The Effects of War Risk on U.S. Financial Markets*

Roberto Rigobon
MIT Sloan School of Management and NBER

and

Brian Sack
Board of Governors of the Federal Reserve System

Abstract

This paper measures the effects of the risks associated with the war in Iraq on various U.S. financial variables using a heteroskedasticity-based estimation technique. The results indicate that increases in what we call the "war risk" factor caused declines in Treasury yields and equity prices, a widening of lower-grade corporate spreads, a fall in the dollar, and a rise in oil prices. This factor accounted for a considerable portion of the variances of these financial variables over the three months leading up to the arrival of coalition forces in central Baghdad.

April 23, 2003

* This paper does not necessarily reflect the views of the Federal Reserve Board or other members of its staff. We thank James Clouse and Robert Pindyck for valuable comments, and Radha Chaurushiya for excellent research assistance.

1. Introduction

Financial markets commentary over the first several months of 2003 repeatedly pointed to the potential for war with Iraq and its eventual realization as primary explanations of daily movements in U.S. asset prices. However, almost all of the "evidence" presented was based on the anecdotal accounts of market participants, and few market observers offered precise estimates of these effects.[1] The lack of formal evidence in large part reflects that the risks associated with the war are unobservable, and hence it is difficult to estimate their effects. Indeed, it is much easier to determine *when* war-related news took place than it is to quantify that news.

This paper attempts to empirically measure the effects of war-related news on U.S. financial markets. For simplicity, we collapse the war-related news into a single "war risk" factor that captures the most important aspects of that news. To measure the effects of this factor, we rely on a heteroskedasticity-based estimator similar to that explored in Rigobon and Sack (2002, 2003).[2] The advantage of this type of estimator is that it allows one to identify the impact of war risk without having to quantify that risk. In fact, implementing this estimator only requires that we are able to determine a set of days on which the variance of war-related news was elevated. These days can be easily identified based on developments that significantly affected the outlook for the war—for example, days on which President Bush addressed the nation regarding the war, or the day that Secretary Powell presented evidence on Iraq to the U.N. Security Council, or days on which significant progress by coalition forces was reported. Determining this set of days is sufficient to estimate the effects of the level of the war risk factor on the asset prices considered.

---

[1] There is a growing literature on the costs of the war; see Nordhaus (2002), Davis et.al. (2003), and reports by the Congressional Budget Office (2002) and the House Budget Committee (2002). Our paper does not discuss the benefits or costs of the war, but instead focuses on measuring its impact on financial markets. Leigh et. al. (2003) also estimate the impact of war risk on financial markets using a futures security that pays out if Sadddam Hussein is ousted from power by a certain date, which they argue reflects the probability of war. They find that movements in the probability of war have very large effects on oil, gold, and equity prices.

[2] The procedure of identification through heteroskedasticity was first introduced by Philip Wright (1928) and has been recently rediscovered by Sentana and Fiorentini (2001) and Rigobon (2003). The first application of these estimators to U.S. financial markets can be found in Rigobon and Sack (2003), although the method used in this paper more closely follows the estimator developed in Rigobon and Sack (2002). Ellingsen and Soderstrom (2001), Bohl, Siklos, and Werner (2003), and Evans and Lyons (2003) employ similar estimators.

The results indicate that war-related news had significant effects on a number of financial variables over this period. In particular, increases in war risk caused considerable declines in Treasury yields and equity prices, a widening of corporate yield spreads, a fall in the dollar, and a rise in oil futures prices. However, we do not find a significant response of liquidity premiums for on-the-run Treasury securities or of gold prices. Taken together, the evidence indicates that greater war risk has been associated with a shift by investors away from many risky assets, but not with a widespread flight into all safe assets or into the most liquid assets.

Finally, we find that the war risk factor explains a considerable portion of the variances of these financial variables (the ones with significant responses) over the three-month period leading up to the arrival of coalition forces in central Baghdad. According to the results, this was a period of remarkable intensity of war-related news, and that any attempt to explain asset price behavior over this period must take this factor into consideration.

2. Econometric Challenges

This paper focuses on the influence of war risk on a number of U.S. financial variables (described below). Two primary difficulties arise in attempting to measure the effects of war risk on financial markets. First, this risk is an unobservable variable, in that the war-related news on any given day cannot be precisely quantified. Second, other factors are continuously influencing asset prices in addition to war risk.

These issues can be seen more clearly if we add some structure to the problem. In particular, we assume that the daily changes in a set of financial variables can be characterized by a system of linear equations. For simplicity, we will consider two variables at a time. Daily changes in those two financial variables, denoted $\Delta x = \begin{bmatrix} \Delta x_1 & \Delta x_2 \end{bmatrix}'$, are assumed to be determined as follows:

$$A \cdot \begin{bmatrix} \Delta x_1 \\ \Delta x_2 \end{bmatrix} = B \cdot \begin{bmatrix} z_1 \\ z_2 \\ z_3 \\ \cdots \end{bmatrix} + \begin{bmatrix} \eta_1 \\ \eta_2 \end{bmatrix}. \qquad (1)$$

According to equation (1), movements in the financial variables are driven by a set of common factors, $z = [z_1 \quad z_2 \quad z_3 \quad ...]'$, and a set of idiosyncratic shocks, $\eta = [\eta_1 \quad \eta_2]'$.[3] The common factors include changes in monetary and fiscal policy, macroeconomic developments, war-related news, and any other variables that have a direct influence on a number of financial variables. Some of these factors might be (partially) observable, while others are not. The focus of this paper is on measuring the impact of the war risk factor, which we will denote z_1.

An immediate issue is the interpretation of the war risk factor. War-related news over this sample presumably had many dimensions, including the likelihood of war, its potential success and duration, and whether it will be carried out unilaterally or by a broader coalition. Under our approach, this information is combined into a single factor, so that the results capture the impact of the most important aspects of the war-related news. As discussed in more detail below, it appears that the war risk factor that we identify is most closely associated with risks about the likelihood and duration of the war. Of course, these risks are not easily quantified, which poses one of the primary challenges for measuring their effects. Given the difficulties in quantifying this factor, we take it to be completely unobservable.

Equation (1) allows for contemporaneous spillovers between the financial variables (the matrix A). We instead concentrate on the reduced form of this system of equations:

$$\begin{bmatrix} \Delta x_1 \\ \Delta x_2 \end{bmatrix} = D \cdot \begin{bmatrix} z_1 \\ z_2 \\ z_3 \\ \cdots \end{bmatrix} + \begin{bmatrix} \mu_1 \\ \mu_2 \end{bmatrix}, \qquad (2)$$

where $D = A^{-1} \cdot B$ and $\mu = [\mu_1 \quad \mu_2]' = A^{-1} \cdot \eta$. The matrix D in equation (2) captures the overall impact (direct and indirect) of the common factors on the financial variables (after accounting for their influences on one another). We denote the elements of this matrix as follows:

[3] We assume that the factors and idiosyncratic shocks have zero mean, given that they influence *changes* in the financial variables.

$$D = \begin{bmatrix} 1 & d_{12} & d_{13} & \ldots \\ d_{21} & d_{22} & d_{23} & \ldots \end{bmatrix}, \quad (3)$$

where d_{ij} represents the impact of the *j*th factor on the *i*th financial variable. The first column of the matrix D captures the impact of the war risk factor on the two financial variables. Because z_1 is unobservable, the model is identified up to a normalization, and hence we set the impact on the first variable to unity.[4] The impact of the war-risk factor on the second variable is captured by the coefficient d_{21}, which is the parameter that this paper attempts to estimate (for a number of different financial variables).

If the common factors were all observable, then equation (2) could simply be estimated using an OLS regression. However, as noted above, the war risk factor cannot be easily quantified, and this presumably is the case for a number of other factors as well. Thus, the simple regression approach is not feasible.

One might instead be tempted to simply look at the net changes in the financial variables around significant news about the war. By reading newspapers and various financial market commentary, we collected a list of 21 dates on which war-related events appeared to be the primary determinant of asset price movements, which is shown in Table 1.[5] We will refer to these dates as "war days." Table 2 reports the average changes in the financial variables on the war days relative to all other days from January 6, 2003 to April 7, 2003 (roughly the period spanned by the war days). For nearly all of the financial variables considered, the average change does not differ significantly on the war days from the other days in the sample (and for those that do show a significant change, the magnitude is quite small).

One reason for this finding is that the days listed in Table 1 include some associated with increases in the risk of war and others associated with decreases in the risk of war, so that the net direction of the cumulative war news on these days is not

---

[4] Without this normalization, the scale of the war risk factor would not be determined.

[5] To be sure, there are other important events regarding the possibility of war, such as the day that President Bush first called on the world to confront Iraq in front of the U.N. General Assembly (9/12/02), the day that resolution 1441 passed the U.N. Security Council (11/8/02), and the day following the first attacks against Iraq (3/20/03). However, those events were largely anticipated and therefore did not represent *news* about the war on those days.

clear.[6] Moreover, on some days it is even difficult to determine the sign of the news, and so any attempt to separate out the news by its direction would be subjective. For example, how should one sign the war risk impact when Secretary Powell made his presentation before the U.N. on February 5, 2003? Lastly, one must consider that other factors are continually influencing the financial variables, even on the war days. As a result of these considerations, we argue that it is difficult to estimate the effects of war risk from the first moments of the financial variables.

However, it is clearly the case that the variance of war-related news was much higher on the days identified in Table 1 relative to the other days in the sample. Moreover, as can be seen in Table 2, the variances of the financial variables increased sharply on those days—by a significant amount for most of the financial variables, and by several multiplies for many of them.[7] This observation provides an important hint that war-related news had a significant impact on these financial variables.

Table 2 highlights the claim above that it is easier to determine when news took place than it is to quantify, or even sign, that news. Fortunately, being able to determine these days with higher variance of the war-related news is sufficient to determine the effects of the *level* of the war risk factor on financial variables. In the next section, we develop the methodology.

3. A Heteroskedasticity-Based Estimation Method

This section develops an estimator that is robust to the two primary difficulties mentioned above—that war risk is an unobservable variable, and that other factors are continuously influencing asset prices as well. The approach only requires that we can determine a set of days on which the variance of war risk was elevated. We take those to be the "war days" listed earlier in Table 1. Of course, it is likely that news about the war trickles out on other days as well, but the intensity of war-related news is taken to be much higher on the war days. To implement this estimation method, we also need to

---

[6] One might think that war risks mounted, on balance, over the sample considered. Nevertheless, it is still possible that the net news on the 21 days considered is close to zero. For example, it could be that the war risk accumulated through a series of small movements on days not identified in Table 1.

[7] An exception is oil prices. Oil prices were volatile on our war days, but they were volatile on other days as well. This in part reflects that oil prices were heavily influenced by a strike in Venezuela, which added to the volatility on days other than our war days.

identify an equal-sized set of days with low variance of the war risk factor. For that set, we choose days as close as possible to, but not included in, those listed in Table 1.[8]

Determining these sets of days is sufficient to identify the effects of the level of the war risk factor on all financial variables. The identification comes from the assumption that it is *only* the variance of the war risk factor that changes on the war days. Other factors are still assumed to be present, but with the same intensity as on other days. In addition, we impose the assumption that the war risk factor is unaffected by any other factors. This assumption implies that, for example, U.S. macroeconomic news or innovations to oil prices for non-war reasons do not affect war risk, which seems plausible.[9]

Under these assumptions, consider what happens to the variance-covariance matrix of the daily changes in the two financial variables, $\Delta x = [\Delta x_1 \quad \Delta x_2]'$, around war days. This matrix, denoted Ω, is determined by:

$$\Omega \equiv E\left(\begin{bmatrix} \Delta x_1 \\ \Delta x_2 \end{bmatrix} \cdot \begin{bmatrix} \Delta x_1 \\ \Delta x_2 \end{bmatrix}' \right) = D \cdot \Sigma_z \cdot D' + \Sigma_\eta , \qquad (4)$$

where Σ_z and Σ_η are the variance-covariance matrices of z and η, respectively. We can compute this variance-covariance matrix for the set of war days, denoted Ω_H (where the subscript *H* stands for high variance of war news), and likewise for the set of other days, denoted Ω_L. Under our identification assumptions, the change in the variance-covariance matrix between these sets of days, $\Delta\Omega = \Omega_H - \Omega_L$, must be driven entirely by the change in the variance of the war risk factor, or the (1,1) element of the matrix Σ_z. More specifically:

$$\Delta\Omega = \Delta\sigma^2(z_1) \cdot \begin{bmatrix} 1 & d_{21} \\ d_{21} & d_{21}^2 \end{bmatrix}, \qquad (5)$$

[8] Choosing low-variances days that are close to the high-variance days helps to minimize any changes in variance arising from the other factors.
[9] Fiscal policy seemed somewhat tied to war-related developments. However, the causality likely goes from war risk to the fiscal accounts, and not the other way around. In this case, our assumption is valid—the effects of the war risk factor would include its fiscal implications and would still be captured by the matrix *D*.

where $\Delta\sigma^2(z_1)$ is the shift in the variance of the war risk factor.

As equation (5) makes clear, the shift in the variance-covariance matrix of the financial variables on the days of high war variance is shaped by the relative responsiveness of the financial variables to that factor. As a result, we can derive several estimates of the parameter d_{21}, as follows:

$$\hat{d} = \Delta\Omega_{22} / \Delta\Omega_{21} \tag{6}$$

$$\hat{d} = \Delta\Omega_{21} / \Delta\Omega_{11} \tag{7}$$

where $\Delta\Omega_{ij}$ denotes the *(i, j)* element of the matrix $\Delta\Omega$.[10] These two estimators would be equal if the assumptions imposed held perfectly—namely, that the factors other than war risk are homoskedastic over our two sets of days, and that the structure of the model is linear. If these assumptions were not satisfied—for example, if the variance of other factors also increased on our war days—then the two estimators would likely be statistically different. In the empirical section we use this overidentification to evaluate the validity of our model.

As shown in Rigobon and Sack (2002), these estimators can be implemented by an instrumental variables (IV) approach. Define the instrument to be the change in the first financial variable, Δx_1, on all war days, and the negative of its change, $-\Delta x_1$, on the set of other days:

$$\omega_1 = \{\Delta x_{1,t}, \forall t \in H\} \cup \{-\Delta x_{1,t}, \forall t \in L\}, \tag{8}$$

where H and L denote the set of war risk days and other days, respectively. Consider regressing the change in the second financial variable, Δx_2, on the change in the first financial variable, Δx_1, over both sets of days using this instrument. The standard IV estimator is

$$\hat{d} = (\omega_1' \cdot \Delta x_1)^{-1} \cdot (\omega_1' \cdot \Delta x_2), \tag{9}$$

which equals

[10] Note that a third estimator, equal to $\sqrt{\Delta\Omega_{21} / \Delta\Omega_{11}}$, is also available. However, we do not focus on this estimator, since it is just the geometric average of the first two.

$$\hat{d} = \frac{Cov_H(\Delta x_1, \Delta x_2) - Cov_L(\Delta x_1, \Delta x_2)}{Var_H(\Delta x_1) - Var_L(\Delta x_1)}, \quad (10)$$

where, as above, the subscripts H and L indicate the set of days over which the variances and covariances are taken. The coefficient (10) is identical to the estimator (7).

Likewise, consider an alternative instrument defined in the exact same way, only using the second financial variable:

$$\omega_2 = \{\Delta x_{2,t}, \forall t \in H\} \cup \{-\Delta x_{2,t}, \forall t \in L\}. \quad (11)$$

With this instrument, the IV estimator becomes

$$\hat{d} = \frac{Var_H(\Delta x_2) - Var_L(\Delta x_2)}{Cov_H(\Delta x_1, \Delta x_2) - Cov_L(\Delta x_1, \Delta x_2)}, \quad (12)$$

which is identical to the estimator (6) above.

It can be shown that both ω_1 and ω_2 are valid instruments for this regression under the assumptions that have been imposed. Thus, we can also estimate the regression by combining the two instruments, $\omega_3 = \omega_1 \cup \omega_2$, to arrive at a third estimator. This estimator might be advantageous if one of the sets of instruments is relatively weak.[11]

Overall, an advantage of implementing the heteroskedasticity-based estimator in this manner is that all of the properties of the IV estimator apply, including the asymptotic distribution of the parameter estimate. We now turn to the application of these estimators.

4. Results

We apply the above estimators to various U.S. financial variables that are potentially influenced by war risk. Those variables include the two- and ten-year Treasury yields, the spread between the ten-year nominal and inflation-indexed Treasury yields (the break-even inflation rate), the liquidity premium on the ten-year Treasury note, the S&P 500 index, the BBB corporate yield spread, the high-yield yield spread, oil

[11] The strength of the instruments depends on their correlations with the independent variable Δx_1. In one case, this correlation equals the change in the variance of Δx_1. In the other case, it equals the change in the covariance between Δx_1 and Δx_2.

prices, gold prices, and the dollar.[12] We collected daily data for these series from January 6, 2003 to April 7, 2003, the period spanned by our war days.

In the analysis, we estimate the effects of the war risk factor using two variables at a time, as described above, where the first (normalized) variable is always taken to be the two-year Treasury yield.[13] The results are reported in Table 3. In presenting the results, we show the impact of a change in z_1 by –0.25. Thus, all reported coefficients represent movements induced by an increase in war risk that is large enough to cause a 25 basis point drop in the two-year yield.

The table shows the coefficients obtained under all three of the instruments determined above and their significance levels. As can be seen, the coefficients obtained using the different instrument sets are typically close to one another, suggesting that the structure that we have assumed is not strongly violated in the data. In fact, formal tests show that the estimators are not statistically different in any of the cases. In the instances when the point estimates differ by a wider margin, the estimator based on the ω_2 instrument is typically less precise, and the estimator obtained using the combined instrument set (ω_3) accordingly tends to be closer to that based on the ω_1 instrument. In interpreting the results, we narrow our focus to the point estimates found using the ω_3 instrument.

The primary finding of this paper is that many of the financial variables considered are significantly affected by the war risk factor. An increase in war risk of the magnitude considered results in a jump in the price of the year-ahead oil futures contract by about 73 cents, as one might expect. The increase in war risk also appears to weigh on the prices of risky assets in U.S. financial markets. In particular, equity prices fall 4.6 percent, and corporate yield spreads rise. Investment-grade (BBB) bond spreads widen 6 basis points, which is statistically significant but small in magnitude, while yield spreads

---

[12] The Treasury yields reported are par off-the-run yields from an estimated yield curve; the corporate yields are indexes computed by Merrill Lynch, and the corporate yield spreads are measured relative to the Treasury yield curve; the liquidity premium is the amount by which the on-the-run yield falls below the off-the-run yield curve; the prices of oil futures and gold are taken from Bloomberg; and the dollar is a broad trade-weighted index calculated by the Federal Reserve Board.

[13] It is possible to implement this type of estimator using a larger number of variables at once, which results in additional overidentifying restrictions. However, because we have a limited number of observations to estimate the change in the variance-covariance matrix, we took this more restricted approach.

for lower-quality issuers increase more considerably, with the high-yield spread increasing 35 basis points. In terms of the Treasury yield curve, greater war risk pushes down the ten-year yield by about the same magnitude as the two-year yield, with 8 basis points of that reflecting a decline in break-even inflation. Lastly, the increase in war risk induces a sizeable weakening of the dollar, by 0.62 percent.

Somewhat surprisingly, though, war risk has a statistically weaker effect on the price of gold, and absolutely no effect on the liquidity premium on the on-the-run ten-year Treasury note.[14] One could interpret these last findings as indicating that increases in war risk have not generated a widespread flight by investors towards safe and liquid assets. This interpretation raises the possibility that the negative effects on the prices of equities and corporate bonds, Treasury yields, and the dollar partly reflect a perception among investors that the prospect of war (and the associated increases in energy prices) poses downside risk to the U.S. economy, rather than a shift in investors' risk preferences. Of course, the focus of this paper is on the measurement of the effects of war risk, rather than assessing the reasons for those effects.

At this point it is worth discussing a bit the interpretation of the war risk factor. As noted above, news about the war on any given day is presumably multidimensional. Under our approach, this information is combined into a single factor, so that the results capture the impact of the most important aspects of the war-related news.[15] Judging from financial market commentary on the days listed in Table 1, it appears that increases in the war risk factor are most closely associated with greater uncertainty about the timing of the war and a greater likelihood that the conflict will last for an extended period. Two recent days in our sample provide clear examples. On March 21, the perception that the war would be short and successful apparently led to a decrease in the war risk factor, with the two-year Treasury rising 7 basis points, equity prices jumping 2.3 percent, high-yield spreads narrowing 15 basis points, the dollar appreciating 0.3 percent, and oil futures

---

[14] Although the response of gold is insignificant under the combined instrument set, it is marginally significant under the other two instrument sets (but imprecisely estimated in one of those cases). Also, as shown in Table 2, the volatility of gold increased notably on the war days, indicating some effect. However, these movements in gold prices apparently were not systematic enough to generate a significant coefficient.

[15] Our approach could be refined if one were willing to make assumptions about the variances of the individual components of the war risk factor. However, we believe that imposing such assumptions is infeasible.

dropping \$0.56. On March 24, by contrast, perceived military setbacks over the preceding weekend led to what appears to be a sharp increase in the war risk factor, with the two-year Treasury yield falling 12 basis points, equities plunging 3.5 percent, high-yield spreads rising 11 basis points, the dollar falling 0.39 percent, and oil futures jumping \$0.52. However, while this seems like a plausible interpretation of the war risk factor, it is worth repeating that an advantage of our estimator is that one does not have to make such a determination.

The results from Table 3 can be used to assess the importance of war risk relative to other factors affecting asset prices. According to the set-up above, the greater amount of war-related news on the specified days increases the variance of Δx_j by $d_{j1}^2 \cdot \Delta\sigma^2(z_1)$. Given the normalization for the first financial variable, this increase is equal to $d_{j1}^2 \cdot \Delta Var(\Delta x_1)$. Thus, using the shift in the variance of the two-year Treasury yield in the two samples as the measure of $\Delta Var(\Delta x_1)$, we can obtain an estimate of the shift in the variance of each financial variable that is attributable to the increased volatility of the war risk factor on the specified days.[16]

The *shift* in the war-induced variance has to be smaller than the *level* of the war-induced variance on the war days, and would only be the same if there were no war-related news on other days. Thus, the portion of the variance of the *j*th financial variable that is attributable to war-related news must be greater than $d_{j1}^2 \cdot \Delta Var(\Delta x_1)/Var(\Delta x_j)$. This measure, which is reported in the first column of Table 4, is quite high for those variables that had significant coefficients, indicating that war risk accounted for a sizable portion of the variances of those variables.

Moreover, because the war days are much more volatile than the other days in the sample, the war risk factor accounts for a considerable portion of the cumulative movements in the financial variables throughout this period. Indeed, consider the behavior of each financial variable for the three-month period covered by our sample (January 6, 2003 to April 7, 2003). This period includes 64 business days, of which 21 represent the war days specified above. Assuming that the daily changes in a given

[16] These variances are measured simply by the average size of Δx^2 in the two samples.

financial variable are serially independent, we can compute the variance of the cumulative change in that variable over this period, and then determine how much of this variance can be attributed to the increase in the volatility of the war risk factor on the 21 days specified. The results, shown in the second column, indicate that the war risk factor still accounts for a sizable portion of the variances of many of these variables even looking over the entire three-month period.

5. Conclusions

This paper provides empirical evidence that the risks associated with the war in Iraq had a significant impact on a number of U.S. financial variables over the first several months of 2003. The basis for our methodology is that one can determine a particular set of days during this period on which news about the outlook for the war was particularly prominent. We show that determining this set of days is sufficient to estimate the impact of the war risk factor, even if that factor itself cannot be measured.

The findings accord well with much of the anecdotal evidence offered by financial market participants over this period. Of course, the more formal estimation approach taken here has the advantages of quantifying those effects and determining whether they are statistically significant. The results indicate that increases in war risk caused a rise in oil prices, a fall in Treasury yields and equity prices, a widening of corporate yield spreads, and a decline in the dollar. By contrast, we do not find that war risk had a significant impact on the price of gold or on the liquidity premium on the on-the-run ten-year Treasury note.

Overall, war-related risks appear to have been a very important factor in determining movements in U.S. financial variables over the three months leading up to the arrival of coalition troops in central Baghdad. Indeed, of those variables that were found to have a significant response, war risk accounted for a considerable portion—with a lower bound of between 12 and 56 percent—of the variances of their cumulative movements over that period.

References

Bohl, Martin T., Pierre L. Siklos, and Thomas Werner (2003), "Did the Bundesbank React to Stock Price Movements?" Mimeo.

Congressional Budget Office (2002), *Estimated Costs of a Potential Conflict with Iraq*.

Davis Steven J., Kevin M. Murphy and Robert H. Topel (2003) "War in Iraq versus Containment: Weighing the Costs," Mimeo.

Ellingsen, Tore and Ulf Soderstrom (2001), "Classifying Monetary Policy," Mimeo.

Evans, Martin D. D. and Richard K. Lyons (2003), "How is Macro News Transmitted to Exchange Rates?" NBER Working Paper no. 9433.

House Budget Committee (2002), *Assessing the Cost of Military Action Against Iraq: Using Desert Shield/Desert Storm as Basis for Estimates*, Democratic Staff.

King, Mervyn, Enrique Sentana, and Sushil Wadhwani (1994), "Volatility and Links between National Stock Markets," *Econometrica* 62, 901-933.

Leigh, Andrew, Justin Wolfers, Eric Zitzewitz (2003), "What Do Financial Markets Think of War in Iraq?" NBER Working Paper no. 9587.

Nordhaus, William (2002) "The Economic Consequences of a War with Iraq," in *War with Iraq: Costs, Consequences, and Alternatives*, American Academy of Arts and Sciences.

Rigobon, Roberto (2003), "Identification through Heteroskedasticity," forthcoming, *Review of Economic Statistics*.

Rigobon, Roberto and Brian Sack (2002), "The Impact of Monetary Policy on Asset Prices," NBER Working Paper no. 8794.

Rigobon, Roberto and Brian Sack (2003), "Measuring the Response of Monetary Policy to the Stock Market," forthcoming, *Quarterly Journal of Economics*.

Sentana, Enrique and Gabriele Fiorentini (2001), "Identification, Estimation and Testing of Conditionally Heteroskedastic Factor Models," *Journal of Econometrics* 102, 143-164.

Wright, Philip (1928), *The Tariff on Animal and Vegetable Oils*, New York: Macmillan Company.

Table 1
Days of High Variance of War-Related News

Date	**Event**
1/9/03	U.N. inspectors report finding no chemical weapons
1/16/03	Reports that Saddam Hussein might consider exile
	U.N. weapons inspectors find empty chemical warheads
1/17/03	Saddam Hussein gives speech stating that Iraq is ready for war
1/27/03	Blix report: "Iraq appears not to have come to a genuine acceptance of the disarmament"
1/29/03	President Bush gives State of Union Address
	Secretary Powell says U.S. would assist Saddam Hussein if he sought exile
1/30/03	President Bush comments on continued lack of Iraqi cooperation
2/5/03	Secretary Powell makes U.N. presentation in effort to build a broad coalition
2/10/03	Reports that Iraq will unconditionally allow surveillance flights
2/12/03	Secretary Powell says impasse has reached "moment of truth"
2/13/03	Rumors that President Bush set deadline to attack without resolution
2/14/03	Blix report interpreted as reducing chance of immediate war
3/5/03	Secretary Powell makes tough comments on Iraq
3/7/03	Reports that bin Laden close to being captured
3/10/03	Turkey rejects U.S. use of military bases
3/13/03	CNN reports that Iraq might surrender before conflict begins
3/17/03	President Bush expected to announce an ultimatum with a short deadline for war
	Change in terror alert from elevated to high (explicitly related to the prospect of war)
3/21/03	The war commences; early efforts appear very successful
3/24/03	Coalition forces face apparent setbacks over preceding weekend
3/28/03	Bush, Blair make comments suggesting a long war
4/2/03	Coalition forces approach Baghdad
4/7/03	Coalition troops enter central Baghdad

Table 2

Means and Variances of Changes in Financial Variables

Variable	--- Means --- War days (1)	Other days (2)	Diff. (1) – (2)	--- Variances --- War days (3)	Other days (4)	Diff. (3) - (4)
Two-year Treasury Yield	0.019	-0.012	0.030*	0.0063	0.0014	0.0050**
Ten-year Treasury Yield	0.025	-0.013	0.039*	0.0068	0.0016	0.0053**
Break-even Inflation	0.009	0.001	0.007	0.0012	0.0007	0.0005
Liquidity Premium	0.001	-0.001	0.002	0.0000	0.0000	0.0000
S&P 500	0.237	-0.192	0.429	3.754	1.249	2.505**
BBB Yield Spread	-0.005	-0.008	0.004	0.0005	0.0005	-0.0001
High-yield Yield Spread	-0.024	-0.021	-0.003	0.0138	0.0048	0.0090**
Oil Futures Price	-0.032	0.012	-0.045	0.1305	0.1249	0.0056
Gold Price	-2.058	0.334	-2.391*	31.14	14.96	16.17**
Dollar	0.041	-0.042	0.082	0.0730	0.0312	0.0418**

* denotes significance at 5 percent level; ** at 1 percent level. All Treasury yields and corporate yield spreads are measured in percentage point changes; the S&P 500 and the dollar in percent changes; and oil and gold prices in dollar changes. “War days” are days of significant war-related news.

Table 3

Estimated Impact of Increase in War Risk

(Normalized to cause a 25 bp drop in two-year Treasury yield)

Variable	**Eqn. (6)** **IV w/ ω_1**	**Eqn. (7)** **IV w/ ω_2**	**IV w/ ω_3**
Ten-year Treasury Yield	-0.26 (14.62)	-0.26 (14.40)	-0.26 (14.72)
Break-even Inflation	-0.10 (3.64)	-0.03 (0.73)	-0.08 (3.31)
Liquidity Premium	-0.00 (0.58)	-0.05 (0.55)	-0.00 (0.60)
S&P 500	-4.60 (4.46)	-5.89 (3.80)	-4.61 (4.46)
BBB Yield Spread	0.06 (4.48)	0.07 (4.04)	0.06 (4.88)
High-yield Yield Spread	0.36 (5.95)	0.33 (5.11)	0.35 (6.06)
Oil Futures Price	0.77 (2.67)	0.03 (0.06)	0.73 (2.55)
Gold Price	6.11 (1.63)	28.28 (1.67)	3.96 (1.06)
Dollar	-0.58 (3.66)	-1.02 (3.43)	-0.62 (3.87)

Table reports estimates of $d_{j,1}$, or the impact of the war risk factor on each financial variable (multiplied by –0.25). Absolute t-statistics are shown in parenthesis. All Treasury yields and corporate yield spreads are measured in percentage point changes; the S&P 500 and the dollar in percent changes; and oil and gold prices in dollar changes.

Table 4
Proportion of Variance Explained by War Risk

Variable	**War days**	**All days**
Ten-year Treasury Yield	83.5	55.9
Break-even Inflation	48.8	22.6
Liquidity Premium	2.0	0.9
S&P 500	48.3	28.4
BBB Yield Spread	72.3	21.9
High-yield Yield Spread	74.1	42.8
Oil Futures Price	34.8	11.8
Gold Price	4.3	2.2
Dollar	44.5	23.5

All Treasury yields and corporate yield spreads are measured in percentage point changes; the S&P 500 and the dollar in percent changes; and oil and gold prices in dollar changes. "War days" are days of significant war-related news.