.25%. Response to NY Fed Discount Rate:

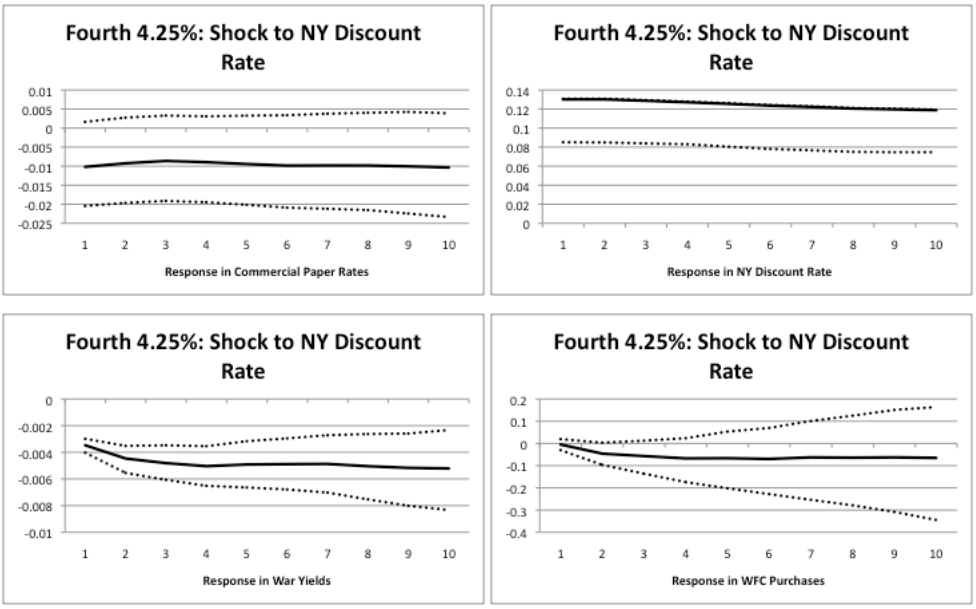


Figure 14 - Impulse-Response Functions Victory Loan at 3.75%. Response to WFC Purchases:

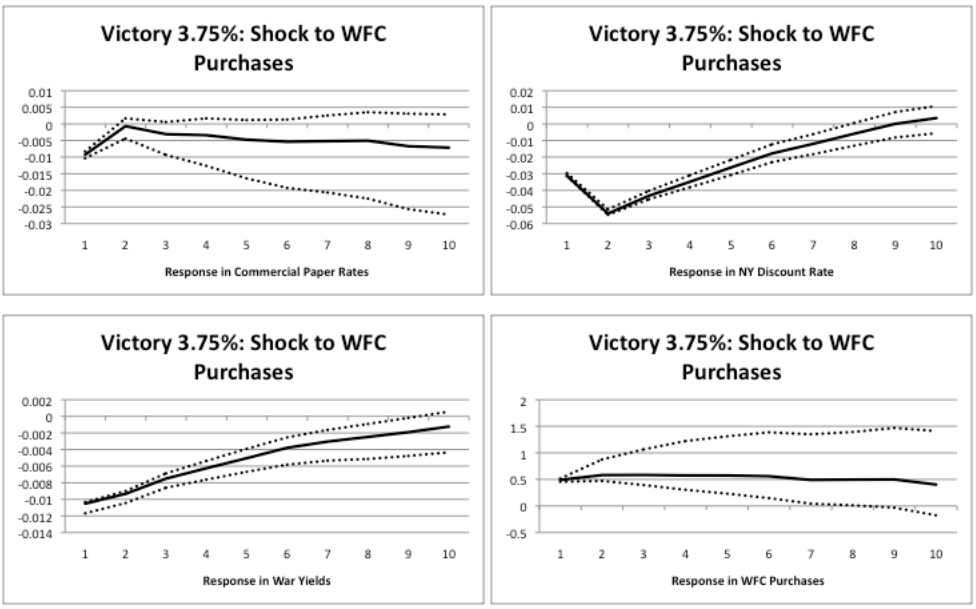


Figure 15 - Impulse-Response Functions Victory Loan at 3.75%. Response to NY Fed Discount Rate:

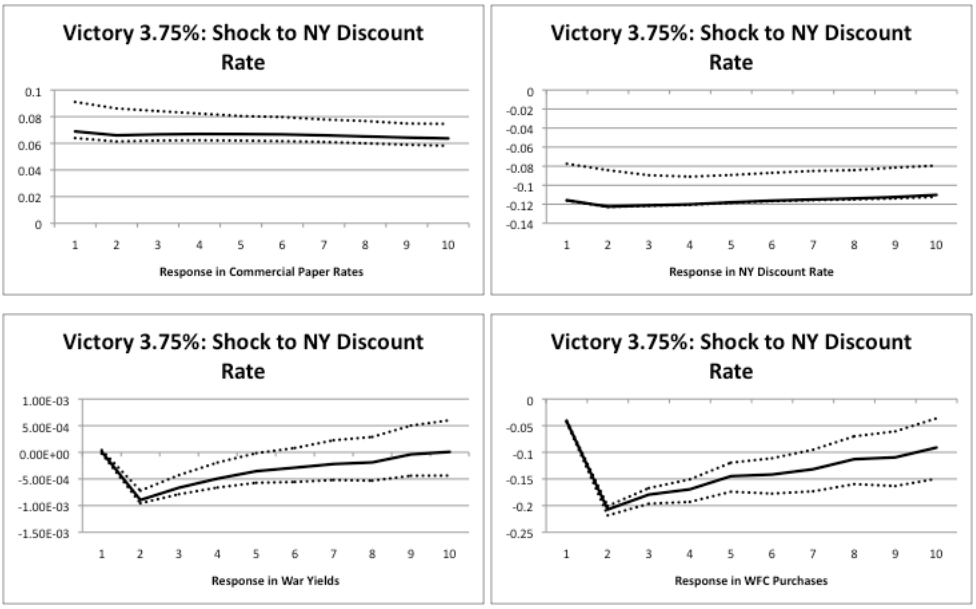


Figure 16 - Impulse-Response Functions Victory Loan at 4.75%.

Response to WFC Purchases:

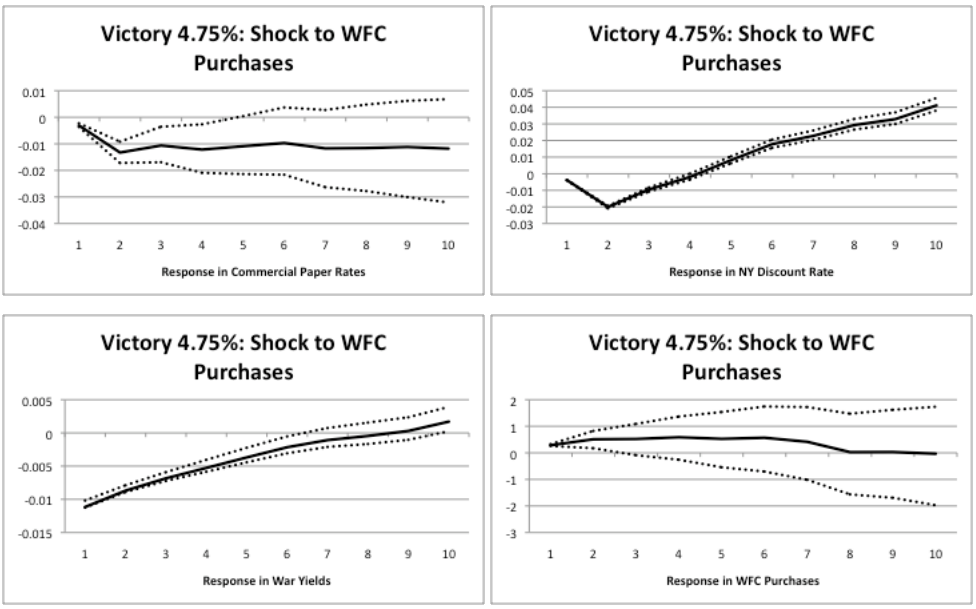
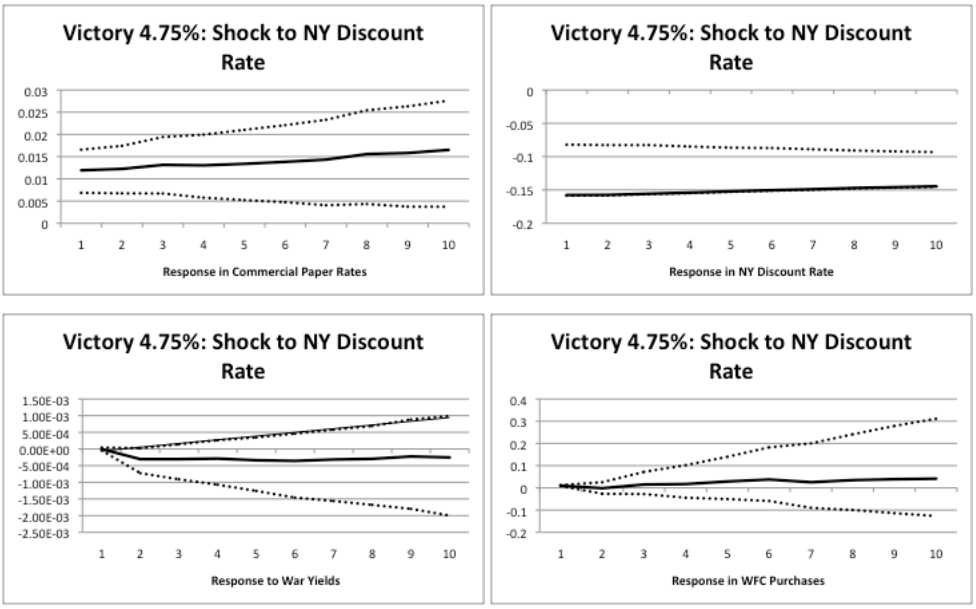


Figure 17 - Impulse-Response Functions Victory Loan at 4.75%.

Response to NY Fed Discount Rate:



Appendix

The figures in the appendix depict the weekly WFC purchases and yields for five war bond issues. The vertical line indicates the end of purchases. The announcement of the end of purchases was made one week (one observation period) earlier.

Figure A1:

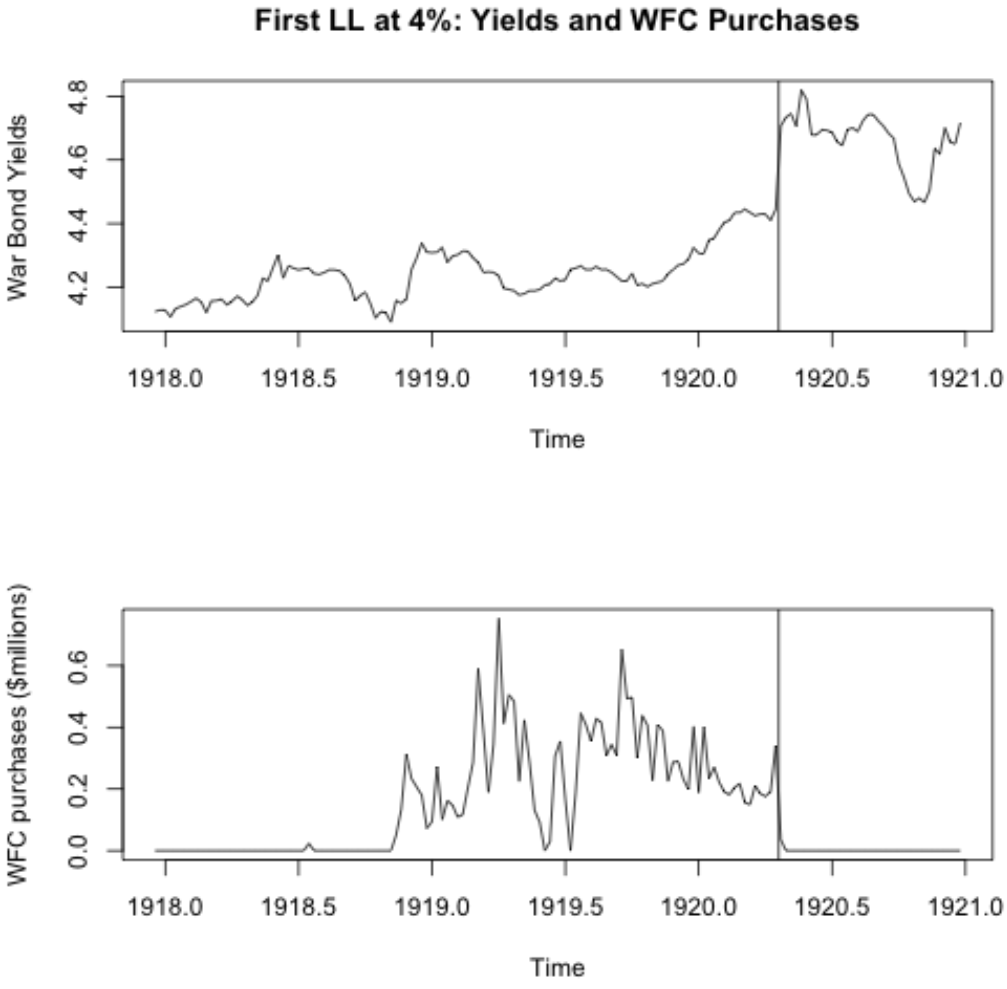


Figure A2:

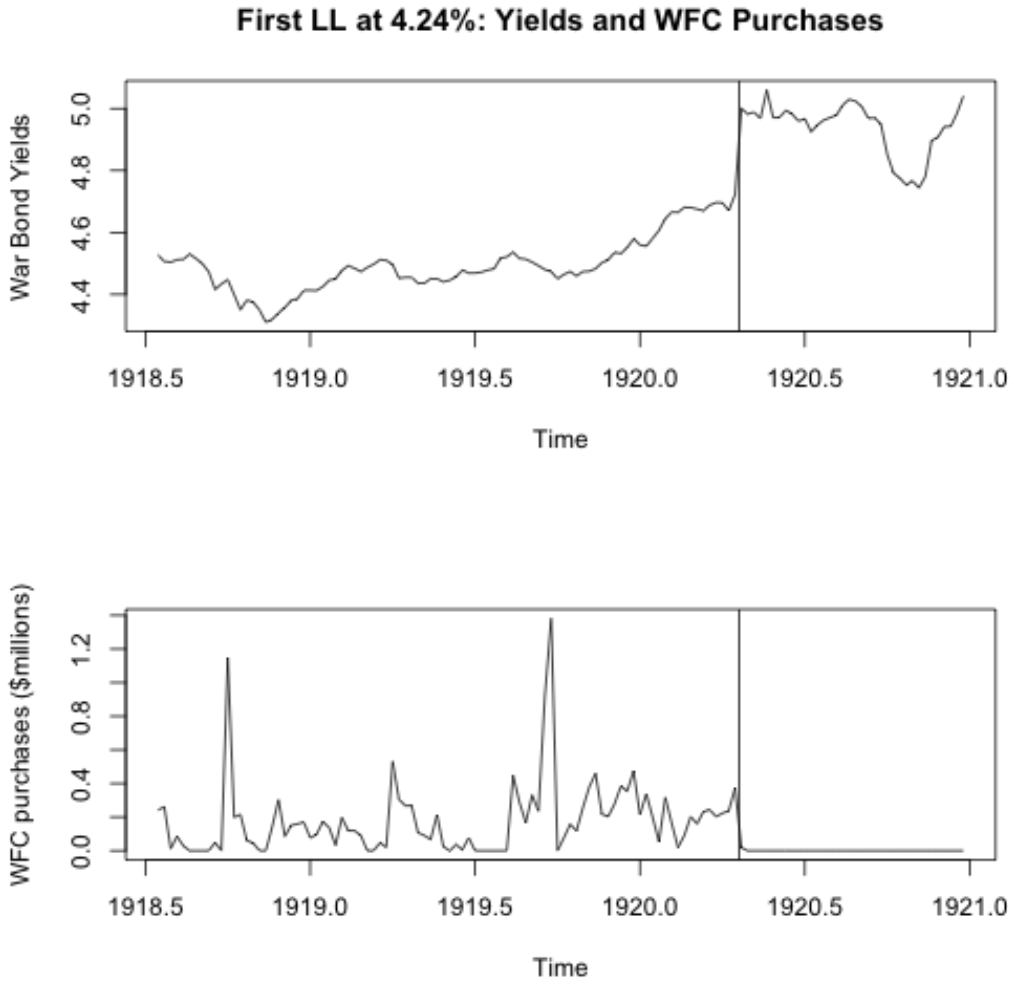

First LL at 4.24%: Yields and WFC Purchases
War Bond Yields
4.4
4.6
4.8
5.0
1918.5
1919.0
1919.5
1920.0
1920.5
1921.0
Time
WFC purchases ($millions)
0.0
0.4
0.8
1.2
1918.5
1919.0
1919.5
1920.0
1920.5
1921.0
Time

Figure A3:

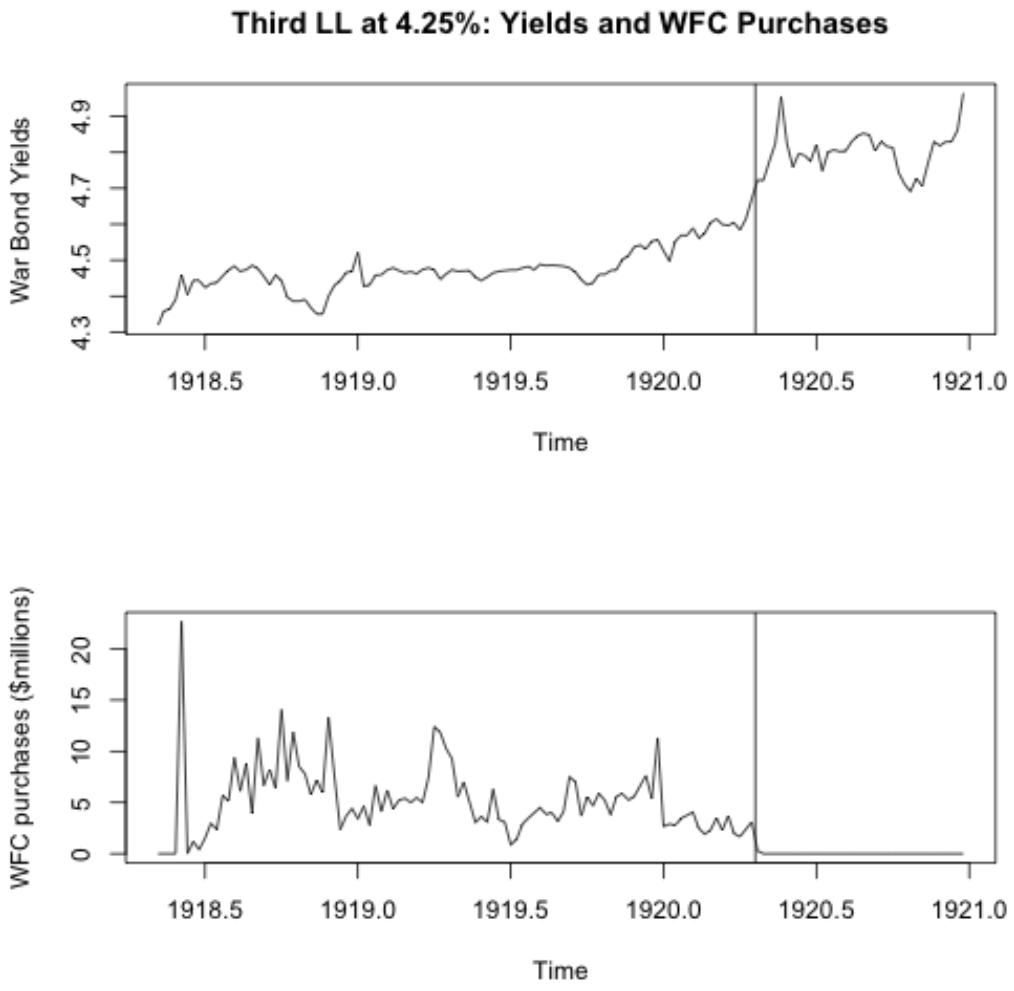

Third LL at 4.25%: Yields and WFC Purchases
War Bond Yields
4.3
4.5
4.7
4.9
1918.5
1919.0
1919.5
1920.0
1920.5
1921.0
Time
WFC purchases ($millions)
0
5
10
15
20
1918.5
1919.0
1919.5
1920.0
1920.5
1921.0
Time

Figure A4:

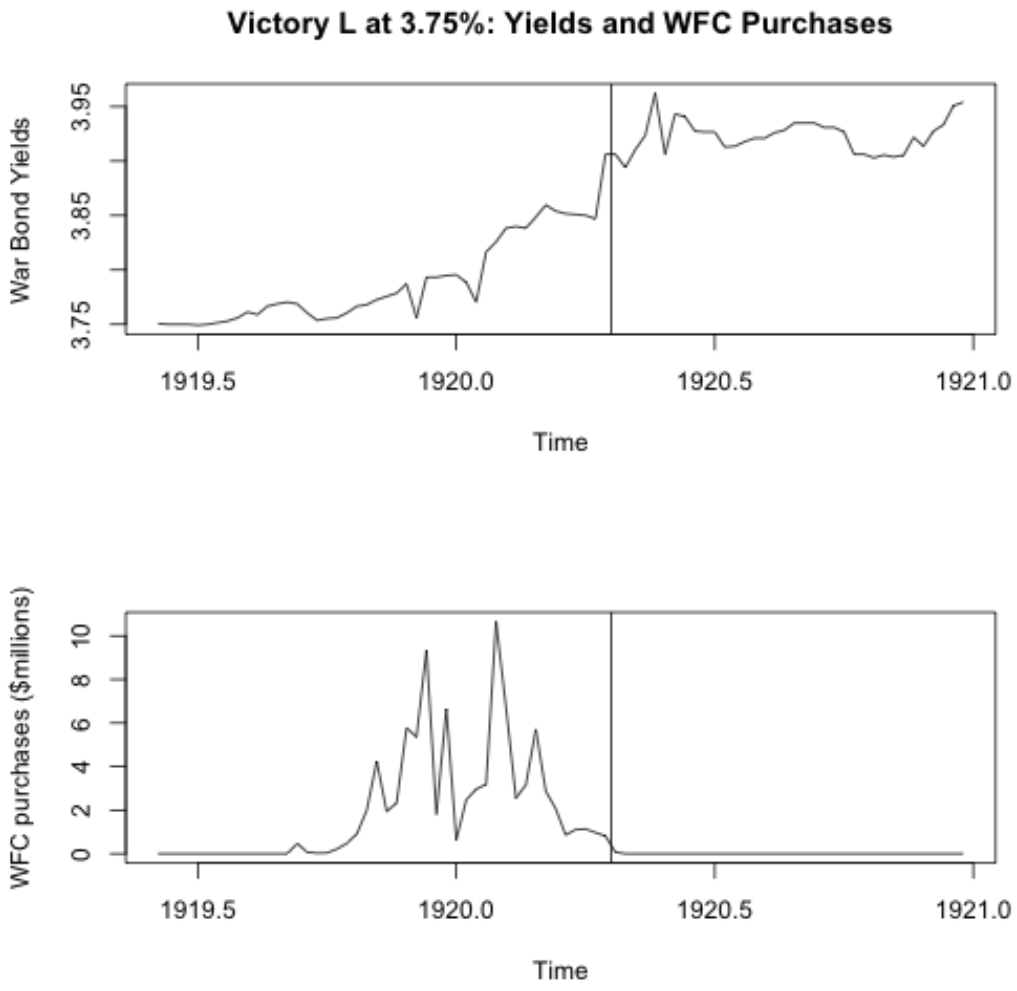
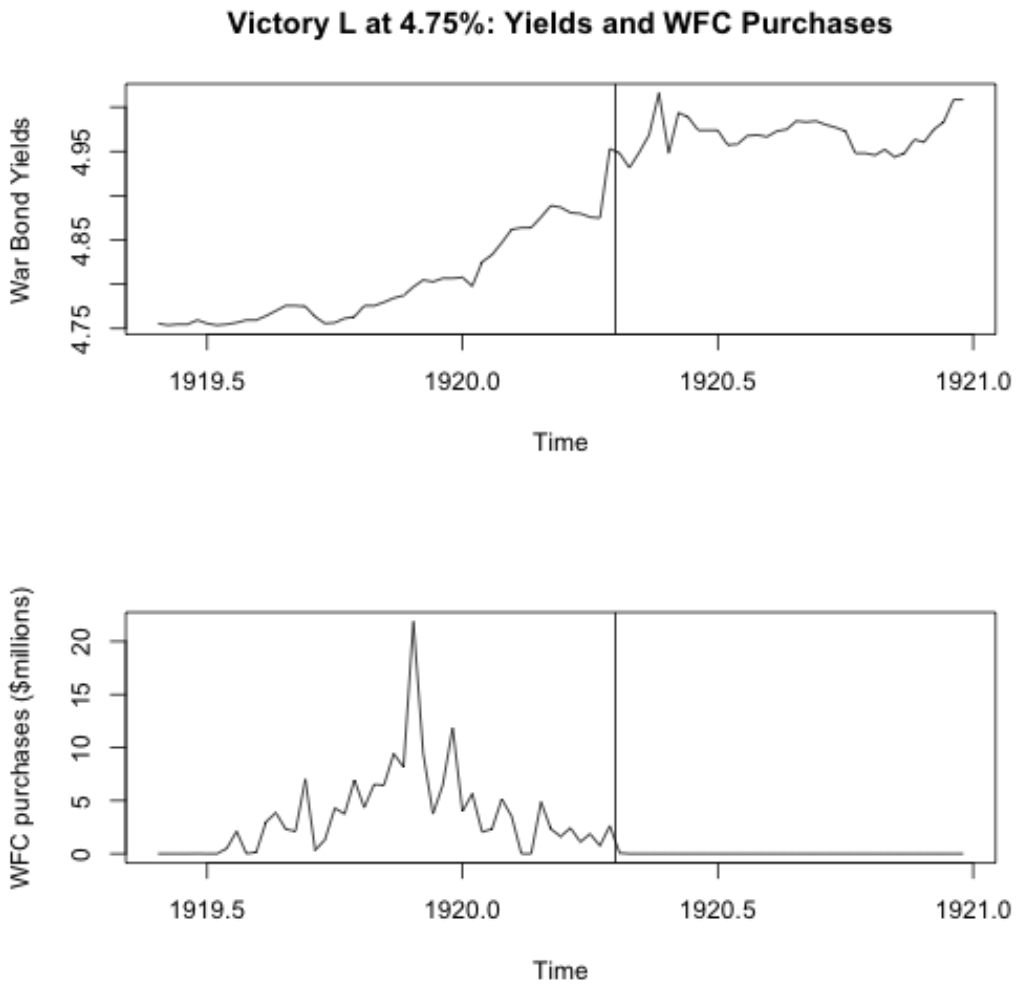

Victory L at 3.75%: Yields and WFC Purchases
War Bond Yields
3.75
3.85
3.95
1919.5
1920.0
1920.5
1921.0
Time
WFC purchases ($millions)
0
2
4
6
8
10
1919.5
1920.0
1920.5
1921.0
Time

Figure A5:


Victory L at 4.75%: Yields and WFC Purchases
War Bond Yields
4.75
4.85
4.95
1919.5
1920.0
1920.5
1921.0
Time
WFC purchases ($millions)
0
5
10
15
20
1919.5
1920.0
1920.5
1921.0
Time