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STOCK VOLATILITY AND THE WAR PUZZLE: THE MILITARY DEMAND CHANNEL

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ABSTRACT

U.S. stock volatility is 25 percent lower during wartime and periods of conflict, including World War II. Schwert (1989) identified the "war puzzle" as a surprising fact from two centuries of realized stock volatility data. We hypothesize that stable demand from defense spending makes corporate America's cash flows easier to forecast during wartime. Using new hand-collected data on 100 years of military spending, we document that defense outlays reduce aggregate, sector-and state-level stock volatility. Firm-level event studies of recent U.S. military conflicts demonstrate that equity analysts' earnings forecasts of procurement-intensive companies became significantly less dispersed in the aftermath of 9/11 and the invasion of Iraq.

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Angela Vossmeyer Robert Day School of Economics and Finance Claremont McKenna College 500 E. Ninth Street Claremont, CA 91711 and NBER Angela.Vossmeyer@cmc.edu "When the world became more unstable due to the attacks on 9/11, analysts pointed out that Boeing consisted of two separate businesses: the relatively more stable defense business and the conversely more volatile commercial business." — TOMPKINS AND BRUNER (2016). "The Boeing 7E7." UVA Darden School of Business, Case Study.

1 Introduction

Schwert's (1989) seminal paper on realized stock volatility found that macroeconomic fundamentals such as inflation, industrial production, interest rates, and money supply explain a small fraction of the time series variation of stock market volatility.¹ Plotting the time series of stock volatility, he also identified two major puzzles left for future researchers to address: the "Great Depression volatility puzzle" and the "war volatility puzzle." The first refers to Officer's (1973) observation that stock volatility was much higher during the Great Depression than in any other period in U.S. history.² The second puzzle refers to the counter-intuitive finding that stock markets do not display volatile behavior during wars, even though military conflicts are periods of heightened uncertainty and economic volatility. In his own words, Schwert (1989, p.1146) states that: *"The volatility of inflation and money growth rates is very high during war periods, as is the volatility of industrial production. Yet the volatility of stock returns is not particularly high during wars."* Indeed, in the standard CRSP sample beginning in the 1920s, stock volatility is about 25 percent lower during major wars and periods of conflict.

This is surprising because major wars should raise the prospects of a U.S. defeat, increasing uncertainty and stock volatility. Perhaps the most puzzling case of low volatility is WWII. Contrary to the naïve view that the Allied forces were ahead during all of WWII, there was substantial uncertainty on which side would be victorious. Military historians consistently view the first half of WWII as one in which the Axis forces led the conflict, and most agree the tide turned against Germany only in 1943 when the Soviets defeated the Nazis in Stalingrad. Specifically for the U.S., the Americans entered the war in December 1941 at a significant disadvantage following the devastating losses inflicted by Japan in the Pearl Harbor surprise attack. The Japanese successfully crippled the U.S. Navy's Pacific Fleet, destroying or disabling all eight battleships, three cruisers, three destroyers, several support vessels, and 164 airplanes, killing 2,335 Americans among sailors, marines, and soldiers, and wounding 1,178 others (Chambers (1999, p.539)). The Battle of Midway (June 1942) is seen as the

¹Schwert's (1989) seminal work is listed as one of the "Top Cited Articles of All Time" in the history of the *Journal of Finance*. See https://onlinelibrary.wiley.com/page/journal/15406261/homepage/top_cited_articles_of_all_time.htm.

²Merton (1987) and Schwert (1989) hypothesized that the persistent high level of stock volatility during the 1930s might be explained by the rise of communism that threatened the survival of market capitalism, although they never formally tested their hypothesis. Cortes and Weidenmier (2019) hand-collected data on socialist-related demonstrations, strikes, riots, and political assassinations, finding no empirical support for the Merton–Schwert hypothesis.

first decisive U.S. victory over Japan in WWII (Dear and Foot (2001, pp.748–749)). It was considered a surprising event as most observers of the time did not expect the U.S. maritime forces to catch up quickly enough to rival an experienced Japanese Navy, which had been collecting victories in the Pacific theater since the invasion of French Indochina in 1940.³ Some of the most prominent American economists who lived through WWII pointed out the risks: *"Even in the Second World War, the mobilization of our potential strength was almost too late"* (Tobin (1966, p.63)). This begs the question: Why did WWII not have one of the largest volatility spikes in the last two centuries?

In this paper, we investigate the war puzzle, which has remained unanswered for over 30 years.⁴ We argue that the demand channel of military spending is essential to explain the puzzle. Government-guaranteed contracts during wartime reduce the uncertainty of firms' expected cash flows, decreasing stock volatility. Using new, hand-collected U.S. military spending data for over 100 years, we estimate predictive regressions of the determinants of stock volatility. Defense expenditures, as a fraction of total government expenditures, have a large, significant, and negative effect on stock volatility. Our proposed explanation underscores a constellation of factors singling out corporate America from other global stock markets. While benefiting from increased and more certain demand during wartime, corporate America also historically had its capital stock spared from damage or destruction as most U.S. conflicts were fought on foreign soil—exceptions being the War of 1812 and the American Civil War. This is not the case for countries like the U.K., whose capital stock was often damaged and destroyed, experiencing volatility spikes in its capital markets during wars (e.g., Brown, Burdekin, and Weidenmier (2006)). Our aggregate tests find empirical support for the hypothesis that defense spending reduces the uncertainty of future cash flows—especially for firms that produce military goods—acting as a stabilizing force to reduce aggregate stock volatility.

We follow up the baseline tests with micro-level analyses. We re-estimate our baseline predictive regressions breaking down the volatility of sector-specific stock portfolios as defined by the Fama and French (1997) 30-industry classification. Again, the empirical analysis shows that military spending reduces stock volatility for many sectors that produce goods and services for the U.S. military, in-

³In the words of two leading military historians of WWII: "*Few could have predicted such an extraordinary American maritime growth before the outbreak of war. Before 1937, the U.S. merchant fleet was on the verge of obsolescence*"; "*From 1939 to 1945, the U.S. Maritime Commission built 5,777 ships; (...) it was the most prodigious construction of ships ever undertaken. Had these ships not been produced, (...) some argue that the Allies would have lost.*" (Dear and Foot (2001, p.1202)).

⁴Shiller (1992) also referred to the war puzzle in his influential book on market volatility. Concerning the Great Depression volatility puzzle, Cortes and Weidenmier (2019) show that the volatility of building permits—a forward-looking construction measure—explains the bulk of the variation in stock volatility between January 1928 and December 1938.

cluding aircraft and ships; petroleum and natural gas; steel; and coal. On the other hand, we find that military spending does not reduce stock volatility in non-defense sectors such as books, beer, or finance industries. These sectors are crowded out in favor of military goods, especially during periods of conflict. Next, we examine the impact of military spending on state-level stock volatility. In this case, the dependent variable is the stock return volatility of a market capitalized index for each state using firms headquartered in each state. The empirical results show that the ratio of defense spending to total expenditures reduces stock volatility in seven states. Nearly all states with lower stock volatility from defense spending have large military bases, are the home to many defense contractors, or have numerous firms manufacturing coal or steel.

Then, we analyze the relationship between stock volatility and defense spending in both contemporaneous and forward-looking dimensions. To do so, we look at the determinants of news-implied volatility (NVIX) constructed by Manela and Moreira (2017) as a proxy of implied (forward-looking) volatility in stock markets. The defense expenditure ratio is negatively and significantly associated with NVIX. One consideration when employing news-implied volatility is that it is forward-looking, whereas our defense expenditure variable is not. To further inspect this relationship, we use data from Ramey and Zubairy (2018) defense news announcements to construct a "fully forward-looking" specification of our proposed mechanism and its effect on stock volatility. We convert the Ramey-Zubairy quarterly time series into a monthly frequency showing the present discounted value of defense expenditure announcements as a fraction of GDP. The empirical analysis shows that the forward-looking monthly Ramey–Zubairy defense news narrative series is negatively and significantly associated with news implied volatility. The forward-looking specifications indicate that announcements of defense expenditure lead to a reduction in expected aggregate stock market volatility. These results support our hypothesis that firms' profits become easier to forecast once market participants are aware of large government transfers to those firms and that market participants incorporate news of future cash flows into their expectations.

We conclude our empirical investigation of the mechanism linking defense expenditures and lower stock volatility with two granular tests that further disaggregate the analysis at the firm level. First, we explore the relative importance of cash-flow news and discount-rate news for the sample of Dow Jones Industrial Average firms from 1937 to 2017. Following the VAR methodology of Vuolteenaho (2002) and Campbell and Vuolteenaho (2004), we find that

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cash-flow news dominates discount-rate news, especially during periods of conflict. These results support our mechanism that government purchases (i.e., cash flows for America's firms) create stable demand, lowering stock volatility.

Second, we formally test the hypothesis that military conflict makes firms' profits easier to forecast due to expectations of massive government purchases in a firm-level event study framework. We construct a firm-level measure of the dispersion of earnings-per-share (EPS) forecasts for recent conflicts for which equity analyst data are available. Consistent with our proposed channel, we find that the dispersion of EPS forecasts following 9/11 and the ensuing invasions of Afghanistan (2001) and Iraq (2003) significantly decline for defense-related firms relative to non-defense-related firms. The expectation of and the effective increase in military spending following the outbreak of the war on terrorism plausibly explains the decline in the dispersion of EPS forecasts for defense-related firms. Intuitively, we also find that the dispersion of forecasts for firms likely to benefit from defense spending *vis-à-vis* those unlikely to benefit was not significantly different for the Gulf War (1990) and the War for Kosovo (1999). The U.S. downsized the military in the 1990s due to the end of the Cold War, suggesting equity analysts are aware that only a noteworthy expansion of defense spending matters for corporate America: our proposed channel is dampened in less belligerent contexts.

Beyond proposing a solution to Schwert's (1989) long-standing puzzle in financial economics, our paper contributes to several branches of the literature. First, we contribute to a body of research on how financial markets and the macroeconomy behave during wars. Several studies focused on different markets for specific wars or encompassed a general analysis of conflicts fought by the U.S. (e.g., Friedman (1952); Roll (1972); Calomiris (1988); Oosterlinck and Landon-Lane (2006); Hall and Sargent (2014)). Long-run studies also point to international stock markets weakening during wars and other periods of less global integration (e.g., Jorion and Goetzmann (1999); Goetzmann (2004); Goetzmann, Li, and Rouwenhorst (2005)). We add to this literature by analyzing all wars fought by the U.S. in the twentieth century and beyond. Our work documents and explains patterns of overwhelming historical and modern significance. From a historical standpoint, our study is in the spirit of Milton Friedman's classical quote about the war economy: *"Data for wartime periods are peculiarly valuable. At such times, violent changes in major economic magnitudes occur over relatively brief periods, thereby provid-ing precisely the kind of evidence we would like [to] get by 'critical' experiments if we could conduct them."* (Friedman (1952, p.612)). Moreover, understanding the consequences of American military conflict is

also crucial from a contemporary and practical standpoint, given the recent geopolitical stress resulting from the Russian invasion of Ukraine in 2022 and the rising tensions between the U.S. and China over Taiwan (e.g., Reuters, January 28, 2023, "U.S. four-star general warns of war with China in 2025").

Second, we add to an extensive body of macroeconomics and corporate finance research investigating the direct consequences and spillovers of large-scale procurement-driven fiscal stimulus. Our results are consistent with Goldman (2020), who documented that fiscal stimulus stabilized firms that received government contracts during the 2008-2009 Global Financial Crisis. Our evidence of broader spillovers of military spending also aligns with Goldman, Iyer, and Nanda's (2023) findings that procurement-driven U.S. defense spending after the 9/11 attacks led to lower non-performing loans at banks and increased lending to small businesses in not-directly-impacted counties (see also Bonfim et al. (2022)).

Finally, we add to the macro-finance and asset pricing literature on the determinants of stock price movements (e.g., Campbell and Shiller (1988); Campbell (1991); Vuolteenaho (2002); Campbell and Vuolteenaho (2004); Campbell et al. (2001, 2023); Nicholas (2008); Baker et al. (2021)). We contribute to an extensive body of research that examines stock returns and volatility during rare historical events associated with "consumption disasters," like wars, banking crises, and economic depressions (e.g., Rietz (1988), Barro (2006), Berkman, Jacobsen, and Lee (2011), Koudijs (2016), Manela and Moreira (2017), Cortes, Taylor, and Weidenmier (2022), and Hirshleifer, Mai, and Pukthuanthong (2024)). Our paper is the first to establish that a war economy enhances firms' cash flow predictability, reducing stock market volatility. We contribute to the existing literature by elucidating why U.S. stock markets exhibit distinct behavior compared to other global financial markets during wartime. Our study sheds light on the advantages of improved cash flow predictability for firms transitioning from serving a private clientele to engaging in public-private partnerships with the military.

2 Narrative Evidence: Corporate America in World War II

We motivate the empirical analysis by showing some narrative evidence of the close relationship between corporate America and the U.S. military during WWII. Figure 1 presents photos from the Library of Congress World War II Collection to illustrate how large U.S. corporations contributed to the war economy. Panel A shows a Boeing plant in Seattle, WA, assembling hundreds of B-17 heavy bombers ("Flying Fortresses") instead of commercial aircraft. Boeing produced an estimated 12,741

of the four-engine bombers during the war. The B-17 helped secure the Allied merchant sea lanes of the Atlantic from the German "U-boats" between 1939 and 1945 (Dimbleby (2016)). Panel B of Figure 1 shows workers in a Chrysler factory in Detroit, MI, engaging in the mass assembly of M4-A4 Sherman tanks. Despite German Panzers and Tiger tanks being technologically superior to the Allied tanks, the overwhelming industrial power of the U.S. economy-which includes corporate Americaallowed the Allies to defeat the Axis forces with 88,479 tanks produced between 1940 and 1945 (Dear and Foot (2001, Statistics, Table 2)). The National WWII Museum of New Orleans (2023) estimates that Ford Motor Company alone produced over 12,500 Sherman tanks of the M4-A3 specification in 1943. The consensus among military historians of WWII is that the "quantity-over-quality" advantage paved the way for the Allied victory in 1945 (Dear and Foot (2001)). Panel C shows an advertisement from Chevrolet, a division of General Motors. The ad noted "From 'ducks' to trucks, from bomber and cargo plane engines to guns and shells," along with pictures of hundreds of military trucks, artillery, planes, amphibious vehicles, and bombshells. Panel D shows how Anaconda Copper Company in Butte, MT, provided valuable metals for the production of military goods. During wartime, copper was considered "more valuable than gold." Finally, Panel E shows three poster campaigns of the Association of American Railroads. The first is the "Keep 'em Rolling" campaign depicting Sherman tanks and a locomotive with the slogan "Tanks don't fight in factories!" and that "Railroads are the first *line of defense."* The second poster also shows the importance of the railroad industry for the war effort, declaring that "war traffic must come first" and a war job advertisement campaign displaying "Railroad workers URGENTLY NEEDED." The main takeaway from Figure 1 is that many sectors of the U.S. economy retooled their production to meet the demands of the military during WWII.

[Place Figure 1 About Here]

Another way to see the importance of the military spending channel is through the front pages of the financial press. Are war-economy sectors picked up by the financial newspapers' most salient coverage? We characterize wartime financial press coverage using Manela and Moreira's (2017) text data of all front-page headlines and articles in the *Wall Street Journal*. Figure 2 plots word clouds of the top terms covered by the *WSJ*'s front page in each year of WWII. Larger fonts mean more important words; dark blue highlights words related to the war economy. In 1939 and 1940, words like "defense" and "steel" were significant, although they appeared more modestly as the U.S. remained neutral.

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[PLACE FIGURE 2 ABOUT HERE]

Defense coverage skyrocketed in 1941 when President Roosevelt signed the Lend-Lease Act in March, and Japan attacked Pearl Harbor in December, leading the United States to declare war. The word "defense" became the second most important *WSJ*-front-page word in the entire year.⁵ In 1942, with the U.S. fully engaged in the war effort, more sectors beyond steel ascended to top-ranked terms in financial press coverage: rubber, oil, and gasoline. Other apparent words related to the economic reality of wartime also show up consistently, like "war production," "production board," "rationing," and "shortage" (Field (2022, p.217)).

We follow this narrative evidence by analyzing balance sheet data on U.S. corporations during WWII. To examine the economic impact of massive government purchases of goods and services, we hand-collected sales data on all 30 companies that were components of the Dow–Jones Industrial Average (DJIA) index in 1939. We then examine the sales growth rate for DJIA firms from 1939 through 1944, the last year before the war economy was undergoing demobilization following the surrender of Nazi Germany and Imperial Japan in 1945. The sample captures the effect of moving from a peacetime economy to a "command economy," in which large government purchases drive a significant portion of firms' profits. Panel A of Figure 3 reports 1939–1944 growth rates of net sales for the 30 components of the DJIA.

[Place Figure 3 About Here]

Fourteen of the 30 firms on the DJIA had growth rates above 100 percent between 1939 and 1944. United Aircraft Corporation (now part of Raytheon) had the highest growth rate in net sales of all DJIA firms, rising more than 1,300 percent. IBM had the second-highest growth rate, expanding net sales growth by 587.5 percent during World War II. The computer company developed the radiotype that transmitted coded text messages from one electric typewriter to another by shortwave radio or wire (da Cruz (2021)). Net sales for National Distillers Product Corporation grew 392.3 percent between 1939 and 1944, putting the company in third place. Its chemicals were needed to produce ammunition and to make synthetic rubber for trucks and planes. Ranked in the fourth position, Westinghouse saw its net sales grow by 374.4 percent. The firm made essential developments in radar, bombsights, and atomic energy. They also improved the engines of U.S. Navy

⁵Manela and Moreira (2017) have a **companion website** with time-varying word clouds generated from their supportvector regressions. They show each word's weight in explaining their news-based volatility index (NVIX). Interestingly, during WWII, "defense" was one of the largest negative-weight contributors, which aligns with our hypothesis.

battleships (Pennsylvania Historical and Museum Commission (2022)). Rounding out the top five, net sales at General Electric increased 344.1 percent during WWII. General Electric constructed a 12,000 horsepower engine for Navy destroyers. The corporation also developed the first American jet engine in 1942. Nearly three-quarters of the Navy's total propulsion and auxiliary turbine horsepower was built by General Electric (Stowe (2020)).

A small group of firms listed on the Dow Jones 30 conducted little business with the U.S. military. As shown in Panel A of Figure 3, Loew's Theatres is ranked 29th in net sales growth during WWII. Woolworth and Procter & Gamble are firms with relatively low growth rates, producing a wide range of home and consumer products. Nevertheless, each company still experienced solid growth rates, suggesting positive spillover effects from defense spending. Overall, the analysis of net sales growth during WWII demonstrates the importance of government spending on DJIA firms' earnings.

Many companies listed on the DJIA also received direct investment from the government during World War II. As of June 1945, the Defense Plant Corporation (DPC), a subsidiary of the Reconstruction Finance Corporation (RFC), had invested nearly \$4 billion (equivalent to \$69 billion in 2024) in firms providing goods and services to the U.S. military (White (1980)). Panel B of Figure 3 plots the top 25 corporations receiving funds from the DPC for developing projects specifically related to national defense. Aluminum Company of America topped the list with over a half billion dollars (\$509 million) invested during wartime, followed by General Motors with roughly another half-billion dollars (\$471 billion). United Aircraft received \$143 million in investment, likely contributing to the significant growth rate in net sales shown earlier in Panel A. The DPC gave General Electric \$137 million. Direct government investment and large-scale procurement contracts with firms helped propel the enormous growth rates in net sales, which reduced the uncertainty of future profits for many U.S. firms.

Scientific research and innovation for defense purposes is another channel through which corporations can receive substantial inflows of military resources. During World War II, the Office of Scientific and Research Development (OSRD) had multi-million dollar contracts with many large U.S. companies (Baxter (1946)). Gross and Sampat (2023) hand-collected data on all government contracts with the OSRD and list the top ten largest firms, reproduced here in Table 1.

[PLACE TABLE 1 ABOUT HERE]

Western Electric, for example, had a contract of \$15 million with the government (equivalent to \$258 million in 2024). It was followed by General Electric (\$7.6 million), Radio Corporation of America (\$6 million), DuPont de Nemours (\$5.4 million), and Monsanto Chemical Company (\$4.5 million). The OSRD financed many important military projects during World War II, including the development of radar and the atomic bomb. Many technological advances in rocketry, radio, and electronic computing had commercial applications after the war (Gross and Sampat (2023)). The OSRD is another example of a government funding source during World War II that plausibly contributed to reducing the uncertainty of future profits for firms.

Another unique aspect of corporate America during World War II is its international breadth. In March 1941, President Roosevelt signed the Lend-Lease Act, allowing the U.S. to sell, transfer, rent, or loan goods and services to any country whose security was vital to U.S. security. It aimed initially at helping Britain, which was on the verge of bankruptcy. It was later expanded to China and the Soviet Union in 1941, the French Committee of National Liberation in 1942, and eventually to circa 40 countries. The President delivered annual reports to Congress detailing the expenses to allied nations, which we display in Figure 4.

[Place Figure 4 About Here]

Panel A of Figure 4 shows the nominal annual balance of Lend-Lease aid in billions of USD and its composition. It shows that international assistance (mainly composed of munitions and industrial items) peaked at 17% of total war expenditures in 1944 and was never below 12% between 1941 and 1945. Panel B shows the organizational chart of federal government procurement in a 1942 Report to Congress on Lend-Lease Operations. We highlight in blue the portion focused on the suppliers' direct production and procurement, showing that corporate America was a central engine in the international organization of the Allied Forces' war economy. Finally, Panel C shows the stunning magnitude of more than 17,501,000 gross long tons shipped from the U.S. to the U.S.S.R. between June 1941 and September 1945 through five maritime routes. The evidence on Figure 4 clearly shows how corporate America supplies a significant share of the military-related goods and services that are demanded internationally.⁶

While WWII is undoubtedly the most prominent example of private-public partnerships for defense efforts, retooling the private sector for military purposes has roots even earlier in American

⁶For more recent evidence, see Wall Street Journal, "How War in Europe Boosts the U.S. Economy," February 18, 2024.

history. In 1918, the War Finance Corporation (WFC) was established to provide financing to industries essential to World War I efforts, serving as a federal financing intermediary (Butkiewicz and Solcan (2016)). Under the WFC's "war powers," it made direct advances to the private sector. In 1919-denominated dollars, the WFC advanced \$5.2 million to banks funding military-related firms, \$39.7 million to public utilities, \$23.8 million to industrial corporations, \$204.7 million to railroads, \$25.2 million to warehouses, and \$7.8 million to cattle businesses (Willoughby (1932)). The operations and functions of the WFC became the foundation of the RFC, which supported banks during the Great Depression and financed war efforts in WWII (Calomiris and Mason (2003, 2004)).

More modern examples of private-public partnerships for defense efforts include the competition between Microsoft and Amazon Web Services for the Joint Enterprise Defense Infrastructure contract and subsequent likely involvement with the Joint Warfighting Cloud Capability (Department of Defense News, July 7, 2021, "DOD Aims for New Enterprise-Wide Cloud by 2022"). Microsoft has also partnered with the U.S. Army to develop mixed reality headsets and the U.S. Navy to scale weather and ocean pattern predictions (Microsoft Official Blog, July 6, 2021, "Microsoft's commitment to the DoD remains steadfast"). IBM has been contracted several times for IT management services for the U.S. Army's Materiel Command Logistics Data Analysis Center (IBM Newsroom, February 10, 2021, "U.S. Army Selects IBM for the Third Time to Provide Full Portfolio of IT Management Services"). These are just a few examples of Department of Defense partnerships with the private sector outside the usual large defense contractors (e.g., Lockheed Martin, Raytheon Technologies, and Northrup Grumman).

3 Data and Empirical Strategy

3.1 Data Sources and Variable Construction

Our time-series analyses use monthly data from January 1890 to December 2017. We combine various sources to assemble a database with macroeconomic, financial, and defense variables to explain stock volatility movements for over a century.

Defense Expenditures. We use U.S. Treasury statements from 1890 to 2017 to construct a monthly data series of defense expenditures, total expenditures, and total receipts. From 1890 to 1980, we use the *Annual Report of the Secretary of the Treasury on the State of Finances for the Fiscal Year*. From 1980 to 2017, we use the *Monthly Treasury Statement of Receipts and Outlays of the United States Government*.

Defense spending is reported annually from 1890 to 1900, quarterly from 1900 to 1916, annually from 1916 to 1921, and monthly from 1921 to the present. Total receipts and total expenditures are reported monthly throughout the entire sample period.

Our novel defense variable is calculated from expenditures for military, war, or national defense purposes. Our series does not include expenditures for civilian purposes, even if it was through a military branch or defense department. We then construct the ratio of defense spending to total expenditures. Despite not using them in our baseline tests due to reporting inconsistencies, we also break down defense spending into the three military departments (Army, Navy, and Air Force) and other defense agencies in Appendix A.3.1 using annual and monthly reports. We present ratios of Army expenditures to total expenditures, Navy expenditures to total expenditures, Air Force expenditures to total expenditures, and other defense agencies expenditures to total expenditures in Appendix Figure A.3. This allows us to identify the impact of each military department on stock volatility. Appendix A.1.1 presents more details on the collection process of defense data.

Macroeconomic Fundamentals. For a monthly measure of economic activity, we use the industrial production (IP) series constructed by the Federal Reserve System that starts in 1919. In empirical tests that include data before 1919, we use Miron and Romer's (1990) IP series, who extend the Fed's series back to 1884. Appendix A.1.2 details the IP series constructed by Miron and Romer (1990) and their splicing procedure. Data for the money supply (M1) are taken from the website of the Federal Reserve Bank of St. Louis (FRED), while consumer prices are provided by Global Financial Data (GFD).

Aggregate Stock Volatility. We follow Schwert (1989) and construct our measure of realized stock return volatility by calculating the monthly standard deviation of stock returns from daily data using CRSP for the post-1926 period. We use Schwert's (1989) stock volatility indices for the pre-CRSP period.

Aggregate Financial Leverage. The financial leverage measure is taken from Jordà, Schularick, and Taylor (2016), the most comprehensive source of long-term macro-financial data. Their data are publicly available on www.macrohistory.net/data. We calculate leverage as the sum of *"tloans"* (Total loans to the non-financial private sector) and *"tmort"* (Mortgage loans to the non-financial

private sector), scaling it by "gdp" (nominal GDP). As in Cortes and Weidenmier (2019), we interpolate the annual series of financial leverage into monthly data.

Sector-Level Stock Volatility. Data for returns on stock portfolios of 30 Fama and French (1997) sectors (FF-30 hereafter) are from Ken French's data library. We again follow Schwert (1989) and compute monthly standard deviations from the daily stock returns of each sector. The choice of the FF-30 classification is driven by practical problems that arise from our long sample period. While choosing more granular aggregations (e.g., the Fama and French 49 industries classification) is beneficial for gauging with more precision the stock volatility of different sectors in the economy, doing so is unfeasible in our long sample. The evolving life cycles of industries and the long-run dynamics of the U.S. economy mean that choosing more granular classifications makes the sector indices too sparse in the first half of the sample. Sectors that are too modern (e.g., "software" in the FF-49 classification) only begin in the last few decades of the sample, which does not allow us to exploit the heterogeneity across sectors over the entire sample period. The Fama and French 30-sector classification provides the best combination of sectoral disaggregation and time-series coverage in the early decades of our sample.

State-Level Stock Volatility. We use firms' headquarters (HQ) locations to link each stock to a state. For the historical sample starting with CRSP in January 1926, we use the corporate headquarters mapping constructed by Graham, Leary, and Roberts (2015), further expanded by Cortes and Weidenmier (2019) and Cortes, Taylor, and Weidenmier (2022). For the post-1969 period, we use COMPUSTAT's location of a firm's headquarters. Because COMPUSTAT records only the *current* HQ location of a firm, it lacks the *history* of HQ locations. To deal with this limitation, we use the hand-collected HQ locations since 1969 from Bai, Fairhurst, and Serfling (2020) and made available through Matthew Serfling's data library. With firm-level location data, we construct state-level value-weighted stock return indices at the daily frequency. Finally, we compute each state's stock volatility as the monthly standard deviation from the daily returns of each state index. There is one practical problem in constructing these indices for less populated states. When too few firms are headquartered in a particular state (or in a specific period), the volatility is computed from a small number of stocks. The sample problem can cause the return on the state stock indices to exhibit explosive

behavior. To mitigate this problem, we restrict our sample to states with at least five stocks every decade of the 1926–2017 sample period. Nineteen states meet the minimum threshold.

Firm-Level Data: Accounting Fundamentals. We use firms' accounting fundamentals, equity analyst forecasts, and stock price data in two of our granular tests. In Section 5.1, we inspect the mechanism of our channel at the firm level and run Vuolteenaho's (2002) VAR-based decomposition into cash flow and discount rate shocks. Using firm-level data for such an extended sample is challenging and requires hand collection to extend traditional data sets further in the past. Following a recent stream of long-run corporate finance studies (e.g., Graham, Leary, and Roberts (2015); Graham and Leary (2018)), we use Moody's Industrial Manuals to complement the standard COM-PUSTAT sample of accounting fundamentals. The COMPUSTAT Annual Fundamentals data set starts in 1950, becoming more consistent from 1954. To ensure coverage of all DJIA firms around the most important conflicts of our sample, we use Moody's Industrial Manuals for the 1935–1950 period. Appendix Figure A.2 shows example pages of the 1950 Moody's Industrial Manual for United Aircraft Corporation, the DJIA firm with the most considerable sales growth during WWII as seen in Figure 3. United Aircraft is now part of Raytheon Technologies Corporation, one of the world's leading defense contractors. We begin our manual collection in 1935 to ensure the outbreak of WWII in 1939 is in our analysis. Vuolteenaho's (2002) decomposition requires us to construct three variables at the firm level: log stock returns, log book-to-market ratio, and log profitability. We follow Vuolteenaho (2002) in constructing the profitability measure for all DJIA firms in the COMPUSTAT period as the log of the return on equity (GAAP ROE), given by operating income before depreciation divided by common equity. We hand-collect data on operating income from Moody's Manuals for the pre-COMPUSTAT period. As noted in several studies (e.g., Davis (1994); Davis, Fama, and French (2000)), there are challenges in constructing firm characteristics consistently due to the lack of harmonized reporting practices in the pre-COMPUSTAT period. In calculating our profitability measure for the pre-COMPUSTAT period, we closely follow the guidance of Davis (1994) and Davis, Fama, and French (2000) and refer to the details therein and in our Appendix A. One advantage of focusing only on DJIA companies is that these larger corporations have relatively comparable reporting practices, unlike Davis's (1994) random sample of 100 firms—which included smaller companies. Finally, to construct the book-to-market ratio, we obtain market value data

from CRSP and the book value of equity from Davis (1994), later expanded by Davis, Fama, and French (2000), also available from Ken French's data library.

Firm-Level Data: Equity Analyst Forecasts. In Section 5.2, we use I/B/E/S data to calculate the well-known Diether, Malloy, and Scherbina (2002) forecast dispersion measure as the dependent variable in our event-study analysis of the dispersion of equity analysts' forecasts. In this exercise, we also use firm-level procurement intensity measures from Baker, Bloom, and Davis (2016), who hand-matched each firm and its subsidiaries to their parent company using *Dun & Bradstreet's* data and the universe of Federal government procurement contracts between 2000–2016 (cf. details in Section 5.2). In these regressions, we also use COMPUSTAT data to control for firm size (log of total assets) and financial leverage, constructed according to Graham, Leary, and Roberts (2015).

Summary Statistics. We present summary statistics in Table 2 by breaking down our sample into peace and conflict periods. "All Wars" are all conflicts and wars fought by the U.S. in the Correlates of War Database (Sarkees and Wayman (2010)). In this data set, some wars span several decades (e.g., Afghanistan between 2001 and 2021). Since it is not the case that the American economy was in a war economy state for twenty years during the Afghanistan conflict, we restrict our indicator variable to equal one up to a year after the invasion of both Afghanistan (2001:M10) and Iraq (2003:M3). Finally, we consider "Major Wars" as the conflicts with the most significant increases in military expenditures: WWI, WWII, and the Korean War. "Peacetime" is when "All Wars" equals zero, and "Peacetime NFC" is when the peacetime sample omits the months of the two major financial crises—the Great Depression and the Great Recession, as defined by the NBER.

[PLACE TABLE 2 ABOUT HERE]

As noted by Schwert (1989), stock volatility is lower during wartime. Stock volatility is 0.882 during periods of no conflict and 0.632 during periods of conflict, meaning that stock volatility is about 25 percent lower during conflicts. This fact is true both for major and non-major wars. A differencein-means test between the peace and conflict periods is statistically significant at the one percent level. Stock volatility during wartime is also lower than in peacetime, even if we drop the Great Depression and Global Financial Crisis from the peacetime period. For the remaining variables, leverage is lower during wartime, while defense expenditures are much higher during periods of conflict. Growth in industrial production, CPI, and M1 are also higher during conflict periods. Notably, the standard deviations are higher or about the same for most of our variables during wartime compared to peacetime. This is not the case for stock volatility, where the values are much lower during wartime. This comparison holds even when we omit financial crises from the peacetime sample.

3.2 Empirical Strategy

We begin our time series exploration using our monthly aggregate data. Specifically, we follow Schwert (1989) and Cortes and Weidenmier (2019) to estimate predictive regressions of aggregate stock volatility:

Stock
$$Vol_t = \beta_0 + \sum_{m=1}^{11} \beta_{1,m} \cdot D_m + \sum_{p=1}^{12} \beta_{2,p} \cdot Stock \ Vol_{t-p} + \sum_{p=1}^{12} \beta_{3,p} \cdot Lev_{t-p}$$

+ $\sum_{p=1}^{12} \beta_{4,p} \cdot Defense \ Expenditure \ Ratio_{t-p} + \sum_{p=1}^{12} \beta_{5,p} \cdot Macro_{t-p} + \epsilon_t,$ (1)

where *Stock Vol* is our monthly measure of stock market volatility (standard deviation of stock returns), D_m is a set of seasonal monthly indicators, *Lev* is the market value of aggregate corporate leverage, *Defense Expenditure Ratio* is the ratio of defense expenditures to total expenditures, and *Macro* is a vector of macroeconomic determinants of stock volatility that includes industrial production growth (% ΔIP), money supply growth (% $\Delta M1$), and the inflation rate calculated from the consumer price index (% ΔCPI). We also include the ratio of federal receipts to expenditures to disentangle defense-specific spending from general deficit spending. Also following Schwert (1989), the autoregressive specification includes 12 lags of each variable.

4 **Results**

4.1 Aggregate Analysis: Time Series Evidence

Figure 5 shows our monthly series of the ratio of defense expenditures to total expenditures (blue) and stock volatility (gray) from 1921 to 2017. The figure shows evidence of an inverse relationship, where a higher (lower) defense expenditure ratio is associated with lower (higher) volatility. There is a -0.26 correlation between the defense spending ratio and stock volatility time series.

[Place Figure 5 About Here]

We then model the data using the linear regression specification in Equation (1). We begin with a simple aggregate specification, where the outcome variable is stock volatility in month-year *t*. Results for four models are in Table 3. In the first specification of Table 3 (column (1)), the controls include 12 lags of stock volatility and month indicators. Column (1) shows that 12 lags of stock volatility predict stock volatility. In column (2), we add 12 lags of leverage to the autoregressive model. Leverage is positive and statistically significant at the 10 percent level. Next, in column (3), we add 12 lags of the new defense expenditure variable to the stock volatility specification. Leverage remains positive and statistically significant. Defense spending is negative and significant at the one percent level, and its inclusion increases the R-squared. Our rationale is that defense spending and government-guaranteed military contracts make it easier for investors to forecast firms' future earnings.

[Place Table 3 About Here]

In column (4), we add 12 lags of industrial production growth, money growth, and inflation to the right-hand side of the stock volatility model, along with leverage and the defense expenditure ratio. In this specification, the sample begins later because data for M1 is unavailable earlier than 1918. The defense variable is negative and significant at the one percent level. Industrial production and money growth are also statistically significant. Column (4) also includes the ratio of federal receipts to federal expenditures as a control variable. This variable is insignificant, suggesting that our defense result is not simply driven by deficit spending. While omitted here for brevity and to avoid an overfit of our model, we confirm that our conclusions are also robust to controlling for the unemployment rate, political uncertainty (proxied by Baker, Bloom, and Davis's (2016) EPU index), and Treasury bill rates.

To investigate whether wars account for our findings, we run two specifications: one where the sample is limited to all wars and one where the sample is limited to peacetime (omitting all wars from the sample). We consider specifications (1)–(4) in the previous table. Panels A and B of Table 4 present the results for wartime and peacetime subsamples, respectively. Comparing columns (2) and (3) in both panels, the R-squared has a greater increase from including the defense expenditure variable in the wartime sample than in the peacetime sample. This intuitive result supports our findings that defense spending explains volatility, especially during wartime.

[PLACE TABLE 4 ABOUT HERE]

To ensure that our results are not driven by an individual episode in American history, Table 5 presents results where we restrict the sample into ten sub-periods: Classic Gold Standard (1890–1913), Spanish American War and WWI (1890–1928), Great Depression/Pre-World War II (1921–1940), Interwar Period & WWII (1914–1945), World War II and Korean War (1941–1953), Bretton Woods (1946–1975), Vietnam Era (1954–1974), Cold War Era (1975–1997), Globalization (1971–2007), and the Global Financial Crisis (2008–2017). Several of these eras are defined by Obstfeld and Taylor (2004). The results are from specification (4), which includes 12 lags of all seven variables.

[PLACE TABLE 5 ABOUT HERE]

Defense spending has a negative and statistically significant effect in all ten periods.⁷ Overall, the baseline empirical results demonstrate that defense spending lowers stock volatility.

4.2 Disaggregate Analyses and Forward-Looking Specifications

4.2.1 Sector-Level Evidence: Defense-Related Industries and Stock Volatility

We follow up the baseline analysis by examining the impact of defense spending on stock volatility at the sector level. First, we use daily returns starting in January 1926 on portfolios of 30 sectors using the Fama–French classification. Monthly stock volatility is the standard deviation of daily returns in a given month. We then specify autoregressive time series models similar to that of Equation (1). The dependent variable is now the stock volatility of a given sector. The covariates are identical to the independent variables in the aggregate model, except that the lagged dependent variables are also lags of sector volatility instead of aggregate market volatility. Figure 6 presents the empirical results for the sector analysis.

[PLACE FIGURE 6 ABOUT HERE]

The bar plot shows that the sums of coefficients for the defense expenditure ratio are all negative (29 sectors), except for the *Beverages & Liquor* sector. The blue bars depict the sectors for which the sum of coefficients is statistically different from zero (i.e., *p*-value ≤ 0.10). Eleven of the 30 sectors have a negative effect that is statistically significant at the 10 percent level or less. Intuitively, we

⁷The period after the Global Financial Crisis has an uncommonly large coefficient, suggesting the limits of aggregate time series regressions to disentangle the mechanism more clearly in the presence of major disruptions like the GFC in 2008. This limitation motivates our event study specifications using granular firm-level data in Section 5.2 to better disentangle the impact of military expenditures on volatility in the recent period.

find that the sectors with the strongest impact of defense expenditures on lowering stock volatility are steel (-0.317 percentage points) and coal (-0.286 p.p.). Steel is the basis for producing countless military goods (e.g., tanks, artillery, ships, and airplanes).⁸

The second-ranked sector is coal. Coal is often used in blast furnaces in steelworks to produce such military goods, and it has also become a crucial input for synthetic fuel. On April 5, 1944, the U.S. Congress passed the Synthetic Liquid Fuels Act, authorizing \$30 million for a five-year effort for "...the construction and operation of demonstration plants to produce synthetic liquid fuels from coal (...) to aid the prosecution of the war."

Several other well-known military-related sectors have a large and statistically significant coefficient on the ratio of defense spending to total spending, including *Aircraft, Ships, and Railroad Equipment, Engines & Parts* (-0.210 percentage points), construction services and materials (-0.147), petroleum and native gas (-0.200), and transportation (-0.208).

The overall message of the industry-level regressions is that military spending reduces stock volatility for many sectors of the economy. While network effects from military spending have been widely discussed in the economics literature, the topic has received much less attention in the finance literature (see, e.g., Auerbach, Gorodnichenko, and Murphy (2020)). For example, the retail sector has a statistically significant defense coefficient with a point estimate of (-0.113). The meals and apparel sectors have large and statistically significant defense expenditure coefficients of -0.042 and -0.162, respectively. Military spending also lowers stock volatility for textiles (-0.101). We also see a significant decrease in the volatility of "Boat Building & Repairing, Recreation Equipment & Services" (-0.092) in the FF-30 classification. The result is explained by shipbuilding and repairing becoming vital for the Navy during wartime. For example, the Bureau of Labor Statistics's (1944) *Monthly Labor Review* published an article on earnings in ship-repair yards in the Spring of 1943. In it, the BLS documents that "*ship-repair work plays a vital part in our war economy. From a small peacetime industry* (...), this industry has increased greatly since the outbreak of WWII, from the standpoint of both the number of yards and the number of workers. It is estimated that the number of workers now engaged in ship-repair work is more than six times as great as it was at the start of the war." (Bureau of Labor Statistics (1944, p.140)).

⁸Blackford (1982) delved through the archives of Buckeye Steel Castings, a large steel producer based in Columbus, OH. The numbers from the May 1942 board meeting transcripts make it unambiguous that production was overwhelmingly going to the war effort: *"Buckeye's expanded plant was designed to produce 1,000 tons of cast steel armor per month (75% was expected to be three-ton tank turrets) as well as parts for railroad cars."* (Blackford (1982, p.103)).

Overall, the empirical analysis demonstrates that military spending has far-reaching spillover effects in reducing stock volatility for non-military sectors. These results align with Auerbach, Gorodnichenko, and Murphy (2020), who find Department of Defense spending has sizeable positive spillover effects for both intermediate inputs and general equilibrium spillovers.

4.2.2 State-Level Evidence: The Geography of Wartime Stock Volatility

We now examine the geography of military spending's effects on stock volatility at the state level. We construct a measure of stock volatility for each state using a value-weighted index of firms headquartered in each state. For less populated states, we must ensure that state-level indices are representative and not driven by a single firm. To do so, we focus on 19 states that meet the threshold of at least five unique company headquarters in every decade of our sample. The results are qualitatively identical if we adopt a stricter minimum threshold of 10 stocks, which we omit here for brevity but are available from the authors upon request. After constructing monthly state-level stock volatility from the standard deviation of daily equity returns for each state index, we regress stock volatility on the defense variable. We estimate predictive time series models as in specification (4) of Table 3. The dependent variable is now the stock volatility of a given state. The controls are identical to the aggregate model except that the lagged dependent variables are also state-level stock volatility instead of aggregate stock volatility. The results are in Figure 7.

[PLACE FIGURE 7 ABOUT HERE]

The results provide insight into the effect of defense spending on stock returns for local companies. It is important to note that the coefficient on the defense spending ratio is negative for all states and statistically significant for seven states. Intuitively, the top 2 states with statistically significant declines in volatility due to military spending are Maryland (-0.159 percentage points) and Pennsylvania (-0.151). Maryland is home to the Naval Academy and several large defense contractors (e.g., Lockheed Martin in Bethesda and AAI Corporation in Hunt Valley), and Pennsylvania is home to many steel firms, which the sector results in Figure 6 demonstrate as a crucial military input. The defense ratio coefficient is also significant for Illinois, Delaware, Virginia, Missouri, and North Carolina. Several of these states have large military bases or defense contractor presence. For instance, Virginia is home to the United States Fleet Forces Command and many defense contractors (e.g., Northrup Grumman in Falls Church and Huntington Ingalls in Newport News). Similarly, North Carolina houses Camp Lejeune for the Marine Corps and Fort Liberty for the Army. Missouri is home to the Fort Leonard Wood Army Base and Whiteman Air Force Base. Lastly, Delaware is the state of incorporation for numerous firms due to tax advantages, but it is also the headquarters location of crucial contractors like E.I. DuPont de Nemours and Company, based in Wilmington since 1915. These findings align with Hultquist and Petras (2012) and Nickelsburg (2020), who demonstrate that military bases are linked to local and state economies. Additionally, Rahman (2020) shows that military representation in a county is associated with more naval spending during World War II.⁹

4.2.3 Forward-Looking Specification: News-Implied Volatility

As Figure 2 demonstrates, the influence of defense and war on news implied volatility is large. We explore this relationship further by respecifying Equation (1), where the outcome variable is now the News-Implied Volatility Index (NVIX) from Manela and Moreira (2017). The covariates remain the same except for 12 lags of $NVIX_t$ instead of $Stock Vol_t$. Table 6 presents the estimation results. Columns (1) to (4) in Table 6 show similar results as the same columns of our baseline Table 3. Our defense expenditure ratio is negatively and significantly associated with news-implied volatility. This shows that changes in defense expenditures also lowers forward-looking volatility.

[PLACE TABLE 6 ABOUT HERE]

One consideration when employing news-implied volatility is that it is forward-looking, whereas our defense expenditure variable is not. To further inspect this relationship, we employ data from Ramey and Zubairy (2018) to construct a "fully forward-looking" specification of our proposed mechanism and its effect on stock volatility. Ramey and Zubairy (2018) constructed a quarterly "defense news narrative" from well-known newspapers between 1889 and 2015. We went through the narrative document with the kind assistance of Valerie Ramey, noting the specific dates of defense spending announcements. We then disaggregated the series to the monthly level to capture the present discounted value of defense expenditure announcements as a fraction of GDP each month to be consistent with our monthly financial and macroeconomic data.

⁹In Appendix A.3.1, we also explore each military department's influence on stock volatility. While there are inconsistencies in the reporting for each department and model selection criteria favor the specification with total defense spending, investigating each department offers an opportunity to understand their different expenditures. The results suggest that the negative effect is more pronounced in the Navy, Air Force, and Defense Agencies (e.g., Missile Defense Agency, Defense Advanced Research Projects Agency, and Defense Intelligence Agency). Recent DoD reports show that these departments spend relatively more on "Procurement" and "Research, Development, Test, and Evaluation."

Columns (5) and (6) of Table 6 present the *NVIX* model results when we use the new variable for defense expenditure *announcements* instead of realized expenditures from the monthly Treasury statements. These forward-looking specifications indicate that announcements of defense expenditure lead to a reduction in expected future stock market volatility. These results support our hypothesis that firms' profits become easier to forecast once market participants know about large government transfers to those firms in forthcoming periods. Market participants seem to incorporate news of future cash flows into their expectations. In the next section, we dive deeper into firm-level evidence on the cash flow mechanism.

5 Firm-Level Evidence

5.1 Identifying the Mechanism: Cash Flow vs. Discount Rate Shocks

To assess what drives an individual firm's stock volatility, we follow Vuolteenaho (2002) and Campbell and Vuolteenaho (2004) that extended Campbell and Shiller's (1988) aggregate decomposition. Following the same methodology, we use a vector autoregressive (VAR) model to decompose firm-level stock volatility into cash-flow news and expected-return news. Given that the mechanism behind our hypothesis is that firms' future cash flows become easier to forecast during wartime because of large government expenditures, we expect cash-flow shocks to dominate discount rate shocks, particularly during wartime.

To test this, we construct a novel database of firm-level fundamentals needed for the estimation. Our final sample is a firm-level, annual panel featuring the firms in the Dow Jones Industrial Average from 1937 to 2017. The VAR follows Vuolteenaho (2002). However, due to the long-run aspect of our study, it is crucial to consider the challenges we face relative to his original specification. We only have the DJIA firms, which is much more limited than the rich CRSP–COMPUSTAT cross-section of firms in Vuolteenaho (2002).¹⁰ As described in our data section, it is necessary to hand-collect annual firm-level accounting fundamentals data to construct our measure of profitability. With this in mind, we estimate the VAR model for our sample of firms and present simple VAR statistics demonstrating the importance of cash-flow news relative to expected-return news in Figure 8.

[PLACE FIGURE 8 ABOUT HERE]

¹⁰Our focus on the 30 DJIA firms is justified by the costly data collection efforts necessary to expand the accounting fundamentals data beyond the largest and most recognizable companies in the U.S. stock market earlier than the WWII.

The line in Figure 8 presents the fraction of firms in the DJIA where cash-flow news dominates expected-return news each year. War periods are shown in gray areas with annotations for each conflict fought by the United States. The figure has two key takeaways. First, consistent with Vuolteenaho (2002), firm-level cash-flow news dominates discount-rate (i.e., expectedreturn) news across the sample period. Second, in the greatest conflicts that the U.S. fought in our firm-level sample—WWII, Korea, and Vietnam—the importance of cash-flow shocks increases, often capturing all firms in the DJIA. The most striking case is naturally WWII when virtually all firms in our sample show up as having cash flow news shocks with greater importance. This firm-level finding is important and provides evidence for the mechanism underlying our results. Interestingly, Hirshleifer, Mai, and Pukthuanthong (2024) estimated a standard aggregate Campbell and Shiller (1988) VAR decomposition, finding similar results that aggregate cash flow news shocks become more influential during wartime.

The period after 9/11 does not exhibit a similar pattern to earlier large-scale wars. Two complementary explanations merit consideration. Firstly, while selecting firms from the DJIA is a reasonable choice for tracking prominent companies, it may not constitute the optimal sample for cleanly identifying the magnitude of the military demand channel when defense spending is not as high as during a full-scale war economy. Although virtually all sectors and firms were impacted by the mobilization efforts of WWII, the same is not necessarily true for more recent conflicts. Secondly, recent decades have also witnessed other confounding events, such as the Dot-Com market crash in the early 2000s (contemporaneous with 9/11 and the invasion of Afghanistan) and the Global Financial Crisis in 2008 (persisting through the last three years of the Iraq War). In the next section, we estimate an event study specification to better isolate the impact of military expenditures on volatility during this period.

5.2 Military Conflict and the Dispersion of Analysts' Forecasts

That military conflict makes firms' profits easier to forecast due to expectations of massive government purchases is an intuitive idea with abundant narrative evidence. For example, Tompkins and Bruner's (2016) case study of Boeing states that "Defense corporations were the beneficiaries when the world became more unstable due to the terrorist attacks on September 11, 2001. Analysts pointed out that Boeing consisted of two separate businesses: the relatively more stable defense business and the con*versely more volatile commercial business."* (Tompkins and Bruner (2016, p. 306)). We now formally test the hypothesis using granular firm-level data.

[PLACE FIGURE 9 ABOUT HERE]

We identify this effect by analyzing the dispersion of earnings per share (EPS) forecasts released by equity analysts for each firm in the I/B/E/S data. Since the EPS forecast data start in 1990, we can cover only the four most recent conflicts: (*i*) Gulf War (1991); (*ii*) War for Kosovo (1999); (*iii*) the 9/11 terrorist attacks and the ensuing invasion of Afghanistan (2001); and (*iv*) the invasion of Iraq (2003). Despite the limited number of conflicts relative to our time series tests, there has been significant variation in the importance of the defense budget throughout this period. Figure 9 plots the annual changes in U.S. defense spending as a share of GDP. The negative bars in the first ten years document that the first two conflicts (i.e., the Gulf War in 1990 and Kosovo in 1999) were fought in an era of contraction in the defense budget. Defense went from almost seven percentage points of the GDP in 1990 (6.8%) to less than four percentage points (3.8%) at the turn of the century. It was only in 2001, following the 9/11 terrorist attacks, that the trend reversed, making defense spending a priority once again and an increasing share of U.S. GDP. This reversion occurred mainly in 2002 and 2003, a period related to the preparation for and the invasion of Iraq.

For our dependent variable, we follow an extensive literature (e.g., Diether, Malloy, and Scherbina (2002); Da and Warachka (2009)) and construct a cross-sectional measure that aggregates the dispersion of equity analyst forecasts on firms' earnings-per-share (EPS). Dispersion is defined as the standard deviation of earnings forecasts scaled by the absolute value of the mean earnings forecast. If the mean earnings forecast is zero, then the stock is assigned to the highest dispersion category.¹¹ We consider shorter and longer horizons of EPS forecasts: 1 quarter, 2 quarters, 3 quarters, 1 year, and 2 years. This section presents the results for a 2-year horizon for brevity, but the Appendix features the other horizons.

We then define firms as military-spending-related and non-related based on their share of revenues coming from federal government procurement contracts. The firm-level measure of federal procurement intensity is from Baker, Bloom, and Davis (2016), who hand-match each firm and its subsidiaries to their parent company using *Dun & Bradstreet's* data and the universe of Federal gov-

¹¹As in Diether, Malloy, and Scherbina (2002), excluding observations with a mean earnings forecast of zero does not significantly affect the results. Moreover, our results remain virtually unchanged if we use the ratio of the standard deviation of earnings forecasts to the book equity per share as an alternative measure of dispersion.

ernment procurement contracts between 2000–2016. A firm is a military-spending-related company if it is in the top decile of the distribution of federal procurement contracts relative to total revenues. The cutoff is equivalent to including firms with roughly 20% of their revenues coming from federal government contracts. To assess the validity of this criteria, Baker, Bloom, and Davis (2016) document that companies at the top of the distribution are from 3-digit SIC industries with significant revenues from producing military goods: *ordnance and accessories* (39% of revenues are from federal procurement contracts), *search, detection, navigation, guidance & aeronautical systems* (27%); engineering services (21%); aircraft and parts (20%); ship and boat building and repairing (15%). In our event study framework, military-spending-related firms are the "treated" group, while non-defense firms are part of the "non-treated" group. A total of 83 firms in the treated group satisfy the criteria above. As in Baker, Bloom, and Davis (2016), we confirm several of these firms are well-known defense contractors (e.g., Lockheed Martin, Northrop Grumman).

Finally, we must define the time window of our event study specification. Using an excessively narrow time window is challenging because some of our conflicts have key developments spanning over a month. For example, the terrorist attacks of September 11, 2001, were followed immediately by the American invasion of Afghanistan on October 7, 2001. We choose a two-month time window to ensure equity analysts' forecasts incorporate all relevant information about each conflict while still close to the news shock. Formally, the empirical specification can be written as follows:

$$Disp(2Y)_{i,t} = \beta_0 + \sum_{\tau=-2}^{+2} \beta_{1,\tau} \cdot [\mathbb{1}\{Military \ Spending \ Related_i\} \times \mathbb{1}\{t=\tau\}] + \mathbf{X}_{i,t-1} + \lambda_i + \lambda_t + \varepsilon_{i,t}, \quad (2)$$

where τ is used to index normalized time expressed in months relative to the conflict event and ranges from -2 to +2. We consider $\tau = -1$ as the base period, so the event-study coefficients $\{\beta_{1,\tau}\}_{\tau\neq-1}$ are relative to one month before the outbreak of each conflict's outbreak. The indicator variable $\mathbb{1}\{t = \tau\}$ is used to identify leads and lags around the outbreak of each war event.

The dependent variable $Disp(2Y)_{i,t}$ is the dispersion of earnings-per-share forecasts of all analysts covering firm *i*, at monthly date *t*, for a two-year-ahead forecast horizon. We focus on two-year forecasting horizons (i.e., the longest horizon available in the data) because large defense procurement contracts undergo prolonged federal acquisition bidding processes. Therefore, this crucial feature of the treated firms suggests that analysts will likely incorporate the military demand channel in their longer-run forecasts. In robustness checks, we also show results for all forecast horizons $h \in \{1 \text{ quar-}$ ter, 2 quarters, 3 quarters, 1 year, 2 years} and find results qualitatively similar. Indicator variable $\mathbb{1}\{Military Spending Related_i\}$ equals one if firm *i* meets the criterion discussed above (top decile in procurement). Our coefficients of interest are the set of $\{\beta_{1,\tau}\}$, which capture the differential effect on the change of the forecast dispersion of defense-related firms around each event date *vis-à-vis* their non-related peers. The *Military Spending Related* indicator and individual event time indicators are subsumed by our firm (λ_i) and time (λ_t) fixed effects, respectively.

We control for firm-level characteristics **X**, a vector including firm size (defined as the log of total assets) and financial leverage (defined as in Graham, Leary, and Roberts (2015)), as well as interactions of both controls with the event-period dummies. This allows us to control for the effects of firm size and leverage varying in each period before and after the shock relative to the baseline period.¹² Following standard practice in the corporate finance literature, we lag our firm-level controls by one period, i.e., a quarter. Finally, we cluster standard errors at the firm level. The estimated $\beta_{1,\tau}$ coefficients (with 90% confidence intervals) for each war are reported in Figure 10.

[PLACE FIGURE 10 ABOUT HERE]

Panel A of Figure 10 focuses on conflicts during the era of U.S. military spending contraction after the end of the Cold War, which we color in light gray as in Figure 9. Both plots show that defense-intensive firms did not have significantly lower dispersion in earnings forecasts compared to non-defense companies following the outbreaks of the Gulf War in 1991 (left plot) and the War for Kosovo in 1999 (right plot). This is consistent with our hypothesis, given that the U.S. military is being downsized. An analyst should not perceive defense-related firms' risks differently if they are less likely to benefit from a shrinking defense budget.

Panel B of Figure 10 (in dark blue) refers to conflicts in the era of military spending expansion. Defense spending began to increase again in 2001, following the attacks of 9/11 and the ensuing war on terrorism. There are two important takeaways from the bottom panels. First, there are no statistical differences between the defense and non-defense firms in the t = -2 period (i.e., two months before the event). This absence of pre-trends for the bottom two panels suggests that the parallel trend assumption, necessary for the validity of event study designs in a standard panel setting, is satisfied. Second, after the war outbreak, we find that defense-related

¹²We also experimented with a larger set of firm-level controls, including cash flows, cash holdings, ROA, and Tobin's *Q*. These results, available upon request, are broadly similar to our baseline results and were omitted for brevity.

firms are associated with a statistically significant reduction in the dispersion of their forecasts relative to their non-defense-related peers. The magnitudes are economically meaningful as the normalized forecasts are less dispersed by 0.50 or 0.10.

These results are robust to alternative forecast horizons. Figure A.4 in the Appendix shows that the same effect in Figure 10 is also present in the blue-colored panels for different forecast horizons. In particular, the effects are also statistically significant for shorter horizons. The firm-level analysis confirms the mechanism behind the aggregate results. After the outbreak of war, even in a completely unexpected case like 9/11, defense firm volatility is predicted to be lower as analysts incorporate future procurement in their forecasts. Overall, the empirical evidence in Figure 10 is consistent with our hypothesis and proposed war puzzle explanation. The expectation of large future government purchases of military goods and services seems to reduce the uncertainty of future profits for firms likely to benefit from military spending.

6 Concluding Remarks

We investigate the war puzzle which—despite being discussed in some of the most influential and widely cited studies on stock volatility (Schwert (1989); Shiller (1992))—has not yet received a comprehensive examination. The puzzle states that U.S. stock volatility was surprisingly low despite high macroeconomic volatility, even during major conflicts like World War I, World War II, and the Korean War. We hypothesize that stock volatility is low during war and periods of conflict for two reasons. First, massive military spending and government-guaranteed contracts during military conflicts reduce uncertainty about firms' future profitability. Second, corporate America benefits from the military demand channel with relatively few episodes of homeland destruction. Most military conflicts the U.S. fought, except the War of 1812 and the American Civil War, have been on foreign soil. This fact spares the U.S. from damage or destruction of the capital stock.

Using the ratio of defense spending to total spending, we document a negative and statistically significant impact of military expenditure on aggregate stock volatility, especially during major wars and conflicts. Next, we disaggregate our analysis. First, we look at the relationship between stock volatility and defense spending at the sector level. Again, we find strong evidence of a negative relationship between stock volatility at the sector level and military spending, particularly in sectors involved with defense efforts, along with spillovers to others. Second, we explore stock volatility at the state level and show that defense spending has a more significant impact in states that are home to large military bases and defense contractors. Lastly, we examine the relationship between forward-looking news implied volatility (NVIX) and defense spending. The regression analysis demonstrates that both coincident defense expenditures and Ramey and Zubairy's (2018) forward-looking measure of announcements of military outlays predict movements in newsimplied stock volatility. Thus, not only do realized expenditures reduce realized volatility but also forward-looking expenditures reduce forward-looking volatility.

We further our analysis by investigating the mechanism behind the defense spending and volatility relationship using a novel hand-collected, firm-level data set from 1937 to 2017. We examine the impact of military spending on cash flow for the firms listed on the DJIA, finding that cash flow news shocks are more important than discount rate news during the most important military conflicts since WWII.

We then use an event study setting to formally test the hypothesis that military conflict makes firms' profits easier to forecast due to expectations of massive government purchases. We identify this effect by analyzing the dispersion of earnings per share forecasts released by equity analysts for each firm. Exploiting conflict events such as the terrorist attacks of 9/11 and the invasions of Afghanistan and Iraq, we find empirical evidence consistent with our hypothesis and our proposed explanation of the war puzzle. The expectation of large future government purchases of military goods and services seems to reduce the uncertainty of future cash flows for defense-related firms, making it easier for analysts and investors to forecast future profits. This reduction in forecast dispersion is consistent with analysts agreeing more on the company's future prospects, contributing to lower stock volatility.

Finally, we answered the intriguing question raised in the introduction: Why did the U.S. stock market fail to experience a substantial volatility spike even amid the extreme risk of World War II? From a financial market perspective, the answer lies in the government's issuance of military contracts, which afforded companies a stable source of revenue and reduced uncertainty about their future profits. Reducing cash flow uncertainty during wartime helped mitigate realized stock market volatility.

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Figures

(A) Boeing's Seattle Plant: B-17 "Flying Fortress" Bombers

(B) Chrysler's Detroit Plant: M4-A4 Sherman Tanks





CHEVROLET Turns Out Volume for Victory for Our Fighting Men



(D) Anaconda Copper Mining Co: Metal Scrap Campaign



(E) Association of American Railroads: Poster Campaigns

CHEVROLET GENERAL MOTORS



Figure 1. Corporate America and the War Effort. This figure shows photographs from the Library of Congress World War II Collection and Poster Campaigns of the Association of American Railroads.



Figure 2. Top *WSJ* **Front-Page Words during World War II: Defense- and War-Economy Industries.** This figure shows word clouds using Manela and Moreira's (2017) text data to show the Top 30 most important words in each year of World War II in the headlines and front-page articles of the *Wall Street Journal*. Words related to war, national defense, and the war economy are dark blue. We remove "stop words" to improve the visualization.



(A) Dow-Jones Industrial Average Companies' Sales Growth: 1939–1944

Investment (Million USD, 1945)

Figure 3. Corporate America and the World War II Effort: Sales Growth of DJIA Companies and Top Companies by Investments from the RFC. This figure shows evidence of the substantial economic expansion experienced by U.S. corporations during World War II. Panel A shows the total growth rate of all 30 Dow Jones Industrial Average companies between 1939 and 1944. The data are from the companies' SEC filings reproduced in the *Moody's Industrial Manuals*. Panel B shows the leading corporations operating DPC Facilities during WWII as of June 1945. The data refer to investment funds from the Reconstruction Finance Corporation's Defense Plant Corporation (DPC) to private corporations to finance projects related to the war effort. Data are from the Comptroller General of the United States (1947) *apud* White (1980, Table 1).



Figure 4. Lend-Lease Aid: The Global Reach of Corporate America during WWII. This figure shows visualizations from Erlandson (1997) of the data in several reports of the Lend-Lease Act operations sent by the U.S. President to Congress. Panel A shows the nominal annual balance of Lend-Lease aid in billions of USD, sourced from the 22nd Report to Congress on Lend-Lease Operations (June 14, 1946). Panel B shows the organizational chart of federal government procurement in the 4th Report to Congress on Lend-Lease Operations (March 11, 1942), p.37. We highlight in blue the portion of Panel B focused on the suppliers' production and procurement. Panel C shows the gross long tons shipped from the U.S. to the U.S.R. between June 1941 and September 1945, per the Department of State's Report on War Aid furnished by the United States to the U.S.S.R. (November 28, 1945), p.26.



Figure 5. Monthly Stock Volatility and Defense Expenditures over Total Expenditures: 1921:M1–2017:M12. This figure shows the monthly time series of stock volatility (right axis, in gray) and defense expenditures as a share of total government expenditures (left axis, in blue).



Figure 6. Sector-Level Analysis: Sums of Coefficients of Defense Expenditure Ratio on Sector-Level Stock Volatility. This figure shows a disaggregated analysis of sector-level stock volatility constructed using the Fama–French 30 sector classification. Blue bars refer to cases in which the statistical significance of the sum of coefficients is at least 10% as given by a joint-significance F test.



Figure 7. State-Level Analysis: Sums of Coefficients of Defense Expenditure Ratio on State-Level Stock Volatility. This figure shows a disaggregated analysis of state-level stock volatility constructed using each company's headquarters. Blue bars refer to cases in which the statistical significance of the sum of coefficients is at least 10% as given by a joint-significance F test.



Figure 8. Cash Flow vs. Discount Rate Shocks in the Dow–Jones Industrial Average Firms. This figure shows the share of all 30 DJIA firms whose Cash Flow shocks exceed Discount Rate shocks, constructed by using Vuolteenaho's (2002) firm-level implementation of the aggregate Campbell and Shiller (1988) decomposition. As in Campbell and Vuolteenaho (2004), the time series are smoothed. Shaded areas represent years in which the U.S. is at war as defined in Section 3.



Figure 9. Recent Eras of Defense Spending: Post-Cold-War Contraction *vs.* **War-on-Terror Expansion.** This figure shows the time series of defense spending relative to GDP. It shows the year-over-year change (first differences) in aggregate defense spending relative to GDP. The figure highlights the shrinkage and expansion of the defense budget. We highlight the period of contraction in light gray and the period of expansion in dark blue. Data are from the Federal Reserve Bank of St. Louis' FRED database.





Figure 10. Event Study Plots: Monthly Dispersion in 2-Year-Ahead earnings-per-share forecasts for Military-Spending-Related vs. Non-Military-Spending-Related Companies. This figure shows the $\{\beta_{1,\tau}\}$ coefficients and 90% confidence bands estimated in Equation (2). The top two panels (Panel A, in light gray) focus on conflicts during the era of U.S. military spending contraction after the end of the Cold War. The bottom two panels (Panel B, in dark blue) refer to conflicts in the era of military spending expansion following the 9/11 attacks of 2001. The top left plot shows the event study results around the Gulf War's outbreak in 1991:M1. The top right plot depicts the outbreak of the war for Kosovo in 1999:M3. The bottom left plot depicts the 2001 terrorist attacks of 9/11 and the following invasion of Afghanistan in October of that year. The bottom right plot displays results for the invasion of Iraq in 2003:M3. The forecast dispersion variable, $Disp(2Y)_{i,t}$ is the standard deviation of 2-years-ahead earnings forecasts scaled by the absolute value of the mean earnings forecast. $Disp(2Y)_{i,t}$ is defined for each firm *i*, in month *t*.

Tables

Rank	Contractor	Total Obligation (Million \$)	Share of Total OSRD Obligations (%)
1	Western Electric Co	\$15.2	3.3%
2	General Electric Co	\$7.6	1.6%
3	Radio Corp of America	\$6.0	1.3%
4	E.I. DuPont De Nemours	\$5.4	1.2%
5	Monsanto Chemical Co	\$4.5	1.0%
6	Eastman Kodak	\$4.3	0.9%
7	Zenith Radio Corp	\$4.2	0.9%
8	Westinghouse Electric Corp	\$3.9	0.8%
9	Remington Rand	\$3.7	0.8%
10	Sylvania Electric	\$3.1	0.7%
	Total	\$57.81	12.5%

Table 1. Top 10 OSRD Contractors, by Contract Obligations. This table reproduces the data from Gross and Sampat (2023). The table presents the top 10 firms with R&D contract obligations with the Office for Scientific Research and Development. Percentages measure each contractor's percent of total OSRD research spending.

Table 2. Summary Statistics. This table presents averages and standard deviations (in parenthesis) of the variables used in our analysis from 1921 to 2017. "Major Wars" includes WWII and the Korean War. "All Wars" includes major wars as well as short-lived conflicts. "Peacetime" is defined when "All Wars" equals 0. "Peacetime NFC" stands for peacetime non-financial crisis years, i.e., it omits the Great Depression and the Great Recession years as defined by the NBER. For numerical precision, stock volatility is multiplied by 100.

Variable	Full Sample	Major Wars	All Wars	Peacetime	Peacetime NFC
Stock Volatility	0.834 (0.568)	0.633 (0.339)	0.632 (0.317)	0.882 (0.603)	0.751 (0.394)
Defense Expenditure Ratio	0.311 (0.187)	0.649 (0.248)	0.491 (0.241)	0.264 (0.135)	0.282 (0.136)
Leverage	0.446 (0.136)	0.199 (0.055)	0.361 (0.155)	0.468 (0.120)	0.472 (0.118)
%ΔIndustrial Production	0.296 (1.835)	0.764 (2.059)	0.525 (1.496)	0.235 (1.911)	0.300 (1.329)
%ΔConsumer Price Index	0.233 (0.519)	0.358 (0.572)	0.322 (0.419)	0.209 (0.540)	0.268 (0.473)
$\Delta M1$	0.089 (0.270)	0.264 (0.406)	0.163 (0.297)	0.069 (0.260)	0.070 (0.155)
Receipts-to-Expenditures	0.879 (0.399)	0.624 (0.364)	0.798 (0.357)	0.900 (0.407)	0.938 (0.391)
Observations (T)	1,152	110	241	911	781

Table 3. Aggregate Time Series Results: Defense Expenditure and Stock Volatility. This table shows the OLS estimates of Equation (1) with HAC standard errors (24 lags). Specifically:

$$Stock \ Vol_{t} = \beta_{0} + \sum_{m=1}^{11} \beta_{1,m} \cdot D_{m} + \sum_{p=1}^{12} \beta_{2,p} \cdot Stock \ Vol_{t-p} + \sum_{p=1}^{12} \beta_{3,p} \cdot Lev_{t-p} + \sum_{p=1}^{12} \beta_{4,p} \cdot Def \ Exp \ Rat_{t-p} + \sum_{p=1}^{12} \beta_{5,p} \cdot Macro_{t-p} + \epsilon_{t},$$

Coefficients are the sum of all 12 lags of a variable, and test statistics in parentheses refer to joint-significance *F*-tests. Stock Volatility is multiplied by 100 for numerical precision. Significance levels: * p < 0.10, ** p < 0.05, *** p < 0.01.

	Stock Volt					
Lags of Variables ($p = 12$)	(1)	(2)	(3)	(4)		
Stock Volatility	0.859***	0.856***	0.847***	0.829***		
	(820.97)	(802.98)	(677.56)	(850.39)		
Leverage		0.111^{*}	0.056***	-0.024**		
		(20.09)	(25.09)	(24.26)		
Defense Expenditure Ratio			-0.072***	-0.123***		
			(31.62)	(29.52)		
Macroeconomic Controls				0.010*		
762Industrial Froduction				(10 - 57)		
0/ AN/1				(19.57)		
/0/21/11				-0.174		
% ACPI				(20.43)		
/02011				(6.71)		
Receipts-to-Expenditures				(0.71)		
Receipts to Experiantics				(15.37)		
Month Effects	Yes	Yes	Yes	Yes		
Sample Period	1890:M1-2017:M12	1890:M1-2017:M12	1890:M1-2017:M12	1918:M8-2017:M12		
Observations	1,525	1,525	1,525	1,176		
R-Squared	0.511	0.518	0.522	0.604		

Table 4. Robustness to Alternative Samples: Wartime *vs.* **Peacetime.** This table shows the OLS estimates of Equation (1) with HAC standard errors (24 lags). Panel A presents estimates of our baseline specifications restricting the sample to wartime months. War dates are defined according to the Correlates of War data set (Sarkees and Wayman (2010)) as explained in Section 3. Panel B restricts the sample to peacetime months. Coefficients are the sum of all 12 lags of a variable, and test statistics in parentheses refer to joint-significance *F*-tests. Stock volatility is multiplied by 100 for numerical precision. Significance levels: * *p* < 0.10, ** *p* < 0.05, *** *p* < 0.01.

Panel A. Wartime Sample							
		Stor	ck Vol _t				
Lags of Variables ($p = 12$)	(1)	(2)	(3)	(4)			
Stock Volatility	0.701***	0.692***	0.672***	0.696***			
	(297.48)	(302.02)	(179.23)	(195.62)			
Leverage		0.144^{***}	0.053***	-0.093*			
		(27.14)	(34.65)	(20.97)			
Defense Expenditure Ratio			-0.084^{***}	-0.247***			
			(116.84)	(30.85)			
Macroeconomic Controls							
%∆Industrial Production				-0.025^{***}			
				(46.73)			
$\Delta M1$				0.205***			
				(27.44)			
%ΔCPI				0.085***			
				(61.27)			
Receipts-to-Expenditures				-0.031***			
				(35.47)			
Month FE	Yes	Yes	Yes	Yes			
Observations	302	302	302	241			
R-Squared	0.403	0.429	0.476	0.685			

Panel B. Peacetime Sample								
		Stock Vol _t						
Lags of Variables ($p = 12$)	(1)	(2)	(3)	(4)				
Stock Volatility	0.869***	0.866***	0.860***	0.833***				
	(834.16)	(816.61)	(762.85)	(810.21)				
Leverage		0.104	0.028**	-0.006***				
		(18.13)	(23.62)	(38.11)				
Defense Expenditure Ratio			-0.123***	-0.209***				
			(43.61)	(36.85)				
Macroeconomic Controls								
%∆Industrial Production				0.016**				
				(21.76)				
$\Delta M1$				-0.225***				
				(42.47)				
%ΔCPI				-0.012				
				(4.77)				
Receipts-to-Expenditures				-0.054				
				(17.59)				
Month FE	Yes	Yes	Yes	Yes				
Observations	1,222	1,222	1,222	935				
R-Squared	0.527	0.538	0.544	0.624				

Table 5. Robustness to Alternative Samples: Historical Eras. Results for the defense expenditure ratio variable when we restrict the sample to specific historical eras in the spirit of Obstfeld and Taylor (2004). OLS estimates are the sum of all lags of a variable, and test statistics in parentheses refer to joint-significance F-tests. *Stock Volatility* is multiplied by 100 for numerical precision. These specifications include monthly indicators and 12 lags of stock volatility, leverage, defense expenditures, industrial production, M1, CPI, and receipts-to-expenditures. Exceptions are the 1890–1929 and 1890–1913 samples, which exclude M1 because that variable does not go back to 1890. Significance levels: * p < 0.10, ** p < 0.05, *** p < 0.01.

Time Subsample	Defense Expenditure Ratio	<i>F</i> -test statistic
1890–1913, Classic Gold Standard	-0.377***	(81.71)
1890–1928, Spanish American War & WWI	-0.094***	(34.85)
1929–1940, Great Depression	-0.284^{***}	(35.25)
1914–1945, WWI, Interwar Period & WWII	-0.073***	(32.63)
1941–1953, WWII & Korean War	-1.060***	(62.39)
1946–1975, Bretton Woods, Korean & Vietnam Wars	-0.318***	(31.62)
1954–1974, Vietnam Era	-0.383***	(68.27)
1975–1997, Cold War Era	-0.253**	(23.36)
1971–2007, Globalization	-0.216*	(19.39)
2008–2017, Global Financial Crisis	-2.728***	(48.07)

Table 6. Forward-Looking Specification: NVIX and Defense Announcements. Results for the defense expenditure ratio and defense expenditure announcement ratio. OLS estimates with HAC standard errors (24 lags). Estimates are the sum of all 12 lags of a variable, and test statistics in parentheses refer to joint-significance *F*-tests. These specifications include monthly indicators and 12 lags of Manela and Moreira's (2017) NVIX, leverage, defense expenditures (or defense announcements from Ramey and Zubairy (2018)), industrial production, M1, CPI, and receipts-to-expenditures. Significance levels: * *p* < 0.10, ** *p* < 0.05, *** *p* < 0.01.

			NV	VIX _t		
Lags of Variables $(p = 12)$ (1)NVIX 0.928^{***} (3859.26)LeverageDefense Expenditure RatioRamey–Zubairy Defense Announcement RatioMacroeconomic Controls % Δ Industrial Production% Δ M1% Δ CPI	(1)	(2)	(3)	(4)	(5)	(6)
NVIX	0.928***	0.927***	0.925***	0.908***	0.927***	0.917***
	(3859.26)	(3931.71)	(3522.82)	(2083.34)	(4058.06)	(2569.38)
Leverage		-0.045	-0.280	-0.306	-0.167	-0.078
		(17.23)	(15.24)	(12.97)	(15.93)	(10.67)
Defense Expenditure Ratio			-0.266**	-0.377**		
			(21.39)	(24.15)		
Ramey–Zubairy Defense Announcement Ratio					-0.008^{***}	-0.010^{*}
					(28.88)	(19.77)
Macroeconomic Controls						
%∆Industrial Production				-0.067		-0.040
				(13.87)		(14.52)
$\Delta M1$				0.408**		0.385*
				(22.15)		(19.59)
%ΔCPI				-0.379		-0.287
				(10.75)		(8.64)
Receipts-to-Expenditures				0.158***		0.247***
				(27.98)		(26.25)
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,472	1,472	1,472	1,141	1,446	1,115
R-Squared	0.717	0.719	0.721	0.732	0.723	0.733

A Appendix

A.1 Data Details

Below we present details on the data and the construction of the variables used in our empirical tests.

A.1.1 Defense Expenditures and Total Expenditures

We use U.S. Treasury statements from 1890 to 2017 to construct a monthly data series of defense expenditures, total expenditures, total receipts, Army expenditures, Navy expenditures, Air Force expenditures, and other defense agencies expenditures. From 1890 to 1980, we use the *Annual Report of the Secretary of the Treasury on the State of Finances for the Fiscal Year*. These reports were also employed in Hall and Sargent (2014) and Hall et al. (2021) to construct their data on war financing. From 1980 to 2017, we use the *Monthly Treasury Statement of Receipts and Outlays of the United States Government*. Monthly receipts and expenditures (outlays) are reported consistently from 1890 to 2019.

Defense and branch spending are reported annually from 1890-1900, quarterly from 1900 to 1916, annually from 1916 to 1921, and monthly from 1921 to the present. We interpolate the earlier years to create a monthly series beginning in 1890. Before the establishment of the Department of Defense or the Office of the Secretary of Defense, defense expenditures are defined as expenditures for "National Defense," "War Activities," "National Military Establishments," or "Military Functions," often encompassing expenditures by the War Department (Army) and the Navy Department. Once the Office of the Secretary of Defense are established, defense expenditures are the total expenditures of that department for military purposes. We do not include any expenditures for "civil functions" by the Department of Defense or the branches in our calculations, only "military functions."

Other agencies' defense expenditures are expenditures for military functions that do not fall under the three departments (Army, Navy, or Air Force). In the Treasury reports, these are often labeled as "Other agencies under the Secretary of Defense" or "Other Military Activity Expenditures." Under the present Department of Defense shown in Figure A.1, "Other Agencies" include the Defense Advanced Research Projects Agency (DARPA), the Defense Intelligence Agency, and the Missile Defense Agency, among several others.

[PLACE FIGURE A.1 ABOUT HERE]

A.1.2 Industrial Production

We splice the Miron and Romer (1990) industrial production (IP) index with the Federal Reserve Board's (FRB) industrial production index using the procedure described in the Appendix of Romer (1994), which we briefly summarize here. We adjust the Miron–Romer index of industrial production for 1884 to 1918 to be more

consistent with the modern FRB index. We run a regression between the two series over the period 1923 to 1928. The specification that we use regresses the log level of the FRB index (not seasonally adjusted) on a constant, a trend, 11 monthly dummy variables, the contemporaneous log level of the Miron-Romer index, and six lags and six leads of the Miron-Romer index. The contemporaneous value of the Miron-Romer series is included to capture the main relationship of interest. The constant and the monthly dummies are present to take into account seasonal fluctuations. The results of this regression suggest that there is a very close relationship between the two industrial production series. The R^2 of the regression is 90%. The sum of the coefficients on the lags and leads of the Miron-Romer index is 0.67 with a standard error of 0.10. To form the adjusted Miron-Romer index for the period before World War I, we first regress the Miron-Romer index for 1884 to 1918 on a constant, a trend, and 11 monthly dummy variables and form a seasonally adjusted series by removing the effect of the monthly dummy variables. We then use the estimated coefficients from the regression for the 1920s to combine the lags and leads of this index. Because the seasonal effects are removed in a separate step, we do not use the seasonal coefficients in forming these fitted values. This procedure allows for the possibility that seasonal movements may have changed between the turn of the century and the 1920s. The final prewar index of industrial production that we use merges the adjusted Miron–Romer series for 1884 to 1918 with the FRB index for 1919 to 1940. By construction, the series match up very closely in 1919.

A.1.3 Defense Spending News Shocks

We refer the interested reader to Ramey's (2011) Section V and Ramey and Zubairy's (2018) data appendix for comprehensive details. For convenience, we concisely describe the methodology used by Ramey (2011) to construct her time series in what follows. Ramey (2011) read news sources to gather quantitative information about expectations. The defense news variable seeks to measure the expected discounted value of government spending changes due to foreign political events. Ramey (2011) constructed the series by reading periodicals to gauge the public's expectations. The primary source for most of the sample was *Business Week* because it often gave detailed predictions. However, as it became less informative after 2001, Ramey relied more heavily on newspaper sources. When periodical sources were ambiguous, Ramey consulted official sources, such as the budget. Finally, Ramey did not use professional forecasters except for a few examples because the forecast horizon was not long enough. We used Ramey's (2016) data description instructions to create a monthly series of defense spending announcements. To create the ratio of defense spending announcements to GDP, we interpolated the quarterly GDP data to the monthly level.

A.2 Firm-Level Accounting Fundamentals

We closely follow Davis (1994) and Davis et al. (2000) in constructing our firm fundamentals necessary for the Vuolteenaho (2002) firm-level decomposition. Figure A.2 shows an example page of the 1950 volume of Moody's Industrial Manual.

[PLACE FIGURE A.2 ABOUT HERE]

The figure has the example of United Aircraft Corporation, the firm with the largest sales growth rate during WWII according to data in Figure 3. United Aircraft is now part of Raytheon Technologies Corporation, one of the major defense suppliers in the world. Panel A shows the corporate history of the company and its management details, while Panel B shows its accounting fundamentals, such as its income statement and P&L data. The data in the manual draws from firms' reports filed with the U.S. Securities and Exchange Commission. Interestingly, during the WWII years, there are a few war-specific balance sheet items for some companies. In the example of United Aircraft, we can see "Provision for transformation to peacetime economy" (highlighted in yellow in Panel B). However, the lack of consistent reporting for such variables does not allow us to collect war-specific balance sheet items comprehensively.

The Vuolteenaho (2002) VAR-based decomposition requires us to construct three variables at the firm level: log stock returns, log book-to-market ratio, and log profitability. For the first variable, we use stock returns from CRSP. The second variable (book-to-market ratio) requires a couple of steps. We follow Vuolteenaho (2002) to construct our book-to-market ratios using the book value of equity from Davis (1994), later expanded by Davis, Fama, and French (2000), available from Ken French's data library. The market value of equity comes from CRSP by multiplying the total shares outstanding and the share price. The third variable (profitability) is given by the log of the return on equity (GAAP ROE), i.e., operating income before depreciation divided by common equity. For the pre-COMPUSTAT period, we follow Davis (1994) and Davis, Fama, and French (2000) and construct profitability using accounting items that refer to net income before extraordinary items (i.e., less taxes and preferred dividends). When a firm does not report the net income variable, we again follow Davis (1994) and use total sales and service revenues as a proxy. Unlike Davis (1994), who collected data for a random sample of 100 companies that included relatively small firms, our DJIA sample has only larger companies with a more uniform reporting, allowing us to make fewer assumptions in our variable construction.

A.3 Additional Results

A.3.1 Military Departments

Since military departments vary by capital expenditures, labor workforce, and civilian contracts, we investigate if a particular department drives the empirical result that defense spending lowers stock volatility. We construct three new variables, including expenditures for the Department of the Army (formerly the War Department), the Department of the Navy, and the Department of the Air Force. Figure A.3 presents a stacked area graph of our monthly series by each department's expenditures over total expenditures. The earlier decades show the Army and the Navy with roughly similar shares, becoming even more balanced as the Air Force gained prominence after WWII. The "Other Defense Agencies" category includes expenditures for national defense or military activities that do not fall under the three departments. In the Treasury reports, these are often labeled as "Other agencies under the Secretary of Defense" or "Other Military Activity Expenditures." Under the present Department of Defense, other agencies include the Defense Advanced Research Projects Agency (DARPA), Defense Intelligence Agency, and Missile Defense Agency, among many others. Appendix Figure A.1 presents a detailed organizational chart of the Department of Defense with all divisions under the Secretary of Defense as of 2013.

[PLACE FIGURE A.3 ABOUT HERE]

We combine the expenditures of the Army and the Air Force for consistency because the U.S. Department of War existed from 1789 to 1947, and the data in the Treasury statements informs expenditures from this department. In 1947, the Department of War split into the Department of the Army and the Department of the Air Force. Unfortunately, we cannot disentangle U.S. Army Air Force expenditures from Army expenditures before 1947. We, therefore, opt to combine the two series from 1918 to 2017 for consistency.

We re-estimate our baseline specification (column (4) from Table 3) with each department's expenditures (as a ratio of total expenditures) instead of total defense expenditures. The results for the specifications are in Table A.1, demonstrating negative and broadly similar effects for the *Navy* and the *Army & Air Force* expenditures for stock volatility. These findings are interesting when considering the priorities of each department. From the 1980s until the present, the Monthly Treasury Statements outline how each department spends money. The Navy and Air Force spend a high proportion of their budget on "Procurement" and "Research, Development, Test, and Evaluation." This suggests that the Navy and Air Force engage in more contracts with civilians. Second, their contracts are often longer since they involve research and development for large construction projects like aircraft carriers and other expensive military equipment such as destroyers, guided missile cruisers, and military planes (Koyama et al. (2021)). It also appears to be the case that the capital-to-labor ratio is high in the Navy, which means that their military goods are more intertwined with the stock of private and publicly traded firms (Biolsi (2019)). While these results emphasize specific military

departments, model selection criteria strongly favor the model with aggregate defense expenditures over the department-level specification. Therefore, we keep our focus on overall defense spending.

[PLACE TABLE A.1 ABOUT HERE]

A.3.2 Robustness: Dispersion of Equity Analyst Forecasts using Alternative Horizons

Figure A.4 shows the coefficients and 90% confidence bands estimated in Equation (2) for all possible EPS forecast horizons of equity analysts. Following the color scheme in Figure 9, the first two columns of plots in light gray focus on conflicts during the era of U.S. military spending contraction after the end of the Cold War. Similarly, the third and fourth columns of plots in dark blue refer to conflicts in the era of military spending expansion following the 9/11 attacks in 2001. Each row depicts a different forecast horizon in constructing the dispersion variable, $Disp(h)_{i,t}$. For example, the last row of Figure A.4 focuses on 2-year-ahead forecasts, i.e., it repeats the same panels shown in Figure 10. The dispersion is calculated as the standard deviation of earnings forecasts scaled by the absolute value of the mean earnings forecast. $Disp(h)_{i,t}$ is defined for each firm *i*, in month *t*, and EPS forecast horizon $h \in \{1, 2, 3 \text{ quarters}; 1, 2 \text{ years}\}$ ahead. The figure shows that our baseline results in Figure 10 are maintained in alternative forecast horizons.

[Place Figure A.4 About Here]



Figure A.1. Organization of the Department of Defense. This figure shows the organizational chart of the Department of Defense as of 2013. The dashed blue line highlights the three branches of the U.S. Military (Department of the Army, Department of the Navy, and Department of the Air Force). The red dashed line highlights the eighteen Defense Agencies of the DoD. We further highlight in red rectangles the agencies mentioned in the main text (Defense Advanced Research Projects Agency, Defense Intelligence Agency, and Missile Defense Agency). The source is the website of the U.S. Department of Defense.

(A) Corporate History and Management Details UNITED AIRCRAFT CORPORATION

CAPITAL STRUCTURE CAPITAL STOCK Issue 1. 5% cum. conv. preferred... 2. Common Range since 1934. ESubject to ch

HISTORY rated in Delaware July 21, 1934 with a charter, pursuant to reorganization Aircraft & Transport Corp. Ac-

pt., 1925 rd Star ar P

Corp. on June 24, 1935 or-ircraft Manufacturing Corp. ite Pratt & Whitney Alteraft Canadian Pratt & Whitney 1): Chance Vought Corp.; d Propeller Co.; Sikorsky ad United Altports of Con-0 Y.).

1

Dis Name, place of incorpo United Aircraft Service stallation and service. United Aircraft Export Chance Vought Airplane Corp. (Del. Corp. (Del.) p. (Del

Prait & Whitney Aircraft Co., Ltd. PRODUCTS

Aircraft Division

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Aircraft Division manufactures

d Airport Department of Pratt & WI

C A substantial part of ness represents sales to and other departments Government the co

as entered field of jet prop has entered held of jet propulsio ribine engines. Pratt & Whitne cision is building turbo-jet engine Vought Aircraft Division is build wred places A

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Plant at East Hartford, Conn., housh Pratt & Whitney Aircraft and the Ha ng the TI0

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(B) Accounting Fundamentals

OODY'S MAN	UAL OF	INVESTMENTS
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INCOME ACCOUNTS COMPAR	ATIVE CONSO	LIDATED INC	OME ACCOUN	T. YEARS EN	DED DEC. 11		
Salar & constaling second	(Taken from r	sporte to Secur	ities and Exch	ange Commissi	ion)	1844	1843
EAero. producu. parts & serv	\$227,085,032	\$207,956,523	\$208,263,495	\$120,262,916	\$484.310.503	\$7 13,527,684	\$733,590,668
Royaltics, etc., from licensees, net.	218,890	339.531	262.160	321,420	62,268	269.203	447,791
Total sales & operating revenues Cost of goods sold	227,303,923 165,025,698 26,408,299 6,927,940	208,296,054 153,546,184 22,908,736 5,908,274	208.525.655 160.931.475 14.383.223 7.278.348	120,584,336 107,568,870 8,903,605 4,138,821	484.572.771 114.799.721 19.719.651 6.337.846	743,796,886 634,699,271 20,984,360 8,384,205	734.078.140 \$5.578.931 16.963.245 6.847.095
Provision for douotful accounts		30.426	6,536,530	50,000	1.241.371	1.890.525	1,177,336
Depreciation and amortization	6,519,733	4,847,926	4.025,719				
time economy Prov. for inventory write-off					875.964	4.470,941 \$25,458	4.107.194
Net profit from operations	15,313,639	14.240.571	15,370,359	4 5,452,045	24,644,991	60,584,567	SE,TT0,083
Discount on purchases	382,083 952,927	402.833 706.386	293,404 617,103	1.576,244	699,602 844,285	1,445,445 539,478	\$111,009 648,382
Total Interest paid Loss on disposal of fixed assets Plant relevation expenses nat	16,648,649 84,354 41,185 935 148	15,349,790 144,500 100,719	16,380.864 463,242	4 3,903,354 953,189	26,188,878 70,292	62,569,491 124,947	80,329,446 864,919
Other miscellaneous deductions	25,800	34.316	45.147	6,872	44,545	8.845	7,141
Balance Federal income taxes DExcess profits taxes Income tax credits	15,562,033 5,468,851	13,991,298 4,567,581	15.872.475 6,056,150	£ 4,563,415 cr 10,624,16-	26.074.041 6.680.403 7.877.622 cr 1.339.764	62.435.659 6.644.713 40,228,611	6,624,026 8,624,026 96,937,243
Net income to eurplus. Earned surplus, beginning of year	\$10,093,182 67,304,518	\$9,423.718 84,438,527	\$9,816,295 59,287,433	\$6,060,750 33,565,894	\$12,855,280 27,318,341	\$15.562.336 \$1,020.433	\$15,396,114 16,594,751
Preferred dividends	1,294.325 5,313,402	1.294.325 5,313.402	1,294,325 3,320,876	23.611.818 1.294.325 2,656.701	1,294,323 5,313,402	1.294,325 7,970,103	1,300,330
Earned surplus, end of year	\$70,789,973	\$67,304.518	\$64,488,527	\$59,287,433	\$33.565.894	\$27.318,341	\$21,020.433
Maintenance & repairs	\$6,351,181	\$6,289,872	\$5,197,193	\$4,254,948	\$6,180,510 001,096	\$10,131,692	\$10,582,963 \$62,992
ETaxes, other than income Rents & royalties Parent company's net income Equity in carns, of subs, not cons	3,507,612 1,930,504 Not stated 163,377	2,750.287 1,154,300 Not stated 205.295	3,109,993 1,646,343 Not stated 208,979	3,064,824 1,381,170 Not stated	4.531.009 966,729 12.829.514 Not stated	8,162,842 1,077,458 15,525,369 Not stated	15.377.040
El fincluders related portion of itema under "Supplementary p. & 1. data" patter deducting 10% credit in 194 retrainent creait of \$4,354,354 in 1945 106.54 in 1915 and postwar related of 1. 1456 Federal income taxes of orio 2. 1456 Federal income taxes of orio	shown below 5. debt \$286,410 943. T years excess	5: Transfer of post-war cond in reserve for w 136; less additio and excess pro 20; balance, \$23 vision for writ expendable too	reserve for tri itions (less \$7.) ar and transiti nal premium (c fts taxes for pr .611,816. te-off of pryp and supply in-	anaforma- bona costa, crec or Federal form rior years, com exp ortion of rehi yearlories	on claims and et by \$1,923.67 iit and \$1,178.9 halion to post-v porlaing: Contr enses. \$2,252.10 abilitation exp	plant clearance 1 Federal tax 87 transferred war conditions r act termination ; plant rearran enses, \$330,793;	e contracts) carry-back from trans- catry; 1945, costs and gement and plant clear-

Figure A.2. Example of the 1950 Moody's Industrial Manuals: United Aircraft Corporation. This figure shows the 1950 volume of Moody's Industrial Manual to illustrate the data collection procedure. Panel A shows the typical first page of a company with its corporate history and management details. Panel B shows an excerpt of the accounting fundamentals for the years 1943 to 1949.



Figure A.3. Share of Total Defense Expenditures by Military Department: Army, Navy, Air Force, and Other Defense Agencies. This figure shows stacked monthly time series of Army expenditures over total expenditures, Air Force expenditures over total expenditures, and Other Agencies' expenditures over total expenditures.



Figure A.4. Event Study Plots: Monthly Dispersion in earnings-per-share forecasts for Military-Spending-Related vs. Non-Military-Spending-Related Companies. This figure shows the $\{\beta_{1,\tau}\}$ coefficients and 90% confidence bands estimated in Equation (2) for all possible EPS forecast horizons of equity analysts. Each row depicts a different forecast horizon in constructing the dispersion variable, $Disp(h)_{i,t}$. The dispersion is calculated as the standard deviation of earnings forecasts scaled by the absolute value of the mean earnings forecast. $Disp(h)_{i,t}$ is defined for each firm *i*, in month *t*, and EPS forecast horizon $h \in \{1, 2, 3 \text{ quarters}; 1, 2 \text{ years}\}$ ahead. The first two columns (in light gray) focus on conflicts during the era of U.S. military spending contraction after the end of the Cold War. The third and fourth columns (in dark blue) refer to conflicts in the era of military spending expansion following the 9/11 attacks in 2001.

Table A.1. Defense Spending Disaggregated by Military Department. Results for the expenditure ratio variables by military departments. OLS estimates with HAC standard errors (24 lags). Estimates are the sum of all 12 lags of a variable, and test statistics in parentheses refer to joint-significance *F*-tests. These specifications include monthly indicators and 12 lags of stock volatility, leverage, each branch's expenditures, industrial production, M1, CPI, and receipts-to-expenditures. Stock Volatility is multiplied by 100 for numerical precision. Significance levels: * *p* < 0.10, ** *p* < 0.05, *** *p* < 0.01.

	Stock Vol _t					
Lags ($p = 12$)	(2)	(1)	(3)			
Army & Air Force Expenditure Ratio	-0.232*** (31.19)					
Navy Expenditure Ratio		-0.195* (20.24)	-0.201*** (25.84)			
Army Expenditure Ratio		× ,	0.309*** (44.03)			
Air Force Expenditure Ratio			-0.489* (18.43)			
Other Defense Expenditure Ratio			-1.195 ^{**} (24.77)			
Month FE	Yes	Yes	Yes			
Macroeconomic Controls	Yes	Yes	Yes			
Sample Period	1918-2017	1918-2017	1918–2017			
Observations	1,176	1,176	1,176			
R-Squared	0.601	0.603	0.617			