Government Spending Shocks and Asset Prices *

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ABSTRACT

This paper explores asset pricing implications and macroeconomic dynamics of government spending shocks. I introduce a novel exogenous measure of government spending shocks using financial data. Although consumption and investment decrease in the long run, fiscal shocks cause contemporaneously low marginal utility states. I find that assets with high sensitivity to government spending shocks earn significantly higher expected returns, on average, compared to assets with low sensitivity to government spending shocks. I document that fiscal shocks disproportionately worsen value of growth opportunities relative to value of existing assets. I develop a dynamic stochastic general equilibrium model to explain these insights.

1 Introduction

There is substantial literature in macroeconomics that analyses the implications of government spending on the economy. However, literature remains divided on key issues. Difficulty in identifying an exogenous measure of unanticipated government spending shocks remains the primary challenge limiting the progress on this subject. The endogeneity and predictability eliminate the application of innovations in real government spending as a proxy for fiscal shocks. The recent financial crisis and the European debt crisis have ignited further debate on the effects of government purchases, and in particular, the implications of fiscal stimulus packages. However, there is a paucity of research that examines the effects of government spending shocks on asset returns. The focus of this paper is to fill this gap in the literature.

The goal of this paper is to analyze the implications of government spending shocks on asset prices and study their macroeconomic dynamics.[1] I introduce a novel exogenous measure of government spending shocks, which is available at high frequency, employing stock return data. The proposed measure is the portfolio long firms that contribute most of its final value to government consumption (hereafter, $GOVT$ firms) minus firms that contribute most of its final value to private consumption (hereafter, $PRIV$ firms), the returns to the GMP portfolio.[2] Positive shocks to the GMP portfolio returns coincide with major defence news events based on numerous news sources such as the Business Week and the New York Times and predict future real government spending. Portfolio sorting and cross sectional tests show that assets with high sensitivity to government spending shocks earn significantly higher expected returns,

[1]This article refers to news shocks to government spending as government spending shocks for convenience.

[2]The contribution to the government sector is both direct purchases by the government and indirect purchases through the chain of economic links across industries. For better accuracy, I condition the new measure on investment-specific technological change (see, for e.g., Papanikolaou (2011)) and tradable sector productivity change (see, for e.g., Dissanayake (2016)).

on average, compared to assets with low sensitivity to government spending shocks. I find that the annualized return for the long-short quintile portfolios sorted on the exposure to the government spending shock is approximately 6.7 percent. The positive risk premium is economically significant and is consistent with government spending shocks causing contemporaneously low marginal utility states. I also show that growth firms, firms that derive most their value from growth opportunities, have lower sensitivity to government spending shocks compared to value firms, firms that derive most of their value of assets in place, providing a justification for the value premium puzzle.[3] I formalize these insights using a two sector dynamic stochastic general equilibrium (DSGE) model subject to government spending shocks, in which consumption and asset prices are endogenously determined.

I provide evidence that a positive shock to the GMP portfolio returns increases future real per capita government spending. The response of investment and to a lesser degree in consumption are positive on impact but negative in the long run following a positive fiscal shock.[4] The sign of the risk premium is informative as to whether a positive government spending shock results in a contemporaneously high or low marginal utility state. I find a positive risk premium that consistent with government spending shocks causing contemporaneously low marginal utility states. The positive risk premium is robust to the inclusion of additional risk factors such as the Fama and French (1993) three factors and the Carhart (1997) four factors and across a variety of test assets. Assets with high exposure to the government spending shock are riskier to hold as such assets appreciate during low marginal utility states. Investors require compen-

[3]It is well known that value firms consistently deliver higher returns than growth firms (see, for e.g., Fama and French (1992)). The CAPM's failure to explain this phenomenon makes the value premium a puzzle.

[4]The increase in consumption is mostly driven by the durable goods portion of consumption. All forms of consumption decrease in the long run. The temporary increase in consumption disappears for the post 1980 sample.

sation for holding assets that co-move positively with the government spending shock in the form of lower prices, or equivalently, higher expected returns.

This paper relates the value premium, the cross sectional property in which value firms outperform growth firms, to the real economy in a detailed manner. Portfolio sorting analysis shows that growth firms have lower sensitivity to the government spending shock compared to value firms. Firms that derive most of their value from future growth opportunities are disproportionately worsen compared to firms that derive most of their value from assets in place following a positive government spending shock. Despite earning lower average returns, households are willing to hold growth firms since they have lower sensitivity to government spending shocks. In a rigorously controlled VAR framework, I show that the value premium significantly increases following a shock to government spending. The increase in the value premium is robust to the use of the GMP portfolio returns and the Ramey (2011a) defence news shocks as the measure of government spending shocks, and to the use of different time horizons.

Finally, I formalize the empirical insights in a two sector real business cycle model. The purpose of the model is twofold. Firstly, I show the mechanism in which government spending shocks affect the cross section of asset returns. The combination of correlated news shocks to government consumption and government investment and distortionary taxes generate a temporary low marginal wealth state following a positive government spending shock. The model generates a long term decrease in consumption observed in data, consistent with the neoclassical literature. Secondly, I show that the return spread between the $GOVT$ sector and the $PRIV$ sector perfectly captures news shocks to government spending, formalizing the novel measure.

In addition to the novel asset pricing insights, this paper contributes to the current fiscal stimulus debate, which has shifted much of the focus in macroeconomics back to the empirical estimates of government spending multipliers, the ratio of the change in output to the change in government spending. Ramey (2011*b*) surveys recent literature and finds that reasonable estimates of the government spending multipliers range from 0.8 to 1.5, although estimates could be as low as 0.5 or as high as 2.0. Using the GMP portfolio returns to approximate government spending shocks, I show that the estimated output multipliers is 0.85, evaluated after two years.[5]

The rest of the paper is organized as follows. In the next section, I review the related literature. Section 3 discusses data and introduces the new measure of government spending shocks. Section 4 discusses the methodology and macroeconomic dynamics. Section 5 quantifies the risk premium associated with the government spending shock. Section 6 introduces the two sector general equilibrium model with government spending shocks. The last section concludes.

2 Background and Related Literature

This paper contributes to the empirical literature that examines the effects of government spending on investment and asset returns. Using the proportion of each industry's total output that is purchased by the government sector as a measure, Belo, Gala and Li (2013) find significant industry variation in average returns conditional on the presidential partisan cycle. In contrast, by creating a time series aggregate measure, I show that the expected stock returns are linear in asset betas with respect to unanticipated government spending shocks. Using seasonally

[5] I estimate the government spending multiplier as the integral of output response divided by the integral of government spending response.

adjusted nondefense government gross investment as a measure, Belo and Yu (2013) find that government investment in the public sector forecast high risk premiums both at the aggregate and firm-level. I show that the novel measure introduced in this paper significantly forecasts real government gross investment.

This paper also contributes to the theoretical literature examining the association between government policies, economic activity, and asset prices. Croce, Kung, Nguyen and Schmid (2012) propose a production based model subject to government expenditure shocks that generate tax risk through the government's budget constraint. They find that tax distortions have negative effects on the cost of equity and investment. Gomes, Michaelides and Polkovnichenko (2013) consider an overlapping generations model with incomplete markets and heterogeneous agents, where government debt and capital are imperfect substitutes. The authors find that an increase in government debt increases the riskless rate and decreases the equity premium. Bretscher, Hsu, and Tamoni (2016) estimate a New-Keynesian model to explore the impact of level and volatility shocks to government spending on the term structure of interest rates and bond risk premia, whereas my model explores the implications of news shocks to government spending on equity returns using a two sector real business cycle (RBC) model. Pastor and Veronesi (2012) analyze the effects of political uncertainty and impact uncertainty on stock prices, in a theoretical setting, whereas this study focuses on the effects of exogenous government spending shocks on asset returns, with perfect information.[6]

This article contributes to the empirical fiscal policy literature, which remains divided on key issues. Several strands of literature assume that government spending is predetermined

[6] Pastor and Veronesi refer to political uncertainty as uncertainty about the change in current government policy and impact uncertainty as uncertainty regarding the impact of new government policy on the profitability of the private sector.

within the quarter (Rotemberg and Woodford 1992; Blanchard and Perotti 2002). Such literature finds that a positive government spending shock increases output, hours, real wages, productivity and consumption, consistent with the New Keynesian theory. Literature using Ramey and Shapiro (1998) "war dates" finds that a positive shock to government spending increases output and hours while decreasing real wages, consistent with the Neoclassical theory (Ramey and Shapiro 1998; Edelberg, Eichenbaum and Fisher 1999; Burnside, Eichenbaum, and Fisher 2004). Ramey (2011*a*) compares the predetermined VAR approach to the "war dates" narrative approach and finds that the key difference is in the timing of the shocks; the Ramey and Shapiro shocks Granger-cause the VAR shocks, which suggests that war dates narrative accounts for anticipation effects. Mountford and Uhlig (2009) use sign restrictions on a VAR system and find that an increase in government spending increases output and decreases real wages and investment, more in accordance with the Neoclassical theory than the New Keynesian theory. Fisher and Peters (2010) use innovations in average excess returns of the top defence contractors to proxy for government spending shocks. However, the measure suffers from using a limited number of stocks in the mimicking portfolio, which limits the diversification of firm level idiosyncratic risk unrelated to defence spending. In addition, the expected returns of the top defence contractors are exposed to other forms of macroeconomic risk unrelated to fiscal shocks such as investment-specific technological shocks and tradable sector productivity shocks. The novel measure proposed in this paper redress the concerns in the Fisher and Peters measure.

Finally, my paper contributes to the theoretical literature that examines the effects of government spending on economic activity. The real business cycle models predict that an increase in government spending increases labor hours and output and decreases real wages and consumption. (Aiyagari, Christiano, and Eichenbaum 1992; Baxter and King 1993). In contrast, the New Keynesian theory with either labor market rigidities or rule-of-thumb consumers suggests that government spending leads to an increase in consumption, labor hours, real wages and productivity. (Rotemberg and Woodford 1992; Devereux, Head and Lapham 1996; Gali, Lopez-Salido and Valles 2007). By i) introducing correlated news shocks to government consumption and government investment, and ii) incorporating distortionary taxes, I show that a positive government spending shock causes low marginal utility state in the short run but high marginal utility state in the long term.

3 Empirical Evidence

Firms that contribute most of their final output to the government sector appreciate in value following a government spending shock (Fisher and Peters (2010)). Military contractors such as Lockheed Martin Corporation and General Dynamics Corporation benefit from an exogenous increase in government spending relative to firms producing household consumption goods. Thus, I employ the return spread between the $GOVT$ sector and the $PRIV$ sector to approximate unanticipated shocks to government spending. I construct the novel measure using both macroeconomic and financial data.

3.1 Data

Firm Level Data The stock return data is from New York Stock Exchange (NYSE), American Stock Exchange (AMEX) and NASDAQ obtained from the Center for Research in Security Prices (CRSP) at the University of Chicago. The quarterly returns are computed using compounded monthly returns. Following Fama and French (1992), I exclude all financial firms from the sample given the unusually high leverage. In addition, excluding financial firms eliminates the possibility of capturing news related to bailouts in the financial sector.

The accounting data is from the COMPUSTAT database. I use screening to satisfy the standard requirements in finance literature. A firm must have a December fiscal-year end and at least two years of data to be included in the sample. The sample time period is from July 1963 to December 2014.

The market value of equity (ME) of a firm, the stock price times the number of shares outstanding, is computed using CRSP data each year at the end of June. Following Fama and French (1993), the book value of equity (BE) of a firm is computed as the COMPUSTAT book value of stockholder's equity plus balance sheet deferred taxes and investment tax credits minus the book value of preferred stock. Depending on the availability of data, redemption, liquidation, or par value is used to estimate the book value of preferred stock. The book-to-market equity (BE/ME) of a firm is the book equity for the fiscal year ending in calendar year $t-1$ divided by the market equity at the end of December of $t-1$. Negative and zero book values are treated as missing.

GMP returns I use two steps to calculate the novel measure of government spending shocks. Following Gomes, Kogan and Yogo (2009) and Papanikolaou (2011), I use the National Income and Product Accounts (NIPA) to classify industries based on the characteristic of their output; industries are categorized into $PRIV$ sector, industries producing goods mostly for private consumption, and $GOVT$ sector, industries producing goods mostly for government consumption.[7] The time series average of the number firms in the $PRIV$ sector and the

[7] I include both direct and indirect government expenditures as total government expenditures.

$GOVT$ sector are 1355.9 firms and 50.7 firms, respectively.[8] First, I construct an unconditional value-weighted portfolio long $GOVT$ firms minus $PRIV$ firms, the $UGMP$ portfolio returns.

The second step controls for investment specific technological shocks and tradable sector productivity shocks. Recent literature has shown that the IMC portfolio returns, portfolio long investment good producers minus consumption goods producers, capture investment specific technology shocks (Papanikolaou 2011; Kogan and Papanikolaou, 2014). Dissanayake (2016) shows that the TMN portfolio returns, returns to the portfolio long tradable minus non-tradable industries, approximate tradable sector productivity shocks. I control for both types of productivity shocks by estimating the residuals from the following time series regression,

$$r_t^{UGMP} = \alpha_t + \beta_{IMC}\, r_t^{IMC} + \beta_{TMN}\, r_t^{TMN} + \epsilon_t^{UGMP}, \tag{1}$$

where r_t^{IMC} is the IMC portfolio returns and r_t^{TMN} is the TMN portfolio returns. I use the estimated residuals $\widehat{\epsilon_t^{UGMP}}$ as the novel measure of government spending shocks, returns to the GMP portfolio.

Table 1 shows the portfolio composition of the two sectors of the economy. Although the $PRIV$ sector is significantly larger in comparison to the $GOVT$ sector, the $PRIV$ and $GOVT$ portfolios have similar fundamental characteristics; both portfolios have similar book-to-market equity ratios, market equity, debt-to-assets ratios, cashflows-to-assets ratios, investment-to-assets ratios and gross profitability.

The top two panels in Figure 1 present the GMP portfolio returns and Ramey (2011a) $defence\ news\ measure$, respectively. Many of the positive shocks to the GMP portfolio

[8]There are enough firms for both portfolios to diversify indiosyncratic effects. Well diversified portfolios mitigate firm level and industry level indiosyncratic effects.

returns coincides with the Business Week and the New York Times defence related articles compiled in Ramey (2013). For example, the positive shock to the GMP portfolio returns in 1974 coincides with the events surrounding the Arab–Israeli war and the consecutive positive returns from end of 2001 until the second quarter of 2002 coincide with the terrorist attacks and the subsequent increases in defence spending. The positive returns in late 2003 concur unexpected news regarding the high defence spending related to the Iraq war.

The third panel in Figure 1 compares the one quarter lagged GMP returns with the changes in real per capita government spending.[9] It is evident that the lagged GMP returns closely co-move with real changes in government spending. The one quarter lagged GMP portfolio returns have a correlation of 0.576 (p-value = 0.00) with the changes in per capita real government spending. In addition, I find that the GMP returns have a positive correlation of 0.135 (p-value = 0.06) with Ramey (2011*a*) defence spending shocks. The bottom panel in Figure 1 presents the GMP portfolio returns and NBER recessions. The dotted lines presents the beginning and end of each recession. This shows that business cycles have no effect on the novel measure of government spending shocks.

4 New Measure of Government Spending Shocks

In order to validate the new measure, I study its macroeconomic dynamics. Specifically, I estimate the following vector Autoregressions (VAR),

$$X_t = A(L)X_{t-1} + \epsilon_t, \tag{2}$$

[9]The real per capita government spending is normalized to mean zero and unit standard deviation for easy comparison.

where X_t is a vector of variables, $A(L)$ is a polynomial in the lag operator and ϵ_t is a vector with white-noise disturbances that may be correlated. Following Ramey (2011a), I include four lags of each variable, a quadratic time trend. I use quarterly data instead of annual data for greater accuracy. Macroeconomic variables are from the U.S. Bureau of Economic Analysis (BEA). Following Burnside, Eichenbaum, and Fisher (2004) and Ramey (2011a), I use a fixed set of variables and rotate additional variables of interest, one at a time. The fixed set of variables consists of returns to the GMP portfolio, log of real per capita government spending, log of real per capita GDP, three-month T-bill rate, log of per capita labor hours, the Barro and Redlick (2011) average marginal income tax rate and the Pastor and Stambaugh (2003) market liquidity measure.[10] The extra variables considered are the business wage, the log of real per capita non-residential and residential investment, the log of real per capita non-durable, durable and service consumption and the Ramey (2011a) $defence\ news\ measure$.

Figure 2 presents the orthogonalized impulse responses. The responses are normalized such that the maximum response of real government spending is equal to one. I include both 68 percent and 95 percent bootstrapped standard error bands.[11] Government spending peaks four quarters after the shock to the GMP portfolio returns. The increase in government spending becomes significant only after one quarter, evincing that the returns to the GMP portfolio capture news shocks, consisting of the anticipation effect. The $defence\ news\ measure$ contemporaneously increases following a positive shock to the GMP portfolio returns, further validating the novel measure. Output increases for five quarters following a shock to the GMP portfolio returns. Recent literature argues that government spending multipliers are better

[10]The average marginal tax rate is available until end of 2008, limiting the time series from 1963 to 2008 for the VAR analysis.

[11]Many fiscal policy papers have appealed to Sims and Zha (1999) for using 68 percent confidence bands.

estimated as the integral of the response in output divided by the integral of the response in government spending (see, for e.g., Mountford and Uhlig (2009), Uhlig (2010) and Fisher and Peters (2010)). Applying this measure, I find that the government spending multipliers are 1.266 and 0.847 evaluated after one year and two years, respectively. Both values are within the reasonable range of 0.8 to 1.5 suggested in Ramey (2011*b*) survey.

The labor hours significantly increase in the short run while the real wage decreases in the long run following a positive shock to government spending. The marginal tax rate increases, however, only at the 68 percent significance level. The increase in the t-bill rate suggests that part of the government spending may be finance through borrowing.[12] These findings are in accordance with the long term negative wealth effect shown in the neoclassical literature.

I find that consumption weakly increases contemporaneously before decreasing over time indicative of a negative wealth effect. The temporary increase in consumption is mainly through the short term increase in durable goods. All three types of consumption decrease in the long run at the 68 percent significance level, consistent with the long run negative wealth effect. Similarly, non-residential investment increases in the short run before significantly decreasing in the longer run. The contemporaneously increase in investment is indicative of government spending shocks causing a temporary low marginal wealth state.

To eliminate the unlikely possibility that the returns to the GMP portfolio captures TFP shocks in the $GOVT$ sector, I also explore the response of industry level TFP in defence sector industries using the VAR framework in (2).[13] At the 95 percent significance level, the response

[12] Issuing interest-bearing debt allows the government to spread the necessary increase in taxes over a longer period of time. Such an increase in interest rates can be viewed as an intertemporal substitution of resources towards times of high need as suggested by Hall (1980).

[13] The response functions are not reported in the paper. The results are available on request. I examine the TFP in the aircraft manufacturing industries, the aircraft engine and engine parts manufacturing industries, the other aircraft parts manufacturing industries, the guided missile and space vehicle manufacturing industries, the ammunition, arms, ordnance and accessories manufacturing industries, the ammunition and bombs

of TFP in defence industries is statistically not different from the steady state level. This suggests that the GMP portfolio returns capture only shock to government spending. I also find that the results are robust to the inclusion of TFP shocks in defence industries.

For robustness, I examine whether the GMP portfolio returns predict future government spending controlling for economic policy uncertainty (EPU). Results are reported in Appendix II. I find that the VAR results are robust to the inclusion of the Baker, Bloom and Davis (2016) index of EPU based on newspaper articles that contain references to economic uncertainty, which is available from 1985. Results are also robust to the inclusion of their EPU index based on historical archives of six newspapers, which dates back to 1900. I find that a positive shock to the GMP portfolio returns significantly reduces economic policy uncertainty on impact. This suggests that the GMP portfolio returns identify news shocks without uncertainty.

5 Asset Pricing Results

In this section, I examine the asset pricing implications of government spending shocks using portfolio sorting and cross sectional estimations.

5.1 Estimation of β^{gmp}

In order to measure firm level exposure to government spending shocks, I use stock return betas with respect to the GMP portfolio returns. Specifically, I estimate the following time series regression for each firm at each quarter using the previous 60 months of data,

$$r_i - r_{f,t} = \alpha_{i,t} + \beta_{i,t}^{mkt} r_t^{mkt} + \beta_{i,t}^{gmp} r_t^{gmp} + \epsilon_{i,t}, \tag{3}$$

manufacturing industries and the military armored vehicle, tank, and tank component manufacturing industries.

where $t = 1, \ldots, 60$, r_i is the monthly stock return for firm i, r^{mkt} is the excess market portfolio returns, and r^{gmp} is the GMP portfolio returns. I employ the β^{gmp} as a measure of firm exposure to government spending shocks. The regression controls for all other systematic risk by including the returns to the market portfolio.

5.2 Portfolio Sorting

I sort firms in to 5 portfolios (quintiles) by their β^{gmp}, which measures the sensitivity to the government spending shock. I exclude $GOVT$ firms and export firms from the analysis. I also restrict the analysis to firms with ordinary common equity. In June of year t, all NYSE, AMEX and NASDAQ stocks are ranked by their β^{gmp} and then allocated to the GMP portfolio quintile.

Table 2 reports the quarterly excess returns and portfolio characteristics of the GMP portfolio quintiles. The average firm level β^{gmp} range from -0.611 to 0.759, capturing a sizable variation in the sensitivity to government spending shocks.[14] The excess returns increase monotonically as the sensitivity to government spending shocks increases. The quarterly value-weighted and equal-weighted return difference between the highest (portfolio with highest sensitivity to government spending shocks) and the lowest quintile (portfolio with lowest sensitivity to government spending shocks) is 1.67 percent and 1.31 percent, respectively. Both the value-weighted and the equal-weighted return spreads are statistically significant at the 5 percent level.

The Capital Asset Pricing Model (CAPM) predicts that stocks with higher exposure to systematic risk, captured by β^{MKT}, have higher expected returns. The results show that the portfolios display a U-shaped pattern with respect to β^{MKT}, which is inconsistent with the

[14] Small variation in betas leads to erroneous factor premia.

predictions of the CAPM. Thus, the CAPM fails to price portfolios sorted by the sensitivity to government spending shocks.

The results show a positive association between the BE/ME ratio and β^{gmp}; the average firm level BE/ME ratio increases monotonically as the portfolio exposure to government spending shocks increases. It is evident that value firms have higher exposure to the government spending shock than growth firms. The returns of growth firms disproportionately worsen compared to value firms as government spending shocks increase future tax liabilities.

I further explore this association by examining the response of the HML factor, the difference between the returns on diversified portfolios of high and low BE/ME stocks, introduced in Fama and French (1993). Figure 3 presents the response of the HML portfolio returns following a positive government spending shock approximated by the GMP returns and the $defence$ *news measure*, using the VAR system in (2). In both cases, the HML portfolio returns significantly increase in response to the positive government spending shock. Value firms appreciate more than growth firms following a positive government spending shock, making them riskier to hold. Despite the lower expected returns, investors are willing to hold growth firms given the lower sensitivity to fiscal shocks.

Figure 4 summarizes the portfolio sorting results; it presents the average returns of portfolios sorted on β^{gmp}, BE/ME ratio and investment along with their sensitivities to excess market returns and their sensitivities to government spending shocks. The first column shows a clear positive association between the β^{gmp} and the average returns for portfolios sorted on β^{gmp}, portfolios sorted on BE/ME ratio, and, to a lesser extent, portfolios sorted on investment. However, as shown in the second column, I do not find a positive association between the β^{MKT} and the average returns in any of the portfolio sorts. The results provide evidence that the sensitivity to government spending shocks better explains portfolio returns than the sensitivity to the excess market returns.

5.3 Cross Sectional Tests

The first set of cross sectional tests include Fama and Macbeth (1973) two-pass regressions using 25 portfolios sorted on β^{gmp} and profitability. The standard errors are corrected using the procedure proposed in Shanken (1992). Table 3 presents the quarterly estimated premia from the second pass regressions. The first and second columns show that the traditional CAPM and the consumption-CAPM fail to price the portfolios sorted on β^{gmp} and profitability. The specifications (III) and (IV) include the GMP portfolio returns in addition to the excess market returns and the growth rate of per capita consumption, respectively. The risk premium associated with the government spending shock is positive and significant in both specifications. I find that the risk premium associated with government spending shocks remains positive and significant controlling for investment specific technological shocks, as shown in specification (V). Specifications (VI) and (VII) control for the commonly used Fama and French (1993) three factors and Carhart (1997) four factors, respectively. The final specification controls for the Pastor and Stambaugh (2003) market liquidity measure in addition to the Fama and French three factors. In all specifications, the risk premium on the GMP portfolio returns remains positive and statistically significant.

The next set of tests employs the one-step Generalized Method of Moments (GMM) procedure as described in Cochrane $(2005, pp.241-243)$. Here, the moment conditions simultaneously include the time-series orthogonality conditions and the cross-sectional orthogonality conditions.[15] Table 4 reports the risk premia using the identity weighting matrix. I also report the mean absolute pricing errors (MAPE), the J-test of the overidentifying restrictions of the model and corresponding p-values. The standard errors are adjusted using Newey West (1978) corrections using 4 lags. For robustness, I use the more conventional 25 portfolios sorted on size and book-to-market equity.[16] Also, for additional validity, I use the Ramey (2011a) $defence\ news\ measure$, $Defence$, to approximate government spending shocks. I apply the innovations in utilization-adjusted Total Factor Productivity, TFP, to control market wide productivity shocks.[17]

The first three specifications show that the risk premium for the GMP returns is positive and significant for the time period 1963 to 2014. The next three specifications show that the risk premium for the $defence\ news\ measure$ is positive and significant for the time period 1939 to 2014. The positive and significant risk premium in all of the cross sectional tests provide further evidence that government spending shocks results in contemporaneously low marginal utility states.

6 General Equilibrium Model

In the empirical section, I established two key facts. Firstly, the return spread between the $GOVT$ sector minus the $PRIV$ sector approximates government spending shocks. Secondly, unanticipated fiscal spending shocks lead to contemporaneously low marginal utility states. In this section, I develop a two sector DSGE model to organize the key empirical findings. I extend the Baxter and King (1993) neoclassical model by introducing an additional private sector

[15] The time-series orthogonality conditions are estimated without an intercept.
[16] The 25 portfolios sorted on size and book-to-market equity are from Kenneth French's web site.
[17] The utilization adjusted TFP is from the Federal Reserve Bank of San Francisco (John G. Fernald 2012).

that benefits from government spending. In addition, I employ Jaimovich and Rebelo (2009) preferences that help limit the wealth effect on labor supply in the standard King, Plosser and Rebelo (1988) preferences. The aforementioned extensions generate the consumption dynamics observed in data. Finally, I extend the neoclassical model by introducing asset prices.

6.1 Households

The model economy is populated by identical agents who maximize their lifetime utility, U, defined over sequences of consumption, C_t, and hours worked, N_t. I employ Jaimovich and Rebelo (2009) preferences which nest both King, Plosser and Rebelo (1988) preferences ($\gamma = 1$) and Greenwood, Hercowitz and Huffman (1988) preferences ($\gamma = 0$) where the wealth effect on labor supply is scaled using lower values of γ. The extreme case in which $\gamma = 0$ completely shuts off the wealth effect on labor supply. Agents internalize the dynamics of X_t in their maximization problem. The use of X_t makes preferences non time separable in consumption and hours worked. The preferences are expressed as

$$U = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{\left(C_t - hC_{t-1} - \psi N_t^{\theta} X_t\right)^{1-\sigma} - 1}{1-\sigma}, \tag{4}$$

where

$$X_t = \left(C_t - hC_{t-1}\right)^{\gamma} X_{t-1}^{1-\gamma}, \tag{5}$$

and $\mathbb{E}_0$ denotes the expectation operator conditional on information at time zero, the parameter $\beta \in (0,1)$ denotes the subjective discount factor, $\theta > 1$ determines the Frisch elasticity of labor supply, $\psi > 1$, and $\sigma > 0$. Literature has shown that habit formation models are successful at explaining both asset pricing and macroeconomic phenomena observed in data (for e.g., see

Constantinides 1990; Campbell and Cochrane 1999, Abel 1990; Boldrin, Christiano, and Fisher 2001; Schmitt-Grohe and Uribe 2012). I extend the Jaimovich and Rebelo (2009) framework by including habit persistence in which the parameter $h \in [0, 1)$ governs the degree of internal habit formation. The economy wide resource constraint is given by

$$Y_t = \underbrace{C_t}_{\text{consumption}} + \underbrace{\frac{I_{1,t}}{Z_t} + \frac{I_{2,t}}{Z_t}}_{\text{private investment}} + \underbrace{I_{G,t} + C_{G,t}}_{\text{government spending}}, \quad (6)$$

where I_1 and I_2 are the investment in sector 1 and sector 2 of the economy, Z denotes the current state of technology for producing capital goods, I_G and C_G are government investment and government consumption, respectively. The investment specific technology evolves according to

$$\ln(Z)_{t+1} = \rho^Z \ \ln(Z)_t + \sigma_{\epsilon^Z} \ \epsilon^Z_{t+1}, \quad (7)$$

where $\sigma_{\epsilon^Z} \ \epsilon^Z_t$ is an i.i.d. process with standard deviation σ_{ϵ^Z} and $\rho^Z < 1$ such that the process $\ln(Z)$ is stationary.

6.2 Firms and Technology

The production of goods and services takes place in two separate sectors. $PRIV$ sector produces goods and services mostly for household consumption and $GOVT$ sector produces goods and services mostly for government consumption. Both sectors of the economy are populated by private sector firms. For simplicity, government owned public firms are excluded from the model. Lockheed Martin Corporation and General Dynamics Corporation, both traded in the New York Stock Exchange, are examples of private sector firms that contribute most their final value to the government sector. Wal-Mart Stores, traded in the New York Stock Exchange, is an example of a private sector firm that contributes most its final value to the private sector.

6.2.1 $PRIV$ sector

The $PRIV$ sector firms produce output Y_1 according to the following Cobb-Douglas production function,

$$Y_{1,t} = A_{1,t} N_{1,t}^{\alpha_1} K_{1,t}^{\alpha_{k1}}, \tag{8}$$

where A_1 is the total factor productivity (TFP) in the $PRIV$ sector, K_1 is the capital in the $PRIV$ sector and N_1 is the labor supply in the $PRIV$ sector. I assume that $0 < \alpha_1, \alpha_{k1} < 1$ and $\alpha_1 + \alpha_{k1} = 1$.

The after tax dividend stream for the $PRIV$ sector is

$$\Pi_{1,t} = (1 - \tau_t)\, A_{1,t} N_{1,t}^{\alpha_1} K_{1,t}^{1-\alpha_1} - w_t N_{1,t} - \frac{I_{1,t}}{Z_t}, \tag{9}$$

where w_t is the competitive wage in the economy.[18]

6.2.2 $GOVT$ sector

The $GOVT$ sector, also populated by private firms, benefits from an increase government spending. Government influences the efficiency and the profitability of the defence industries by setting profit levels on government contracts. Government supports the defence sector through preferential purchasing and through direct subsidy payments. In addition, government invests in infrastructure and research and development activities of corporations, finances the training

[18]Firms are all-equity financed in both sectors of the economy.

and development of employees and provide credit guarantees. To capture such contributions by the government, I include public capital in the production of the *GOVT* sector.[19] The *GOVT* sector produces output Y_2 according to the following Cobb-Douglas production function,

$$Y_{2,t} = A_{2,t} N_{2,t}^{\alpha_2} K_{2,t}^{\alpha_{k2}} K_{G,t}^{\alpha_{g2}}, \tag{10}$$

where A_2 is the TFP in *GOVT* sector, K_2 is the capital in *GOVT* sector, N_2 is the labor in *GOVT* sector and K_G is the publicly provided capital stock. I assume that $0 < \alpha_2, \alpha_{k2}, \alpha_g < 1$ and $\alpha_2 + \alpha_k + \alpha_g = 1$.[20]

The after tax dividend stream for the *GOVT* sector is

$$\Pi_{2,t} = (1 - \tau_t)\, A_{2,t} N_{2,t}^{\alpha_2} K_{2,t}^{\alpha_k} K_{G,t}^{\alpha_{g2}} - w_t N_{2,t} - \frac{I_{2,t}}{Z_t}. \tag{11}$$

The TFP shock in each sector evolves according to the following AR(1) specification,

$$\ln(A_i)_{t+1} = \rho_A^i \ \ln(A_i)_t + \sigma_{\epsilon^{A_i}} \ \epsilon_{t+1}^{A_i}, \tag{12}$$

where $\rho_A^i < 1$ such that the process $\ln(A_i)$ is stationary and $\sigma_{\epsilon^{A_i}} \ \epsilon_t^{A_i}$ is an i.i.d. process with standard deviation $\sigma_{\epsilon^{A_i}}$ for sector $i = 1, 2$.

Investment is subject to Christiano, Eichenbaum and Evans (2005) capital adjustment costs in both sectors of the economy. Adjustment costs to investment provide firms with an incentive to respond immediately to changes in Tobin's marginal q. The capital accumulation in each

[19]Literature has used public capital in production. Some examples include Aschauer (1989), Baxter and King (1993), Nadiri and Mamuneas (1994), and Leeper, Walker, and Yang (2010).

[20]This form of production is consistent with Jaimovich and Rebelo (2009) notation $Y_t = A_t K_t^{\alpha_1} N_t^{\alpha_2} T^{1-\alpha_1-\alpha_2}$,where $\alpha_1 + \alpha_2 < 1$ and T is a firm specific production factor. Note that the firm has constant returns to all factors but decreasing returns to labor and capital.

sector is

$$K_{i,t+1} = I_{i,t}\left[1 - \frac{\phi_i}{2}\left(\frac{I_{i,t}}{I_{i,t-1}} - 1\right)^2\right] + (1-\delta_i)\,K_{i,t}, \tag{13}$$

where $\phi_i > 0$ for sector $i = 1, 2$.

6.2.3 Public Finance Rules

The public investment is exogenously determined and is stochastic over time.[21] The public capital stock evolves according to

$$K_{G,t+1} = I_{G,t} + (1 - \upsilon\delta)\,K_{G,t}, \tag{14}$$

where $\phi_G > 0$, I_G is government investment, υ is a multiplier and δ is capital depreciation rate. The news regarding government investment is known by the households before the actual increase and evolves according to the following specification,

$$\ln(I_G)_{t+2} = \rho_1^{gi}\ln(I_G)_{t+1} + \rho_2^{gi}\ln(I_G)_t + \rho_3^{gi}\ln(I_G)_{t-1} + \sigma_{\epsilon^{gi}}\ \epsilon_t^{gi}, \tag{15}$$

where $\rho_1^{gi} + \rho_2^{gi} + \rho_3^{gi} < 1$ such that the process $\ln(I_G)$ is stationary and $\sigma_{\epsilon^{gi}}\ \epsilon_t^{gi}$ is an i.i.d. process with standard deviation $\sigma_{\epsilon^{gi}}$.[22] Government consumption is exogenous and is stochastic over time. The news shocks regarding government consumption, gc, evolves according to the

[21] Public capital stock includes publicly provided telecommunications, electricity, roads, railways, ports, airports, public research and development, conservation structures, development structures, military structures etc.

[22] Agents receive information at time $t-1$ regarding the innovation in I_G at time t. Households recieve a signal $S_t = \epsilon_{t+1}^{gi} + \nu_t$, where ν_t is the noise in signal. For simplicity, I do not model noise and interchange $S_t = \epsilon_t$ (see Beaudry and Portier (2014) for a detailed analysis of news shocks).

following specification,

$$\ln(C_G)_{t+2} = \rho_1^{gc} \ln(C_G)_{t+1} + \rho_2^{gc} \ln(C_G)_t + \rho_3^{gc} \ln(C_G)_{t-1} + \sigma_{\epsilon^{C_G}} \ \epsilon_t^{gc}, \tag{16}$$

where $\rho_1^{gc}+\rho_2^{gc}+\rho_3^{gc} < 1$ such that the process $\ln(gc)$ is stationary and $\sigma_{\epsilon^{gc}} \ \epsilon_t^{gc}$ is an i.i.d. process with standard deviation $\sigma_{\epsilon^{C_G}}$. The term ϵ_t^{gc} captures the unanticipated news regarding government consumption in the economy. Empirical data shows a strong positive correlation between government consumption and government investment. During military buildups, government increases both investment and consumption spending; government engages in programs that build roads and airports for military and non-military purposes and increases the purchase of military equipment from the private sector. In order to isolate each effect, I introduce correlated government spending shocks.[23] I assume that $\mathbb{E}_t\left[\epsilon_t^{gi}\right] = 0$, $\mathbb{E}_t\left[\epsilon_t^{gc}\right] = 0$ and that the contemporaneous variance-covariance matrix of the innovations ϵ_t^{gi} and ϵ_t^{gc} is

$$\begin{pmatrix} \sigma^2_{\epsilon^{gi}} & \rho_{gi,gc}\sigma_{\epsilon^{gi}}\sigma_{\epsilon^{gc}} \\ \rho_{gi,gc}\sigma_{\epsilon^{gi}}\sigma_{\epsilon^{gc}} & \sigma^2_{\epsilon^{gc}} \end{pmatrix}, \tag{17}$$

where $corr\left(\epsilon_t^{gi}, \epsilon_s^{gc}\right) = 0$, $corr\left(\epsilon_t^{gi}, \epsilon_s^{gi}\right) = 0$ and $corr\left(\epsilon_t^{gc}, \epsilon_s^{gc}\right) = 0$ for all $t \neq s$. Following Sims (1980) , I estimate the triangular matrix to create uncorrelated innovations. The transformed orthogonalized shocks to government investment and government consumption are ν_t^{gi} and ν_t^{gc}, respectively, where $\nu_t = Q\epsilon_t$.

[23] To find the model solution, I use a Cholesky decomposition to orthogonalize the correlated shocks.

I model the flow of government budget constraint as

$$C_{G,t} + I_{G,t} = \tau_t \left(Y_{1,t} + Y_{2,t} \right), \tag{18}$$

where τ is the distortionary income tax rate.

6.2.4 Competitive Equilibrium

The model features five sources of uncertainty: the total factor productivity shocks in each sector, investment-specific technological shocks, shocks to government consumption and government investment. To close the model, aggregate output, capital, investment and labor are defined as

$$Y_t = Y_{1,t} + Y_{2,t}, \;\; K_t = K_{1,t} + K_{2,t}, \; I_t = I_{1,t} + I_{2,t}, \;\; N_t = N_{1,t} + N_{2,t}. \tag{19}$$

In this framework, Y_2 enters the household budget constraint to ensure that $GOVT$ sector production is valued by the households. The first order conditions (FOCs) for the economy are defined in the Appendix. I derive the agent's one-period-ahead stochastic discount factor (SDF) from the household inter-temporal Euler equation,

$$M_{t+1} = \beta \frac{\left(V_t^h\right)^{-\sigma} + \mu_{t+1}\gamma \left(\frac{X_t^{1-\gamma}}{C_{t+1}-hC_t}\right)^{1-\gamma} - \beta h \mathbb{E}_{t+1}\left[\left(V_{t+1}^h\right)^{-\sigma} - \mu_{t+2}\gamma\left(\frac{X_{t+1}^{1-\gamma}}{C_{t+2}-hC_{t+1}}\right)^{1-\gamma}\right]}{\left(V_{t-1}^h\right)^{-\sigma} + \mu_t\gamma\left(\frac{X_{t-1}^{1-\gamma}}{C_t-hC_{t-1}}\right)^{1-\gamma} - \beta h \mathbb{E}_t\left[\left(V_t^h\right)^{-\sigma} - \mu_{t+1}\gamma\left(\frac{X_t^{1-\gamma}}{C_{t+1}-hC_t}\right)^{1-\gamma}\right]}, \tag{20}$$

where $V_t^h = C_{t+1} - hC_t - \psi N_{t+1}^{\theta} X_{t+1}$, μ_t is the Lagrange multiplier associated with (5). The risk free rate is $\frac{1}{R_{f,t}} = \mathbb{E}_t \left[M_{t+1}\right]$.

The $PRIV$ and $GOVT$ sectors hire wages at the competitive rate w_t. The wage rate in the economy is

$$w_t = (1-\tau_t)\,\alpha_1 A_{1,t} N_{1,t}^{\alpha_1} K_{1,t}^{\alpha_{k1}} = (1-\tau_t)\,\alpha_2 A_{2,t} N_{2,t}^{\alpha_2} K_{2,t}^{\alpha_{k2}} K_{G,t}^{\alpha_g}.^{24} \tag{21}$$

6.3 Asset Prices

In this section, I detail the mechanism through which government spending shocks affect the equilibrium asset returns.

6.3.1 Sectoral stock returns

For each firm in sector i, the value of the firm is the discounted present value of its cashflows, which is,

$$V_{i,t} = \mathbb{E}_t\left[\sum_{j=0}^{\infty} M_{t+j}\Pi_{i,t+j}\right], \tag{22}$$

subject to (9) and (11). In each period, $PRIV$ and $GOVT$ sector firms choose K and N to maximize their firm value. The gross return on a claim to the cash flows is

$$R_{i,t+1} = \frac{V_{i,t+1} + \Pi_{i,t+1}}{V_{i,t}}. \tag{23}$$

6.3.2 The Cross Section of Firm Risk Premia

Assume that the projection of the log SDF, $m_{t+1} = \ln(M_{t+1})$, the log of the process in equation (20), spanned by the exogenous shocks in the model is

$$m_{t+1} = \mathbb{E}_t[m_{t+1}] - \Omega_{t+1}^{A_1}\frac{\epsilon_{t+1}^{A_1}}{\sigma^{A_1}} - \Omega_{t+1}^{A_2}\frac{\epsilon_{t+1}^{A_2}}{\sigma^{A_2}} - \Omega_{t+1}^{Z}\frac{\epsilon_{t+1}^{Z}}{\sigma^{Z}} - \Omega_{t+1}^{gc}\frac{\nu_{t+1}^{gc}}{\sigma^{gc}} - \Omega_{t+1}^{gi}\frac{\nu_{t+1}^{gi}}{\sigma^{gi}}, \tag{24}$$

[24] In equilibrium, the marginal product of labor in both sectors are equal, thus $w_{1,t} = w_{2,t} = w_t$.

where $\epsilon_t^{A_1}$, $\epsilon_t^{A_2}, \epsilon_t^Z$, ν_t^{gc} and ν_t^{gi} are shocks that are orthogonal to each other. The quantities $\Omega_{t+1}^{A_1}$, $\Omega_{t+1}^{A_2}$, Ω_{t+1}^{Z}, Ω_{t+1}^{gc} and Ω_{t+1}^{gi} are the market price of risk (the risk premium per unit volatility, i.e. the Sharpe ratio) for the TFP shock $A_{1,t}$, the TFP shock $A_{2,t}$, the IST shock Z_t, the government consumption shock gc_t, and the government spending shock I_{Gt}, respectively. In order to to verify that $\Omega_{t+1}^{A_1}$, $\Omega_{t+1}^{A_2}$, Ω_{t+1}^{Z}, Ω_{t+1}^{gc} and Ω_{t+1}^{gi} are the true market price of risk for each shock, consider a projection of log return of some asset j in the $PRIV$ sector, $r_{j,t+1}^1$, on the space spanned by the exogenous shocks,

$$r_{j,t+1}^1 = \mathbb{E}_t\left[r_{j,t+1}^i\right] \quad + \ \beta_{j,t+1}^{A_1}\epsilon_{t+1}^{A_1} \ + \ \beta_{j,t+1}^{A_2}\epsilon_{t+1}^{A_2} + \ \beta_{j,t+1}^{Z}\epsilon_{t+1}^{Z} + \ \beta_{j,t+1}^{gc}\nu_{t+1}^{gc} + \ \beta_{j,t+1}^{gi}\nu_{t+1}^{gi}, \tag{25}$$

where $\beta_{j,t+1}^{A_1}$, $\beta_{j,t+1}^{A_2}$, $\beta_{j,t+1}^{Z}$, $\beta_{j,t+1}^{gc}$ and $\beta_{j,t+1}^{gi}$ are factor loadings of the TFP shock in the $PRIV$ sector, the TFP shock in the $GOVT$ sector, the shock to government consumption and the shock to government investment, respectively. Specifically, I define the exposures as

$$\beta_{j,t+1}^{i} = \frac{cov\left(\epsilon_{t+1}^i, r_{j,t+1}^1\right)}{\left(\sigma^i\right)^2}, \tag{26}$$

for $i = A_1$, A_2, Z, gc, and I_G. The excess returns for asset j can be expressed as

$$\begin{aligned}\mathbb{E}_t\left[r_{j,t+1}^1 - r_{f,t+1}\right] + \frac{\sigma_j^2}{2} \quad &= \quad -\sigma_{j,m} = \beta_{j,t+1}^{A_1}\sigma^{A_1}\Omega_{t+1}^{A_1} + \beta_{j,t+1}^{A_2}\sigma^{A_2}\Omega_{t+1}^{A_2} + \beta_{j,t+1}^{Z}\sigma^{Z}\Omega_{t+1}^{Z} \\ &+ \underbrace{\beta_{j,t+1}^{gc}\sigma^{gc}\Omega_{t+1}^{gc} + \beta_{j,t+1}^{gi}\sigma^{gi}\Omega_{t+1}^{gi}}_{\text{risk premium for government spending shock}} \quad ,\end{aligned} \tag{27}$$

where σ_j^2 denotes the unconditional variance of log return innovations and $\frac{\sigma_j^2}{2}$ is the Jensen's Inequality adjustment term arising from the use of expectations of log returns.[25] If asset j is

[25]The log excess return in (27) is the log counterpart of the standard asset pricing equation, $\mathbb{E}_t\left[R_{j,t+1}^1\right] -$

perfectly correlated with the government consumption shock, the factor loadings are $\beta^{A_1}_{j,t+1} = 0$, $\beta^{A_2}_{j,t+1} = 0$, $\beta^{Z}_{j,t+1} = 0$, $\beta^{gc}_{j,t+1} = \frac{\sigma_j}{\sigma^{gc}}$ and $\beta^{gi}_{j,t+1} = 0$. Then, the Sharpe ratio for the government consumption shock is

$$\frac{\mathbb{E}_t\left[r^1_{j,t+1} - r_{f,t+1}\right] + \frac{\sigma_j^2}{2}}{\sigma_j} = \frac{\beta^{gc}_{j,t+1}\sigma^{gc}\Omega^{gc}_{t+1}}{\beta^{gc}_{j,t+1}\sigma^{gc}} = \Omega^{gc}_{t+1}, \tag{28}$$

which verifies that Ω^{gc}_{t+1} in equation (24) is the true market price of risk. Similar derivation shows that $\Omega^{A_1}_{t+1}$, $\Omega^{A_2}_{t+1}$, Ω^{Z}_{t+1} and Ω^{gi}_{t+1} are the true market price of risk for each of the shocks. The price of risk for the government spending shock is

$$\Omega^{g}_{t+1} = -\sigma^{g}\frac{\partial m_{t+1}}{\partial \nu^{g}_{t+1}}. \tag{29}$$

The equation (29) shows that the market price of risk depends on the contemporaneous change in the SDF with respect to a change in the spending shock. The price of risk is positive (negative) if a positive government spending shock causes a contemporaneous decrease (increase) in the SDF.

6.4 Calibration

I solve the model using second order approximations around the steady state. I calibrate the model using parameters that generates macroeconomic and asset return moments which reasonably match empirical moments.

$R_{f,t+1} = -R_{f,t+1}Cov\left(R^1_{j,t+1}, M_{t,t+1}\right).$

6.4.1 Parameter Choice

Table 5 summarizes the parameters used to calibrate the benchmark model at a quarterly frequency. The parameter values are taken from previous literature where possible. Following Papanikolaou (2011), I set the relative risk aversion parameter, σ, to equal 1.1. The recent macroeconomic literature has employed a range of values for θ from 1.4 (Jaimovich and Rebelo (2009)) to 4.7 (Schmitt-Grohe and Uribe (2012)). I use the value $\theta = 2.4$ which helps generate the most realistic response in consumption, consistent with the empirical findings. The habit formation parameter is set to $h = 0.32$ such that equity premium volatility approximates the empirical counterpart.

Following Jaimovich and Rebelo (2009), I set the investment adjustment cost parameter, ϕ, to equal 1.3. Following Baxter and King (1993) , I set the quarterly capital depreciation rate to the standard $\delta = 2.5$ percent. I use the value $\upsilon = 5/3$ to better capture forced structure changes, military capital modernizations, and higher R&D depreciation rates. In addition, I use the parameter υ to set the $GOVT$ sector approximate 1/4 of the size of the economy. I choose $\gamma = 0.8$ to generate a high wealth effect on labor supply. The results are robust to the use of $\gamma = 1$, the King, Plosser and Rebelo (1988) preferences.

I choose $\beta = .99$ such that the first moment of the steady state risk free rate approximates the of the long sample risk free rate in Campbell and Cochrane (1999). On the production side, following Baxter and King (1993), I set the labor share in the $PRIV$ sector, α_1, to equal 0.64, and the capital share to equal 0.36. I assume that the private capital share in both sectors are equal and choose $\alpha_k = (1 - \alpha_1) = 0.36$. Literature has diverse views on the productivity of private investment. The reasonable range of parameter values range from 0.1 (see, for e.g., Baxter and King (1993) and Leeper, Walker, and Yang (2010)) to 0.24 (see, for e.g., Aschauer (1989); Nadiri and Mamuneas (1994)). For simplicity, I set the parameter value of publicly provided capital share to $\alpha_g = 0.15$, which is within the reasonable range.

The volatility of shocks are chosen to match their empirical counterparts in data. The volatilities $\sigma_{\epsilon^{gi}}$ and $\sigma_{\epsilon^{gc}}$ are chosen to match the time series volatility in defence investment and consumption. Following Belo and Yu (2013), I set volatility of the TFP shocks, $\sigma_{\epsilon^{A_i}}$, to 0.86%. For the benchmark calibration, I choose a conservative value of $\sigma_{\epsilon^{Z}} = 1.0\%$ for the volatility of the IST shock.

The firms featured in the model are all equity financed, whereas private firms in the U.S. are financed approximately by 40 percent debt and 60 percent equity. Following Boldrin, Christiano and Fisher (2001) and Papanikolaou (2011), I multiply stock returns and their standard deviations by a factor equal to 5/3 to better match the moments in data.

6.5 Model Implications

Table 6 reports the model implied and the empirical moments of the macroeconomic variables. I remove the cyclical component of the empirical time data using the Hodrick–Prescott decomposition. The first two columns report the standard deviations of the change in consumption, investment, labor hours and output for the post World War II time period 1947 to 2014 and the post Compustat time period 1963 to 2014. Columns 3 to 6 report the empirical time series correlation coefficients. The model successfully generates low volatility in the change in labor hours (0.56 percent vs. 1.46 percent) and reasonably low volatility in consumption (1.80 percent vs. 1.21 percent). The higher volatility in the change in investment is consistent with the empirical moments (4.69 percent vs. 5.86 percent). The model also generates correlations between the macroeconomic variables similar to that of the correlations in data. However, the model underestimates the comovement between consumption and labor hours. This is a result of preferences being close to King, Plosser and Rebelo (1988) preferences in which high wealth effect limits the response in labor supply following a shock to the TFP in the $PRIV$ sector.

Table 7 presents the empirical and model simulated moments for asset returns. Column 1 reports the empirical moments for the period 1963 to 2014 time period and column 2 reports the simulated moments from the benchmark model calibration.[26] I calculate the market risk premium in the model as the sum of the value-weighted risk premium for the $PRIV$ sector and the $GOVT$ sector. The model overshoots in terms of the first moment of the risk free rate (2.9 percent vs. 4.1 percent) and the volatility of the risk free rate (4.96 percent), higher than the long term average risk free rate volatility of 3.0 percent reported in Campbell and Cochrane (1999). The model is able to generate an annual equity premium of 2.76 percent with low volatility in consumption and low risk aversion. As a result of high investment adjustment costs and internal habit formation in preferences, my model generates a sizable volatility in equity premium similar to the moments is observed in data (16.2 percent vs. 18.1 percent).

6.6 Model Solution

Figure 5 presents the impulse response functions from the simulated model. The responses are normalized such that the maximum response of government spending is equal to one. The actual increase in government spending takes place two periods after the news shock. Thus the model captures the anticipation effect seen in the empirical data. Output and investment increase in the $GOVT$ sector and decrease in the $PRIV$ sector following a positive government

[26] The risk premium and volatility of the market portfolio is 8.397% and 20.68% for the longer time period from 1927 to 2014.

spending shock.

6.6.1 Stochastic Discount Factor

The correlated news shocks to government consumption and investment generates a temporary increase in consumption. This differentiates my model from the basic neoclassical framework. Consumption contemporaneously increases as a result of the temporary increase in wealth resulting from the appreciation in the $GOVT$ sector and the use of distortionary taxes.[27] The economy reallocates resources from $PRIV$ sector investment to the more productive $GOVT$ sector investment upon a government spending shock.[28] In the long run, households decrease consumption as a result of the negative wealth effect.

The dynamic effects on consumption and labor bundle are reflected in the agent's stochastic discount factor. Figure 5 shows that the SDF contemporaneously decreases upon a government spending shock. As shown in (29), the contemporaneous decrease in the SDF corresponds to a positive price of risk for government spending shocks. Intuitively, assets that co-vary positively with government spending shocks appreciate when the marginal wealth is high. Thus agents command a lower price to compensate for risk.

The temporary increase in consumption disappears as the habit persistence increases. However, the contemporaneous decrease in the stochastic discount factor upon a government spending shock remains[29]. This shows that a temporary increase in consumption is a possible but not a necessary response following a government spending shock.

[27]In the standard neoclassical model with lump sum taxes (e.g., Baxter and King (1993)), a positive fiscal shock increases the expected taxation by the same present value. The representative household experiences a negative wealth shock, immediately decreasing consumption. See Monacelli and Perotti (2008) for an indepth discussion.

[28]Note that the GOVT sector is much smaller than the PRIV sector.

[29]Not shown in paper.

6.6.2 Return spread between the $GOVT$ sector and the $PRIV$ sector

Figure 5 also shows that the return spread between the $GOVT$ sector and the $PRIV$ sector contemporaneously increases upon a positive government spending shock. This formalizes the use of the GMP return spread to approximate government spending shocks.

However, a positive TFP shock in the $GOVT$ sector also generates a positive return spread[30]. I use three approaches to show that the empirical counterpart of the return spread between the $GOVT$ sector and the $PRIV$ sector measures government spending shocks. Firstly, I compare the empirical response of consumption, tax rate and wages to the model solutions. I find that consumption, investment and wages increase for 20 quarters while the tax rate contemporaneously decreases following a positive shock to TFP in the $GOVT$ sector[31]. Thus, a positive shock to TFP generates opposite results to that of a positive news shock to government spending. Figure 2 shows that the macroeconomic responses to the GMP returns are consistent with the simulated responses generated by shocks to government spending. Secondly, I test whether a positive shock to the GMP returns correspond to a significant increase in the TFP in defence industries. I find no statistically significant difference in TFP in the defence industries following a shock to the GMP portfolio returns. Finally, I show that the response of macroeconomic variables in the VAR estimations are robust to the inclusion of TFP in defence industries.

Overall, the model successfully generates the consumption dynamics observed in data. The model successfully formalizes the use of the GMP return spread as a plausible approximate of government spending shocks.

[30]This is an unlikely scenario in reality. Defence contractors are unlikely to increase the production of military goods due to technology improvements.

[31]Results not reported in the paper and are available on request.

7 Conclusion

In this paper, I introduce a novel exogenous measure of government spending shocks to analyze the implications of fiscal spending on asset prices. The proposed measure, the portfolio long firms that contribute most of their value to the government consumption minus firms that contribute most of their final value to the private consumption, the returns to the GMP portfolio, significantly predicts future real per capita government spending.

I provide evidence that a positive government spending shock contemporaneously increases consumption and non-residential investment but decreases consumption, non-residential investment and real wages in the long run as tax liabilities increase. The estimated output multiplier, the ratio of the change in output to the change in government spending, is 0.85 evaluated after two years.

Portfolio sorting and cross sectional asset pricing tests show that government spending shocks are priced in the cross section of asset returns. I show that assets with high exposure to government spending shocks earn higher expected returns, on average, compared to assets with low exposure to government spending shocks. The positive premium is robust to the use of different test portfolios and the inclusion of different risk factors. The positive risk premium is consistent with government spending shocks causing contemporaneously low marginal utility states.

In addition, I show a positive association between firm level book-to-market ratio and the sensitivity to government spending shocks. I find that value firms have higher exposure to government spending shocks than growth firms. Investors are willing to hold growth firms, despite their lower average returns, since they have lower sensitivity to government spending shocks.

Finally, I develop a two sector real business cycle model to explain the key empirical insights. I show that the inclusion of correlated news shocks to government consumption and government investment and distortionary taxes generates a temporary low marginal wealth state following the positive government spending shock. The model formalizes the use of the GMP portfolio returns to approximate government spending shocks.

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Table 1: GOVT Minus PRIV: Portfolio Composition

	PRIV portfolio			GOVT portfolio		
	Median	10%	90%	Median	10%	90%
Book-to-market equity	0.729	0.190	2.060	0.648	0.230	1.638
Market capitalization	0.232	0.010	4.526	0.248	0.012	6.024
Debt-to-assets	0.272	0.004	0.517	0.228	0.026	0.471
Cash flows-to-assets	0.080	-0.005	0.161	0.096	0.026	0.165
Gross profit	0.336	0.097	0.795	0.317	0.144	0.554
Investment-to-assets	0.068	-0.100	0.312	0.066	-0.083	0.311

This table reports the portfolio composition of the GOVT firms, private sector firms that add most its final value to the government sector, and PRIV firms, private sector firms that add most its final value to private sector consumption. I report the market equity, book-to-market equity, debt to assets ratio (Compustat item dltt plus item dlc divided item at), the cash flows to assets ratio (Compustat item ib plus item dp divided by item at), the gross profitability (Compustat item revt minus item cogs divided by item at) and the investment to assets ratio (change in Compustat item at divided by lag item at). The sample includes data from 1965 to 2014.

Table 2: Quarterly Excess Returns and Covariances of 5 Portfolios Sorted on GMP beta

GMP beta	Low	2	3	4	High	High-Low
Value-weighted						
Mean Excess Returns	1.82	1.96	2.44	2.69	3.50	1.67
(t-stat)	(2.35)	(3.20)	(4.11)	(4.19)	(4.44)	(2.66)
Volatility	10.62	8.58	8.02	9.16	12.04	
Sharpe ratio	17.16	22.88	30.42	29.40	29.02	
Equal-weighted						
Mean Excess Returns	2.30	2.67	2.80	3.23	3.60	1.31
(t-stat)	(2.35)	(3.50)	(3.77)	(3.92)	(3.46)	(2.43)
Volatility	14.02	11.11	10.74	12.32	15.24	
Sharpe ratio	16.41	24.04	26.07	26.22	23.62	
Characteristics						
β^{MKT}	1.267	1.086	1.053	1.092	1.184	
β^{GMP}	-0.611	-0.145	0.074	0.297	0.759	
BE/ME	0.84	0.89	0.92	0.96	1.01	
Size	1.36	2.50	2.39	1.79	1.04	
Operating Profit	0.10	0.16	0.22	0.21	0.16	
Investment	0.18	0.14	0.12	0.12	0.16	
Number of firms	432.3	435.0	430.4	424.7	414.4	

The table reports summary statistics for value-weighted and equal-weighted excess returns for 5 portfolios of firms sorted on GMP exposure (β^{GMP}). The sample excludes firms that produce goods and services for the government consumption. The exposure to government spending shocks, β^{GMP}, and the exposure to the market returns, β^{MKT}, are calculated using a single regression with the prior 60 months of data. The t-statistics are reported in brackets using Newey-West standard errors, allowing for four quarter lags. The sample includes quarterly data from July 1963 to December 2014.

Table 3: Estimated quarterly premia

	25 portfolios sorted on GMP beta and profitability							
Factor	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
MKT	1.194		0.258		0.550	-0.068	0.033	-0.310
	(0.97)		(0.21)		(0.43)	(-0.05)	(0.02)	(-0.20)
$\dot{c}$		0.123		-0.023				
		(0.68)		(-0.12)				
GMP			2.013**	2.048**	1.970*	2.245**	1.794*	2.303**
			(1.98)	(2.00)	(1.95)	(2.02)	(1.69)	(2.01)
IMC					-0.538			
					(-0.37)			
SMB						0.466	0.710	0.429
						(0.51)	(0.79)	(0.46)
HML						0.009	-0.410	-0.058
						(0.01)	(-0.43)	(-0.06)
MOM							1.703	
							(0.99)	
LIQ								-0.433
								(-0.37)
Intercept	1.237	2.427***	2.168***	2.371***	1.915**	2.483**	2.434**	2.681**
	(1.65)	(3.66)	(3.07)	(3.59)	(2.45)	(2.58)	(2.51)	(2.60)

This table reports the Fama-MacBeth (1973) quarterly estimates using 25 portfolios sorted on GMP beta and profitability. The t-statistics are reported in brackets using Shanken standard errors. MKT is the excess return on the CRSP value-weighted portfolio and $\dot{c}$ is the growth rate of per capita nondurables plus services consumption. GMP is the returns to the portfolio long GOVT firms minus PRIV firms, which captures unanticipated shocks to government spending. IMC is the returns to the portfolio long investment good producers minus consumption goods producers, which captures investment specific technology shocks. SMB, HML, and MOM are the size, book-to-market, and momentum factors, respectively. LIQ is the Pastor and Stambaugh (2003) market liquidity measure. The sample includes quarterly data from 1963 to 2014. * Significant at the 10 percent level. ** Significant at the 5 percent level. *** Significant at the 1 percent level.

Table 4: Cross Sectional Tests - Robustness

	25 portfolios sorted on BE/ME and Size					
Factor	(I)	(II)	(III)	(IV)	(V)	(VI)
MKT	1.174		-0.733	2.421		-1.909
	(0.59)		(-0.41)	(1.58)		(-0.95)
TFP		1.176			3.056	
		(0.73)			(1.17)	
GMP	5.651***	5.356***	3.344**			
	(2.79)	(2.65)	(2.52)			
Defence				9.706**	9.063**	9.691**
				(2.13)	(2.21)	(2.28)
SMB			0.709			0.727*
			(1.17)			(1.82)
HML			1.352*			1.097**
			(1.95)			(2.52)
Intercept	1.624	2.141*	3.596**	0.714	2.156***	4.945**
	(0.80)	(1.90)	(2.08)	(0.44)	(2.62)	(2.30)
J-stat	11.794	11.914	3.749	8.226	7.839	5.070
p-value	(0.96)	(0.96)	(0.99)	(0.99)	(0.99)	(0.99)
MAPE	2.644	2.704	1.784	2.686	2.643	1.845

This table reports the first-stage GMM estimates using the identity weighting matrix. I report the mean absolute pricing errors (MAPE) and the J-test of overidentifying restrictions along with p-values in brackets. The t-statistics are reported in brackets using Newey-West standard errors, allowing for four lags. I use two proxies for productivity shocks: returns on the market portfolio (MKT) and the total factor productivity (TFP). I use two proxies for Government Spending Shocks: Returns to the GMP portfolio, the returns to the portfolio long GOVT firms minus PRIV firms, and Ramey (2011a) defense news measure, Defence. Specifications (I)-(III) include quarterly data from 1963 to 2014 and specifications (IV)-(VI) inlcude quarterly data from 1939 to 2014 . * Significant at the 10 percent level. ** Significant at the 5 percent level. *** Significant at the 1 percent level.

Table 5: Parameters used for benchmark caliration

Parameter	Symbol	Value
Preferences:		
Discount factor	β	0.99
Governs disutility of labor	ψ	0.0006
Governs intertemporal substitution	θ	2.4
Governs intertemporal substitution of the consumption-hours bundle	σ	1.1
Governs the wealth effect (GHH preferences, γ= 0, KPR preferences, γ= 1)	γ	0.8
Degree of internal habit formation	h	0.32
Adjustment costs:		
Investment adjustment cost parameter in sector 1	ϕ_1	1.3
Investment adjustment cost parameter in sector 2	ϕ_2	1.3
Capital depreciation rate	δ	2.5%
Production:		
Labor share in sector 1	α_1	0.64
Capital share in sector 2	α_k	0.36
Public capital share in sector 2	α_g	0.15
Persistence of TFP shock in each sector	ρ_A^i	0.9
Volatility of the TFP shock in each sector	$\sigma_{\epsilon^{A_i}}$	0.86%
Persistence of IST shock	ρ_Z	0.9
Volatility of the IST shock	σ_{ϵ^Z}	1.0%
Government Spending:		
Persistence of government investment shock	$\rho_1^{gi}, \rho_2^{gi}, \rho_3^{gi}$	1.4, -0.25, -0.2
Persistence of government consumption shock	$\rho_1^{gc}, \rho_2^{gc}, \rho_3^{gc}$	1.4, -0.25, -0.2
Correlation between ϵ^{gi} and ϵ^{gc}	$\rho_{gi,gc}$	0.5
Volatility of a shock to government investment	$\sigma_{\epsilon^{gi}}$	1.0%
Volatility of a shock to government consumption	$\sigma_{\epsilon^{gc}}$	1.5%
Other:		
Financial leverage		5/3

Table 6: Model versus Data: Macroeconomic Quantities

A. Data

	Volatility			Correlation			
	1947-2015	1963-2015		$\dot{c}$	$\dot{i}$	$\dot{n}$	$\dot{y}$
$\dot{c}$	1.260	1.211	$\dot{c}$	1.000			
$\dot{i}$	4.652	4.688	$\dot{i}$	0.634	1.000		
$\dot{n}$	1.550	1.457	$\dot{n}$	0.638	0.856	1.000	
$\dot{y}$	1.628	1.481	$\dot{y}$.	0.772	0.773	0.864	1.000

B. Model

	Volatility		Correlation			
			$\dot{c}$	$\dot{i}$	$\dot{n}$	$\dot{y}$
$\dot{c}$	1.800	$\dot{c}$	1.000			
$\dot{i}$	5.860	$\dot{i}$	0.433	1.000		
$\dot{n}$	0.560	$\dot{n}$	0.250	0.634	1.000	
$\dot{y}$	2.010	$\dot{y}$.	0.938	0.694	0.416	1.000

This table compares moments of the data to simulated moments from the model. The empirical moments are computed using quarterly data from the U.S. Bureau of Economic Analysis. I detrend the data with the HP filter with a smoothing parameter of 1,600. The theoretical moments are estimated by simulating the model for 10,000 periods and dropping the first half of the observations to remove the dependence on initial values. I consider innovations in consumption $\dot{c}$, innovations in non-residential investment $\dot{i}$, innovations in labor supply $\dot{n}$ and innovations in output $\dot{y}$. Correlations are computed using quarterly data from 1947 to 2014 detrended with the HP filter to capture the business cycle properties.

Table 7: Model versus Data: Asset Pricing Moments

Aggregate Moments		
	Data	Benchmark
Risk premium of the market portfolio	6.502	2.760
Volatility of the market portfolio	18.09	16.20
Sharpe ratio of the market portfolio	35.9	17.0
Average risk-free rate	2.900	4.120
Volatility of risk-free rate	3.00	4.96

The table compares key asset pricing moments of the data to simulated moments from the model. I estimate the responses by simulating 20,000 periods. I drop the first half of the observations to remove the dependence on initial values. All figures are in percentage terms. The equity return moments are computed from 1927 to 2014 sample. The moments of the risk-free rate are from the long sample of Campbell and Cochrane (1999).

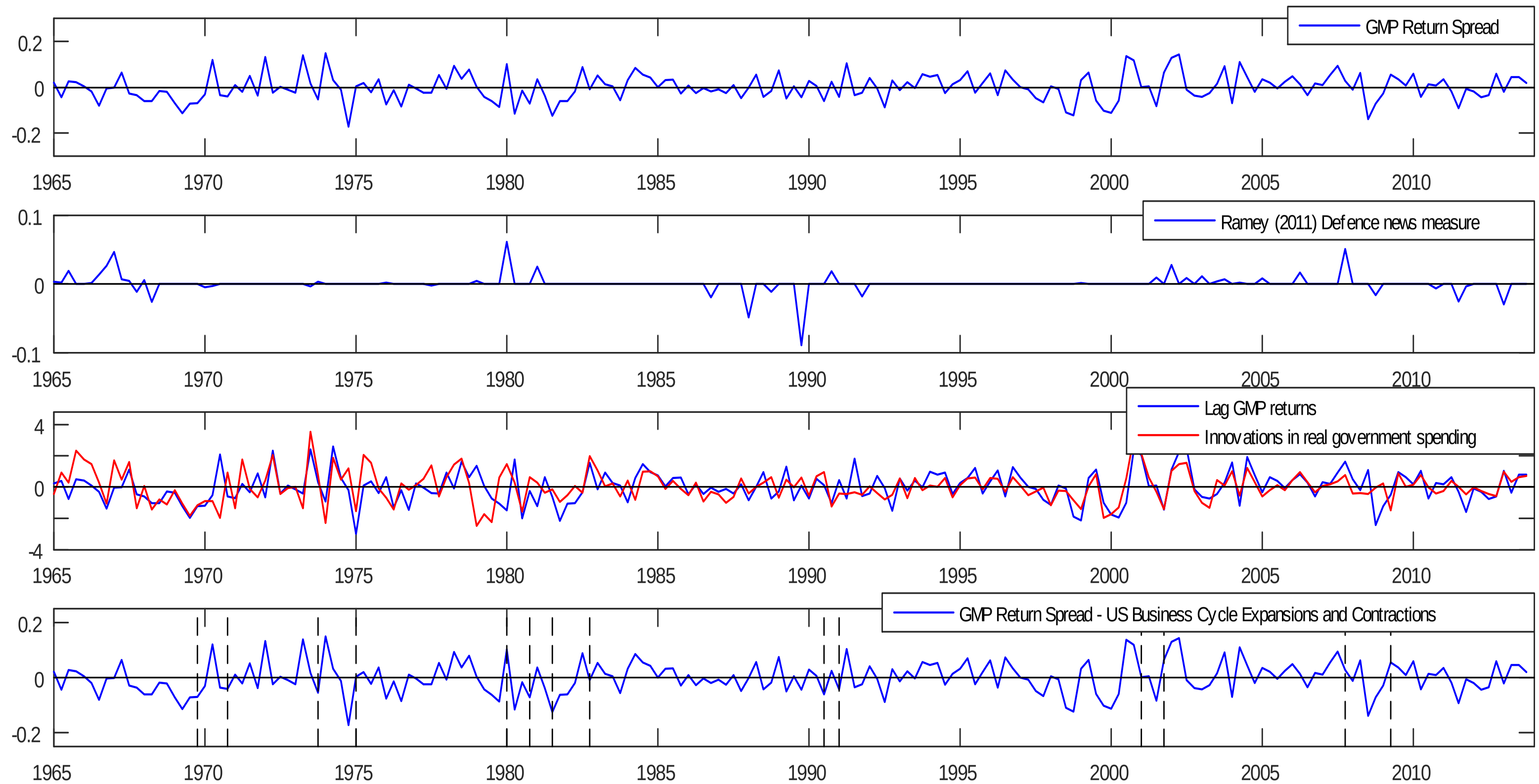

Figure 1: GMP returns, Ramey (2011) defence news measure and innovations in real government spending

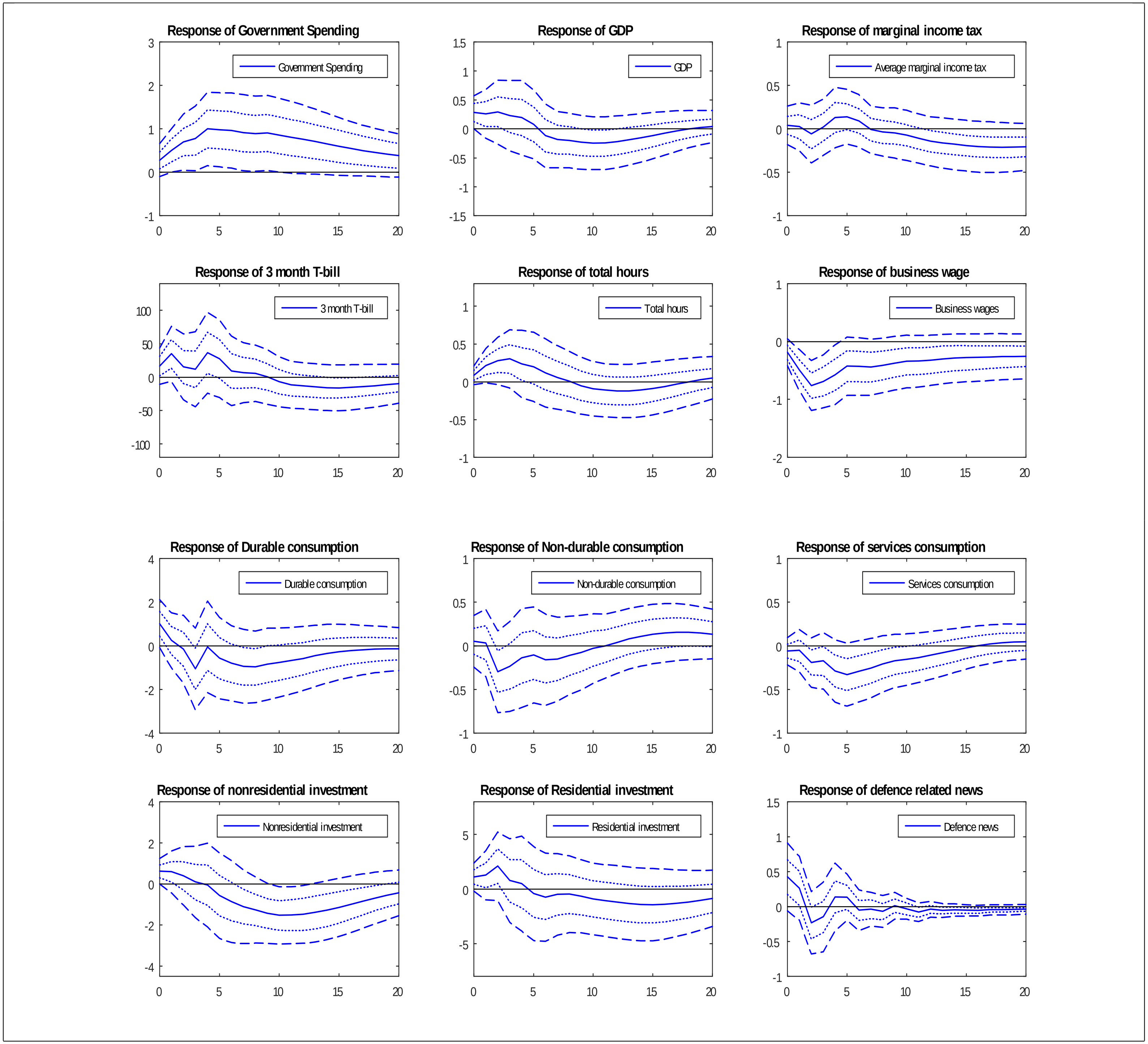

Figure 2: Responses to a positive Government Spending shock

The dotted lines and dashed lines represent 68% and 95% bootstrapped standard error bands, respectively. The responses are normalized such that the maximum response of real government spending is equal to one. The sample includes quarterly data from 1965 to 2008.

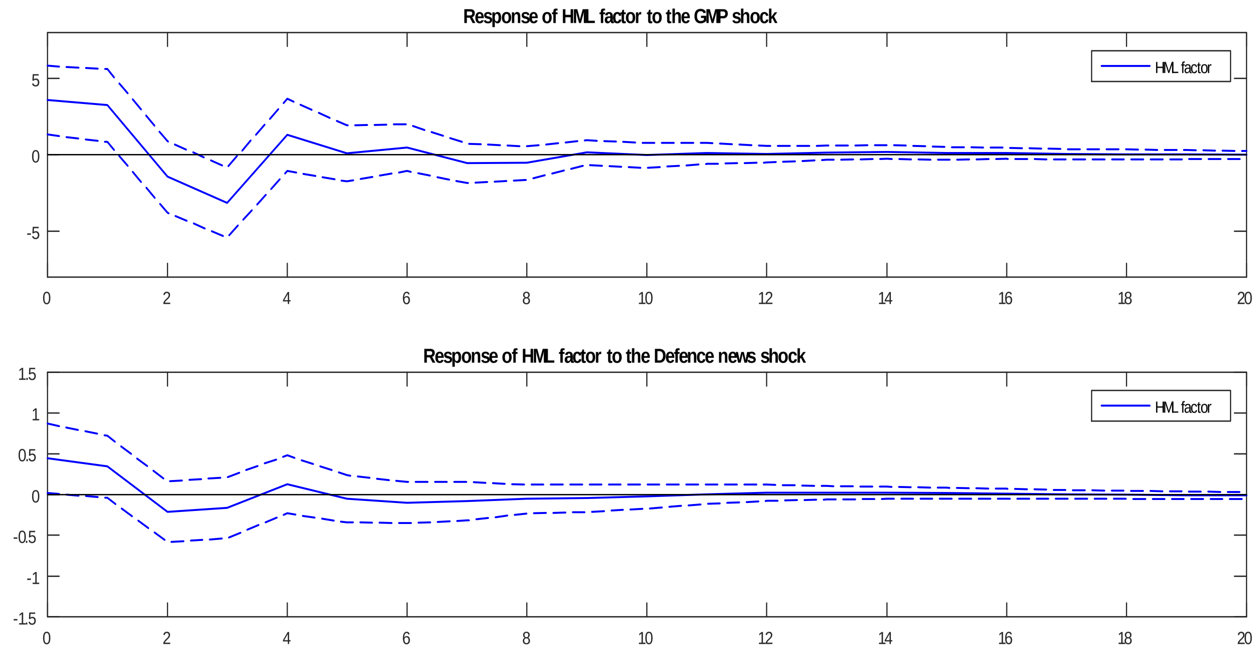

Figure 3: Responses to a positive Government Spending shock

The dotted lines represent 95% bootstrapped standard error bands. The figure presents the response of the HML factor to a positive shock to the GMP portfolio returns, using data from 1965 to 2008. HML factor, the spread in returns between high and low Book-to-Market firms, is from Kenneth French's Web site.

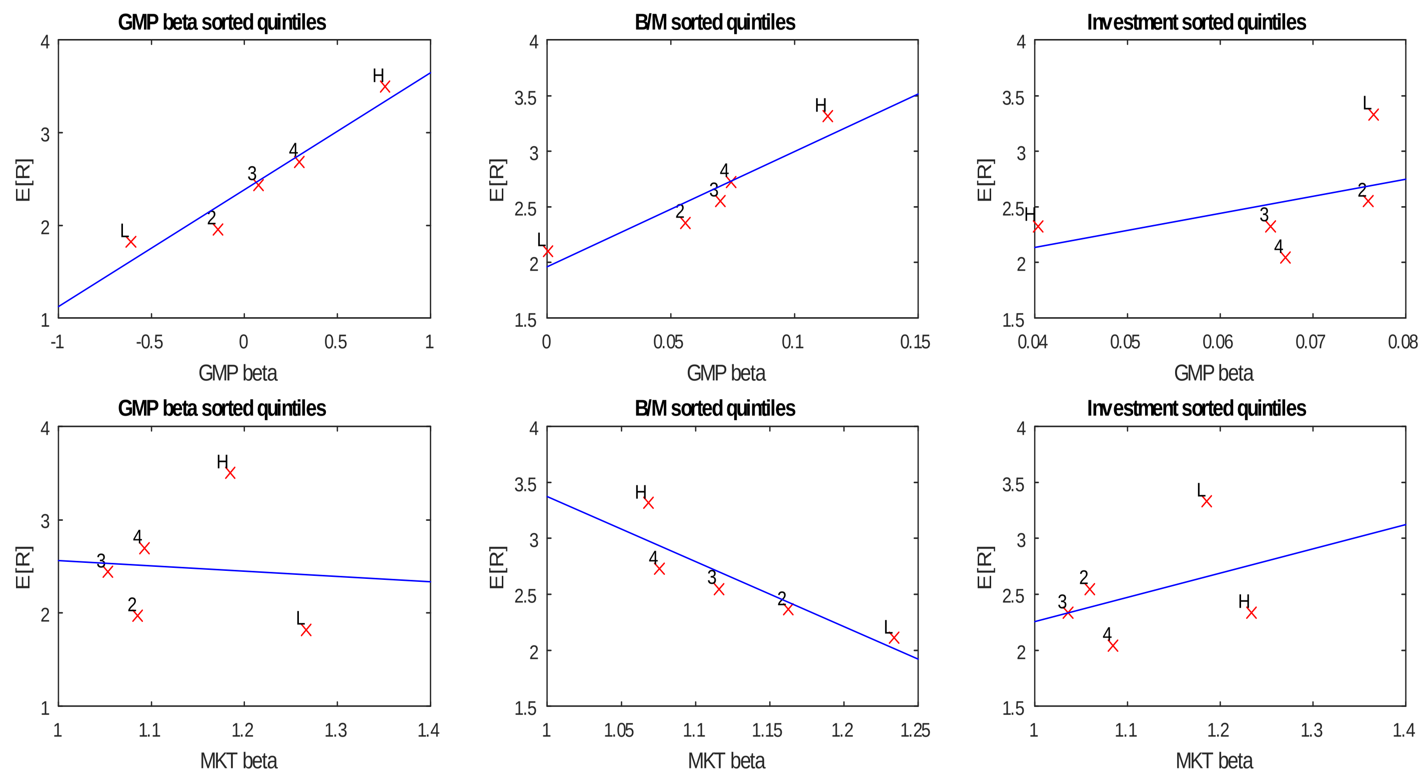

Figure 4: Portfolios sorted on GMP betas, Book-to-Market equity and Investment

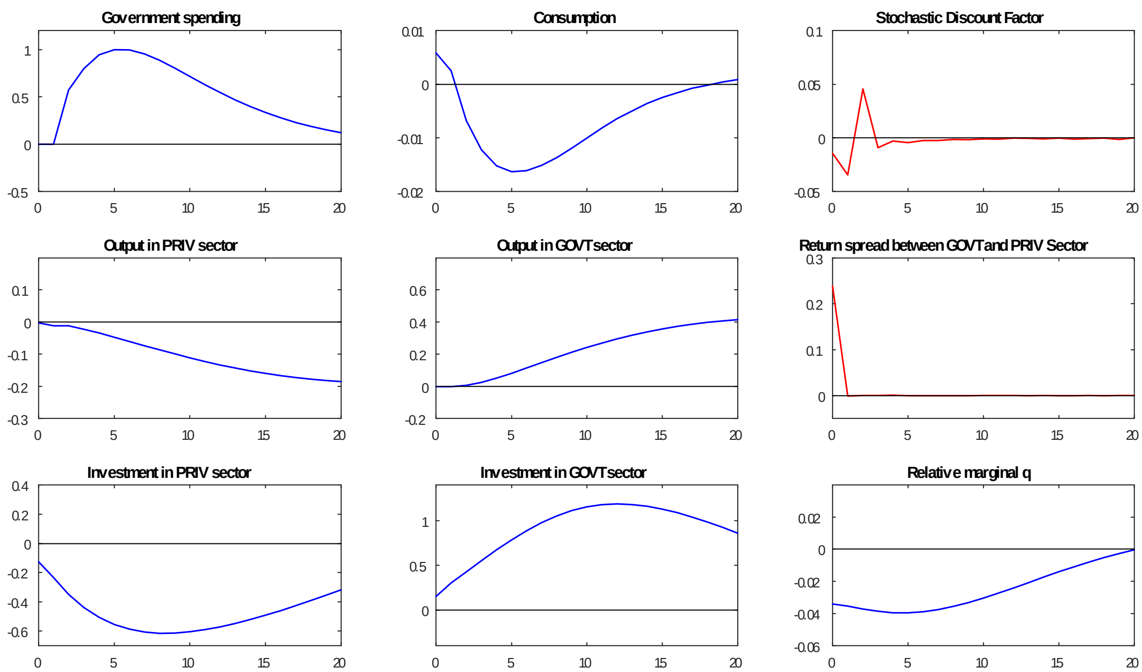

Figure 5: Simulated Response of Macroeconomic Variables to a Government Spending Shock

The figure plots the model response of macroeconomic variables to a positive government spending shock. Specifically, the figure shows quarterly log-deviations from the steady-state. All the parameters are calibrated to the values reported in Table 1. The responses are normalized such that the maximum response of government spending is equal to one.

Appendix I

In this section, I explain the FOCs used to solve the model described in Section 6. The household problem is given by:

$$V_t = \max_{\{C_s, N_s\}} U_t \qquad \text{s.t. } C_s = w_s N_s + \Pi_{1,s} + \Pi_{2,s}, \quad s \geq t,$$

and the corresponding Lagrangian is:

$$\mathcal{L}_t^{HH} = U_t \ + \sum_{s=t}^{\infty} \lambda_s (w_s N_s + \Pi_{1,s} + \Pi_{2,s} - C_s) + \mu_t \left((C_s - hC_{s-1})^{\gamma} X_{s-1}^{1-\gamma} - X_s \right). \tag{A1}$$

The first order conditions with respect to the control variables are given by:

$$\begin{aligned} &\left(C_{t+1} - hC_t - \psi N_{t+1}^{\theta} X_{t+1}\right)^{-\sigma} + \mu_{t+1}\gamma \left(\frac{X_t^{1-\gamma}}{C_{t+1} - hC_t} \right)^{1-\gamma} \\ -\beta h \mathbb{E}_{t+1} &\left[\left(C_{t+2} - hC_{t+1} - \psi N_{t+2}^{\theta} X_{t+2}\right)^{-\sigma} - \mu_{t+2}\gamma \left(\frac{X_{t+1}^{1-\gamma}}{C_{t+2} - hC_{t+1}} \right)^{1-\gamma} \right] = \lambda_t. \end{aligned} \tag{A2}$$

$$\psi N_t^{\theta} \left(C_t - hC_{t-1} - \psi N_t^{\theta} X_t\right)^{-\sigma} + \mu_t = \beta \mathbb{E}_t \left[\mu_{t+1} (1-\gamma) (C_{t+1} - hC_t)^{\gamma} X_t^{-\gamma} \right]. \tag{A3}$$

$$\theta \psi N_t^{\theta-1} X_t \left(C_t - hC_{t-1} - \psi N_t^{\theta} X_t\right)^{-\sigma} = \lambda_t \alpha_1 \frac{(1-\tau_t) Y_{1,t}}{N_{1,t}}. \tag{A4}$$

$$\theta \psi N_t^{\theta-1} X_t \left(C_t - hC_{t-1} - \psi N_t^{\theta} X_t\right)^{-\sigma} = \lambda_t \alpha_2 \frac{(1-\tau_t) Y_{2,t}}{N_{2,t}}. \tag{A5}$$

$$C_t = (1-\tau_t) Y_t - \frac{I_t}{Z_t}. \tag{A6}$$

The $PRIV$ firm's problem is:

$$V_{P,t} = \max_{\{I_{1,s}, K_{1,s+1}, N_{1,s}\}} \mathbb{E}_t \sum_{s=t}^{\infty} M_{t,s} \ \Pi_{1,s} \qquad \text{s.t. } \Pi_{1,s} = (1-\tau_s) A_{1,s} N_{1,s}^{\alpha_1} K_{1,s}^{1-\alpha_1} - w_s N_{1,s} - \frac{I_{1,s}}{Z_s},$$

and the corresponding Lagrangian is:

$$\mathcal{L}_t^{P} = \mathbb{E}_t \sum_{s=t}^{\infty} M_{t,s} \left(\begin{array}{c} (1-\tau_s) A_{1,s} N_{1,s}^{\alpha_1} K_{1,s}^{1-\alpha_1} - w_s N_{1,s} - \frac{I_{1,s}}{Z_s} \\ +\eta_s^1 \left(I_{1,s} \left[1 - \frac{\phi}{2} \left(\frac{I_{1,s}}{I_{1,s-1}} - 1 \right)^2 \right] + (1-\delta) K_{1,s} - K_{1,s+1} \right) \end{array} \right). \tag{A7}$$

The $PRIV$ firm's first order conditions with respect to the control variables are given by:

$$\eta_t^1 = \beta \mathbb{E}_t M_{t+1} \left[(1-\alpha_1)(1-\tau_s) A_{1,t+1} N_{1,t+1}^{\alpha_1} K_{1,t+1}^{-\alpha_1} + \eta_{t+1}^1 (1-\delta) \right]. \tag{A8}$$

$$\begin{aligned} 1/Z_t = {} & \eta_t^1 \left[1 - \frac{\phi}{2}\left(\frac{I_{1,t}}{I_{1,t-1}} - 1\right)^2 - \phi\left(\frac{I_{1,t}}{I_{1,t-1}} - 1\right)\left(\frac{I_{1,t}}{I_{1,t-1}}\right) \right] \\ & + \beta \mathbb{E}_t \left[M_{t+1} \eta_{t+1}^1 \phi \left(\frac{I_{1,t+1}}{I_{1,t}} - 1\right)\left(\frac{I_{1,t+1}}{I_{1,t}}\right)^2 \right]. \end{aligned} \tag{A9}$$

$$\alpha_1 (1-\tau_t) A_{1,t} N_{1,t}^{\alpha_1 - 1} K_{1,t}^{1-\alpha_1} = w_t. \tag{A10}$$

$$K_{1,t+1} = I_{1,t} \left[1 - \frac{\phi}{2}\left(\frac{I_{1,t}}{I_{1,t-1}} - 1\right)^2 \right] + (1-\delta) K_{1,t}. \tag{A11}$$

The $GOVT$ firm's problem is:

$$V_{G,t} = \max_{\{I_{2,s}, K_{2,s+1}, N_{2,s}\}} \mathbb{E}_t \sum_{s=t}^{\infty} M_{t,s} \, \Pi_{2,s} \quad \text{s.t. } \Pi_{2,s} = (1-\tau_s) A_{2,s} N_{2,s}^{\alpha_2} K_{2,s}^{\alpha_{k2}} K_{G,s}^{\alpha_{g2}} - w_s N_{2,s} - \frac{I_{2,s}}{Z_s},$$

and the corresponding Lagrangian is:

$$\mathcal{L}_t^G = \mathbb{E}_t \sum_{s=t}^{\infty} M_{t,s} \left(\begin{array}{c} (1-\tau_s) A_{2,s} N_{2,s}^{\alpha_2} K_{2,s}^{\alpha_{k2}} K_{G,s}^{\alpha_{g2}} - w_s N_{2,s} - \frac{I_{2,s}}{Z_s} \\ + \eta_s^1 \left(I_{2,s} \left[1 - \frac{\phi}{2}\left(\frac{I_{2,s}}{I_{2,s-1}} - 1\right)^2 \right] + (1-\delta) K_{2,s} - K_{2,s+1} \right) \end{array} \right). \tag{A12}$$

The $GOVT$ firm's first order conditions with respect to the control variables are given by:

$$\eta_t^2 = \beta \mathbb{E}_t M_{t+1} \left[(1-\alpha_k)(1-\tau_s) A_{2,t+1} N_{2,t+1}^{\alpha_2} K_{2,t+1}^{\alpha_k - 1} K_{G,t+1}^{\alpha_G} + \eta_{t+1}^2 (1-\delta) \right]. \tag{A13}$$

$$\begin{aligned} 1/Z_t = {} & \eta_t^2 \left[1 - \frac{\phi}{2}\left(\frac{I_{2,t}}{I_{2,t-1}} - 1\right)^2 - \phi\left(\frac{I_{2,t}}{I_{2,t-1}} - 1\right)\left(\frac{I_{2,t}}{I_{2,t-1}}\right) \right] \\ & + \beta \mathbb{E}_t \left[M_{t+1} \eta_{t+1}^2 \phi \left(\frac{I_{2,t+1}}{I_{2,t}} - 1\right)\left(\frac{I_{2,t+1}}{I_{2,t}}\right)^2 \right]. \end{aligned} \tag{A14}$$

$$\alpha_2 (1-\tau_t) A_{2,t} N_{2,s}^{\alpha_2 - 1} K_{2,s}^{\alpha_{k2}} K_{G,s}^{\alpha_g} = w_t. \tag{A15}$$

$$K_{2,t+1} = I_{2,t}\left[1 - \frac{\phi}{2}\left(\frac{I_{2,t}}{I_{2,t-1}} - 1\right)^2\right] + (1-\delta)\, K_{2,t}. \tag{A16}$$

All markets clear in equilibrium. Substituting the government budget constraint, $C_{G,t} + I_{G,t} = \tau_t\,(Y_{1,t} + Y_{2,t})$, and the firm profit functions into the household constraint, $C_t = w_t N_t + \Pi_{1,t} + \Pi_{2,t}$, gives the economy wide constraint:

$$Y_t = C_t + \frac{I_t}{Z_t} + C_{G,t} + I_{G,t}. \tag{A17}$$

The Tobin's marginal q is $q_t^i = \frac{\eta_t^i}{\lambda_t}$. In this form, q_t is the marginal value of investment in terms of consumption for sector i.

Appendix II

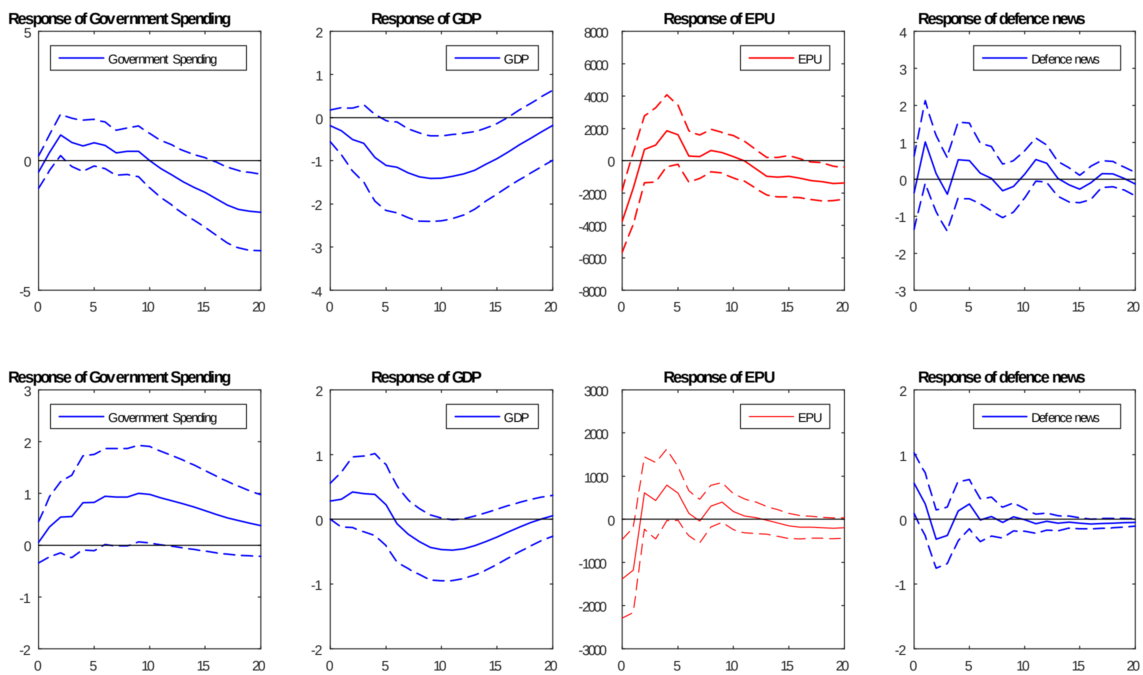

Figure 6: **Response of Economic Policy Uncertainty (EPU) to a positive Government Spending shock.** The top panel shows the response of Baker, Bloom and Davis (2016) EPU measure based on newspaper coverage frequency. This sample includes quarterly data from 1985 to 2008. The bottom panel shows the response of the EPU measure based on historical archives for six major newspapers. This sample includes quarterly data from 1965 to 2008. The dashed lines represent 90% bootstrapped standard error bands. The responses are normalized such that the maximum response of real government spending is equal to one.