



# Market Shocks in the G7 Countries

Nahiyen Azad<sup>1</sup> · Apostolos Serletis<sup>1</sup>

Accepted: 23 November 2020 / Published online: 16 January 2021

© The Author(s), under exclusive licence to Springer Science+Business Media, LLC part of Springer Nature 2021

## Abstract

This paper investigates the impact of unanticipated increases in share prices on economic activity in the G7 countries — Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. Share prices contain information about the current and future state of the economy. We investigate whether different measures of optimism, all of which contain the unanticipated increase in share prices, affect key macroeconomic variations. In particular, do bouts of optimism stimulate economic growth? If so, are the economic booms sustained for a long period of time? To answer our research questions, we use structural vector autoregression models, and three different identification strategies. We address the interdependence between interest rate shocks and stock market shocks, using short-run and long-run restrictions, as in Bjørnland and Leitemo (*J Monet Econ* 56(2): 275–282, 2009). We use pure sign restrictions, as in Uhlig (*J Monet Econ* 52(2): 381–419, 2005). We also implement the theory and numerical algorithms for zero and sign restrictions, recently developed by Arias et al. (*Econometrica* 86(2): 685–720, 2018).

**Keywords** Structural VAR · Share prices · Zero restrictions · Sign restrictions

**JEL Classification** E2 · E3 · E4 · E44

## 1 Introduction

**Background** The information-based monetary misperceptions model of Lucas (1972), originated from Friedman (1968), and Phelps (1970), has been one of the most celebrated business cycle models over the past 50 years. According to the

---

We would like to thank the Editor, George Tavlas, and an anonymous referee for comments that greatly improved the paper.

✉ Apostolos Serletis  
serletis@ucalgary.ca

<sup>1</sup> University of Calgary, Calgary, Alberta, Canada

model, in a rational expectations setting, economic agents have incomplete information about prices in the economy, and monetary shocks are a principal cause of economic fluctuations. However, in recent years, most economists believe that monetary shocks are not the principal cause of business cycles. In fact, the modern core of macroeconomics consists of the real business cycle model, developed by Kydland and Prescott (1982), and the new Keynesian model. According to the (original) real business cycle model, under the classical assumption of fully flexible nominal wages and prices, most aggregate fluctuations are efficient responses to real shocks. The opposing new Keynesian approach advocates models with sticky prices, and points to economic downturns like the Great Depression of the 1930s, the Great Recession during the late 2000s, and the recent crisis from the COVID-19 lockdown, and argues that it is implausible for the efficient level of aggregate output to fluctuate as much as the observed level of output, thereby advocating government stabilization policy.

There are many criticisms of the modern core of macroeconomics. As Serletis (2016, p. 462) puts it, “one is the assumption that economic agents act in isolation and the only interaction between them is through the price system. This is clearly unrealistic as it fails to capture the interdependence, interaction, and economic networks of the real world. Another is the aggregation assumption according to which the behavior of the aggregate (or macro) economy corresponds to that of the representative economic agent, consistent with the reductionist belief that ‘the whole is the sum of its parts.’” Another serious criticism pertains to the formalization of the origins of business cycles. Typically, dynamic stochastic general equilibrium models attribute short-run fluctuations to shocks to fundamentals like preferences, technologies, or government policy. This, however, is highly unsatisfactory. As Angeletos and La’O (2013) recently put it in their Conclusion, “if taken literally, these shocks seem empirically implausible. Instead, short-run phenomena appear to have a largely self-fulfilling nature—one that leads many practitioners to attribute these phenomena to more exotic forces such as ‘animal spirits,’ ‘sentiments,’ or ‘market psychology,’ and one that standard macroeconomic models have failed to capture.”

**Contribution** In this paper, we follow Angeletos and La’O (2013) and Nam and Wang (2019) and explore the view that sentiments of optimism and pessimism are an important source of economic fluctuations. We accomplish this by estimating the dynamic effects of stock market shocks on macroeconomic variations in the G7 countries — Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. Although there is a large number of studies that investigate this relationship for the United States such as, for example, Rigobon and Sack (2004) and Bjørnland and Leitemo (2009), among others, research conducted on the other members of the G7 has been fairly limited. We fill the gap in the literature, and focus specifically on the following questions: What are the effects of positive stock market shocks on key real macroeconomic variables (consumption expenditure, investment spending, and output)? What are the effects on interest rates? What are the effects on unit labour costs? How do the effects differ across the G7 countries?

We provide new evidence, on the relevance of stock market shocks as an important driver of business cycles, in the context of structural vector autoregression (VAR) models. We use three different identification strategies. In the first approach we

address the interdependence between interest rate shocks and stock market shocks, using short-run and long-run restrictions, following Bjørnland and Leitemo (2009). In the second approach, we use pure sign restrictions, as in Uhlig's (2005) Bayesian VAR model, assuming that share price shocks are associated with increases in real consumption expenditure and investment spending, consistent with wealth effects and Tobin's (1969)  $q$  theory of investment. Finally, to avoid the model identification problem of the pure sign restrictions approach, noted by Fry and Pagan (2011), and misidentification of the shocks of interest, noted by Wolf (2020), we implement the theory and numerical algorithms for zero and sign restrictions, recently developed by Arias et al. (2018). We provide evidence that optimism shocks lead to increases in real consumption expenditure, real investment spending, and real output in the G7 countries, a result which is robust across the three different identification strategies.

**Layout** The rest of the paper is structured as follows. Section 2 provides details on the data used in our empirical analysis. Section 3 is divided into three subsections, with the first (briefly) discussing the structural identified VAR model with zero restrictions, the second the Bayesian VAR partially identified with pure sign restrictions, and the third the empirical methodology that achieves identification via both zero and sign restrictions. Section 4 presents the empirical results and conducts robustness checks. The last section briefly concludes the paper.

## 2 The Data

We use quarterly data on real GDP, real private final consumption expenditure, real gross fixed capital formation, real share prices, and interest rates for each of the G7 countries — Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. The real GDP, real private final consumption expenditure, and real gross fixed capital formation series are from the St. Louis Federal Reserve Economic Database (FRED); the series for gross fixed capital formation serves as a proxy for total investment in the economy. All three series are seasonally adjusted, in constant prices, and expressed with a fixed reference year (2015 = 100).

The share price series are extracted from data published by the Organisation for Economic Co-operation and Development (OECD). They are in index form (with 2015 = 100) and are computed from prices of common shares of companies that are traded at both the domestic and the foreign stock markets. They are determined by market forces and are averages of daily closing prices. For more information, see <https://data.oecd.org/price/share-prices.htm>. The original share price data are in nominal terms, so we divide each series by the respective consumer price index (all items), using data from FRED, to get the real share price series.

We retrieve the interest rate series for Canada and the United Kingdom from the newly constructed monetary policy rate series by the Bank for International Settlements (BIS), made publicly available for research on September 2017 — see Bank for International Settlements (2018). The original data are in monthly frequency and we take arithmetic averages to convert to quarterly frequency. For the United States, we use the quarterly effective federal funds rate series from FRED. For each of France,

Germany, and Italy, we use the 3-month interbank rates from FRED, and for Japan we use the 3-month rates on certificates of deposit, also from FRED.

**Appendix** Table 2 provides a comprehensive list of all the series used in our analysis and their URL links. For all the variables, except for the interest rates series, we use logarithmic first differences multiplied by 100 to obtain quarterly growth rates. Column 2 of Table 1 shows that the G7 countries account for 29.22 per cent of the world's total GDP, using data from International Monetary Fund's World Economic Outlook (October 2019). Column 3 indicates the sample period for each country in our econometric analysis below.

### 3 Methodology

#### 3.1 Zero Restrictions

We adopt the model implemented by Bjørnland and Leitemo (2009), who investigate the interdependence between interest rates and stock prices by imposing both short-run and long-run zero restrictions. We assume  $z_t$  to be the  $5 \times 1$  vector of macroeconomic variables, ordered as

$$z_t = [\Delta y_t, \Delta c_t, \Delta i_t, \Delta s_t, R_t]'$$

where  $y_t$  denotes real gross domestic product (GDP),  $c_t$  real consumption,  $i_t$  real investment,  $s_t$  share prices, and  $R_t$  the country's interest rate. Specified in this order, our structural VAR is assumed to be stable, invertible and written in its moving average representation as

$$z_t = Bx(L)v_t \quad (1)$$

where  $v_t$  is a  $5 \times 1$  vector of reduced-form residuals, assumed to be identically and independently distributed,  $v_t \sim \text{iid}(0, \Omega)$ , with  $\Omega$  being the positive-definite covariance matrix.  $B(L)$  is the  $5 \times 5$  convergent matrix polynomial in the lag operator,  $L$ ,  $B(L) = B_0 + B_1L + B_2L^2 + \dots$

The underlying orthogonal structural disturbances,  $\varepsilon_t$ , can be written as a linear combination of the reduced-form innovations,  $v_t$ ,  $v_t = S\varepsilon_t$ , where  $S$  is the  $5 \times 5$

**Table 1** Note: Data are from the International Monetary Fund's World Economic Outlook (October 2019) Retrieved from: <https://www.imf.org/external/datamapper/PPPSH@WEO/ADVEC/MAE>

Country	GDP (based on PPP) share	Sample period
Canada	1.32%	1961Q2 - 2019Q4
France	2.11%	1970Q1 - 2019Q4
Germany	3.07%	1991Q2 - 2019Q4
Italy	1.68%	1981Q2 - 2019Q4
Japan	3.94%	1994Q2 - 2019Q4
United Kingdom	2.17%	1971Q2 - 2019Q4
United States	14.93%	1960Q2 - 2019Q4

contemporaneous matrix. Equation 1 can be written in terms of the structural shocks,  $\varepsilon_t$ , as

$$z_t = C(L)\varepsilon_t \tag{2}$$

where  $C(L) = B(L)S$ . In our identification scheme for  $S$ , the underlying orthogonal structural disturbances,  $\varepsilon_t$ , are normalized to have unit variance, the vector of the uncorrelated structural shocks is ordered as  $\varepsilon_t = [\varepsilon_t^{\Delta y}, \varepsilon_t^{\Delta c}, \varepsilon_t^{\Delta i}, \varepsilon_t^{\Delta s}, \varepsilon_t^R]'$ , and the remaining shocks are identified from their respective equations, but are left uninterpreted.  $\varepsilon_t^{\Delta s}$  represents the share price shock or the optimism shock. From the covariance structure we also get the following relationship

$$\Omega = E [v_t v_t'] = S E [\varepsilon_t \varepsilon_t'] S' = SS' \tag{3}$$

Following the standard monetary VAR literature — see, for example, Christiano et al. (1999, 2005) and Bjørnland and Leitemo (2009) — we identify the country policy rate shock by assuming that macroeconomic variables do not react contemporaneously to the policy rate, while a contemporaneous reaction from the macroeconomic environment to the policy rate is allowed for. We achieve this identification by placing the three macroeconomic aggregates, real GDP, consumption, and investment above the interest rate in the structural VAR ordering and assuming three zero restrictions on the relevant coefficients in the fifth column of the  $S$  matrix, namely  $S_{15} = S_{25} = S_{35} = 0$ . In order to identify the share price shock, we follow Bjørnland and Leitemo (2009) and impose three zero restrictions on the  $S$  matrix, namely  $S_{14} = S_{24} = S_{34} = 0$ . These restrictions reflect the assumption that macroeconomic aggregates do not contemporaneously react to share price shocks. By imposing no zeros in the fourth row of the  $S$  matrix, we allow share prices to contemporaneously react to shocks originating from the macroeconomic aggregates. Specifically,

$$\begin{bmatrix} \Delta y_t \\ \Delta c_t \\ \Delta i_t \\ \Delta s_t \\ R_t \end{bmatrix} = C(L) \begin{bmatrix} S_{11} & 0 & 0 & 0 & 0 \\ S_{21} & S_{22} & 0 & 0 & 0 \\ S_{31} & S_{32} & S_{33} & 0 & 0 \\ S_{41} & S_{42} & S_{43} & S_{44} & S_{45} \\ S_{51} & S_{52} & S_{53} & S_{54} & S_{55} \end{bmatrix} \begin{bmatrix} \varepsilon_t^{\Delta y} \\ \varepsilon_t^{\Delta c} \\ \varepsilon_t^{\Delta i} \\ \varepsilon_t^{\Delta s} \\ \varepsilon_t^R \end{bmatrix} \tag{4}$$

In order to account for two-way causation, we allow for interaction between the interest rate and share prices by following Bjørnland and Leitemo (2009) and assuming that interest rate shocks do not have any effect on real share prices in the long run. We impose this restriction by setting the sum of the infinite number of relevant lag coefficients in Eq. 2 equal to zero,  $\sum_{j=0}^{\infty} C_{45,j} = 0$ . From the relationship  $C(L) = B(L)S$ , we know that  $B(1)S = C(1)$ . Here,  $C(1) = \sum_{j=0}^{\infty} C_j$  and  $B(1) = \sum_{j=0}^{\infty} B_j$  represent the  $5 \times 5$  long run matrix of  $C(L)$  and  $B(L)$ , respectively. Therefore, the long run restriction  $C_{45}(1) = 0$  implies that

$$B_{41}(1)S_{15} + B_{42}(1)S_{25} + B_{43}(1)S_{35} + B_{44}(1)S_{45} + B_{45}(1)S_{55} = 0.$$

The system becomes just identifiable. For a structural VAR with  $n (= 5)$  variables, we need  $n(n - 1)/2 (= 10)$  restrictions for identification. We achieve that in our system by imposing nine short-run restrictions and one long-run restriction.

In short, since share prices and the interest rate appear at the bottom of the system, the identification strategy assumes that innovations in the interest rate,  $\varepsilon_t^R$ , and share prices,  $\varepsilon_t^{\Delta s}$ , percolate into the domestic economy with a lag. On the other hand, real domestic shocks,  $\varepsilon_t^{\Delta y}$ ,  $\varepsilon_t^{\Delta c}$ , and  $\varepsilon_t^{\Delta i}$ , affect the financial markets contemporaneously.

### 3.2 Sign Restrictions

We also use the pure-sign-restrictions approach, proposed by Uhlig (2005), in his investigation of the effects of monetary policy shocks on output. In particular, Uhlig (2005) criticizes the identification strategy in the standard monetary VAR literature of imposing zero restrictions on the short-run response of output to a monetary policy shock, and directly imposes sign restrictions on the impulse responses. In this approach, sufficient sign restrictions are imposed on the impulse responses, guided by economic theory, to correctly identify structural innovations, while at the same time being agnostic about the primary variable of interest, in our case real output.

We follow Uhlig (2005) and keep our key variable of interest, real GDP, unrestricted. Recall from Section 3.1 that the matrix  $S$  is the  $5 \times 5$  contemporaneous matrix. The  $j$ th column of the  $S$  matrix (or its negative) represents the immediate impact on all variables due to the  $j$ th fundamental innovation, one standard error in size. As before, there are  $n(n - 1)/2$  degrees of freedom in specifying the matrix  $S$ . As already noted, we are only interested in identifying the innovation originating from a shock to real share prices. In our model, this is equivalent to identifying a single column  $s \in R^n$  in Eq. 3. From Definition 1 in Uhlig (2005), the vector  $s \in R^n$  is called an impulse vector iff there is some matrix  $S$ , such that  $S S' = \Omega$ .

We propose three restrictions as follows

Shock/Variable	$\Delta y_t$	$\Delta c_t$	$\Delta i_t$	$\Delta s_t$	$R_t$
Restriction		$\geq 0$	$\geq 0$	$\geq 0$	

to analyze the effects of stock market shocks on the macroeconomy. That is, we claim that an optimism shock

- does not decrease real consumption expenditure  $x$  months after the shock
- does not decrease real investment spending for  $x$  months after the shock
- does not decrease the real price of shares for  $x$  months after the shock.

These sign restrictions helps us to identify innovations in optimism that are associated with an increase in stock prices, signalling a boom in the stock market, and an increase in private consumption through the wealth channel. Nam and Wang (2019) impose similar sign restrictions on the prices of shares and consumer spending and state that the sign restrictions imposed on these two variables are generally regarded in the economics literature as the best identifiers of “individuals’ expectations about the future.” Moreover, Baker et al. (2003, p. 969) state that “corporate investment and the stock market are positively correlated, in both the time series and the cross-section. The traditional explanation for this relationship is that stock prices reflect the marginal product of capital. This is the interpretation given to the

relationship between investment and Tobin’s  $Q$ , for example, as in Tobin (1969 and von Furstenberg (1977.”

In the algorithm for the pure-sign-restriction methodology, all impulse vectors that satisfy the sign restrictions on the impulse responses are assigned an equal probability. We denote  $S(\Omega)$  as the lower triangular Cholesky factor of  $\Omega$ . Let  $P^n$  represent the space of positive definite matrices of dimension  $n \times n$  ( $5 \times 5$ ). Assume  $\varphi^n$  to be the unit sphere in the real space  $R^n$  such that  $\varphi^n = \{\alpha \in R^n : \|\alpha\| = 1\}$ , where  $\alpha$  is an  $n$ -dimensional vector of unit length. In the first step of the algorithm, we draw a set of unrestricted parameters  $(A, \Omega)$  from the posterior distribution. The posterior itself is computed as the product of a normal Wishart density and an indicator function in the  $(A, \Omega, \alpha)$  space. To draw from the posterior distribution, we take a joint draw from the unrestricted normal Wishart posterior for the VAR parameters  $(A, \Omega)$  and from the uniform distribution of the unit sphere,  $\alpha_{in}\varphi^n$ . Next, we construct the impulse vector  $s$  using the following relationship

$$s = \tilde{S}\alpha. \tag{5}$$

Subsequently, we compute the impulse responses  $r_{k,j}$  at horizons  $k = 0, 1, 2, \dots, K$  for the variables  $j$ , representing real GDP, real consumer expenditure, real investment spending, real share prices, and the interest rate. If the impulse responses match the mentioned sign restrictions, the algorithm keeps the draw and computes the statistics. In case the impulse responses do not satisfy the sign restrictions, the algorithm discards the draw and repeats the previous steps sufficient times — for more details refer to Uhlig (2005). For computational purposes, we use a VAR(4), and no constant and time trend in the model. We compute 40 steps (10 years). We utilize 2000 draws from the posterior, 1000 sub draws for each of the posterior draws, and keep 1000 accepted draws to construct the impulse vectors and responses to which we apply the Uhlig (2005) pure-sign-restrictions algorithm.

### 3.3 Zero and Sign Restrictions

In this section, we implement the algorithms for sign and zero restrictions recently proposed by Arias et al. (2018). Let us consider the structural VAR model in the general form structured as in Rubio-Ramirez et al. (2010)

$$Z_t' A_0 = \sum_{l=1}^4 Z_{t-l}' A_l + c + \varepsilon_t', \quad t = 1, \dots, T \tag{6}$$

where  $Z_t$  is the  $5 \times 1$  vector of endogenous variables, consisting of real output,  $y$ , real consumption,  $c$ , real investment,  $i$ , unit labour costs,  $l$ , and real share prices,  $s$ , with all the variables entered as percentage changes (logarithmic first differences times 100).  $\varepsilon_t$  is the  $5 \times 1$  vector of fundamental innovations,  $A_l$  is the  $5 \times 5$  matrix of parameters for  $0 \leq l \leq 4$ . The matrix  $A_0$  is invertible,  $c$  is the  $1 \times n$  vector of parameters, and  $T$  is the sample size. The model described in Eq. 6 can be summarized as

$$Z_t' A_0 = X_t' A_+ + \varepsilon_t', \quad t = 1, \dots, T \tag{7}$$

where  $A'_+ = [A'_1, \dots, A'_p \ c']$  and  $X'_t = [Z'_{t-1}, \dots, Z'_{t-p} \ \mathbf{1}]$ . The reduced form representation is

$$Z'_t = X'_t B + v'_t, \quad t = 1, \dots, T$$

where  $B = A_+ A_0^{-1}$ ,  $v'_t = \varepsilon'_t A_0^{-1}$ , and  $E[v_t v'_t] = \Omega = (A_0 A'_0)^{-1}$ . The reduced-form parameters are  $B$  and  $\Omega$ , while  $A_0$  and  $A_+$  are the structural parameters.

Equation 7 represents the structural VAR in terms of the structural parameterization, characterized by the structural parameters  $A_0$  and  $A_+$ . Arias et al. (2018) propose that structural VARs can be written as a product of a set of reduced-form parameters and a set of orthogonal matrices. They name this, the orthogonal reduced-form parameterization. This method of parameterization contains information on the reduced-form parameters,  $B$  and  $\Omega$ , and the orthogonal matrix  $Q$ . The following equation summarizes the orthogonal reduced-form parameterization

$$Z'_t = X'_t B + \varepsilon'_t Q' h(\Omega), \quad t = 1, \dots, T \tag{8}$$

where  $h(\Omega)$ , of dimension  $5 \times 5$ , represents the decomposition of the covariance matrix  $\Omega$ , such that  $h(\Omega)'h(\Omega) = \Omega$ , where  $h$  is the Cholesky decomposition. To make draws from the structural parameterization,  $(B, \Omega, Q)$  needs to be transformed into  $(A_0, A_+)$ . Using Eqs. 7 and 8, and the Cholesky decomposition of  $h$ , a mapping between  $(B, \Omega, Q)$  and  $(A_0, A_+)$  can be defined as follows

$$f_h(A_0, A_+) = \left( A_+ A_0^{-1}, (A_0 A'_0)^{-1}, h \left( (A_0 A'_0)^{-1} \right) A_0 \right).$$

The first element of the triad on the right represents the matrix  $B$ , the second element corresponds to  $\Omega$ , and the last element corresponds to  $Q$ . The function  $f_h$  is invertible, where the inverse of the function is defined as follows

$$f_h^{-1}(B, \Omega, Q) = \left( h(\Omega)^{-1} Q, B h(\Omega)^{-1} Q \right)$$

where the first element on the right hand side of the equation corresponds to the structural parameter  $A_0$  and the second element corresponds to  $A_+$ . Using this relationship, it is evident that the structural parameterization depends on both the reduced-form parameters as well as on the orthogonal matrices.

Let the matrix  $O_j$  contain information on the zero restrictions due to the  $j$ th structural shock for the range  $1 \leq j \leq n$ . The matrix  $O_j$  has dimensions  $o_j \times r$  and is of full row rank, where  $o_j = 0, \dots, n - j$ , for  $j = 1, \dots, n$ . In what follows, we describe Algorithms (2) and (3) in Arias et al. (2018).

ALGORITHM 2: Using this algorithm, we make independent draws from a distribution that lies over the structural parameterization conditional on the zero restrictions imposed in the baseline model.

1. Make independent draws  $(B, \Omega)$  from the normal-inverse-Wishart (NIW) distribution
2. Make independent draws  $X_j \in R^{n+1-j-o_j}$ , for  $j = 1, \dots, n$ , from a standard normal distribution and set  $W_j = X_j / \| X_j \|^2$

3. Define  $Q = [q_1, \dots, q_n]$  using the recursive relationship  $q_j = K_j W_j$  for any matrix  $K_j$ . The columns of  $K_j$  form an orthogonal basis for the null space of the matrix with dimension  $(j - 1 + o_j) \times n$  such that

$$M_j = \left[ q_1 \dots q_{j-1} \left( O_j F \left( f_h^{-1} (B, \Omega, I_n) \right) \right)' \right]'$$

where the function  $F$  is assumed to be continuous.

4. Set  $(A_0, A_+) = f_h^{-1} (B, \Omega, Q)$
5. Go back to Step 1, until the required number of draws is obtained.

ALGORITHM 3: Using this algorithm, we obtain independent draws from the normal-generalized-normal (NGN) distribution over the structural parameterization conditional on both the sign and as well on the zero restrictions. Let  $\Phi$  represent the set of all structural parameters that satisfy the zero restrictions and  $v_{(gof_h)}$  the volume element.

1. Independently draw  $(A_0, A_+)$  using Algorithm 2
2. If  $(A_0, A_+)$  satisfies the sign restrictions, then set the importance weight to

$$\frac{NGN(A_0, A_+)}{NIW(B, \Omega) v_{(gof_h)|\Phi}(A_0, A_+)} \propto \frac{|\det(A_0)|^{-(2n+m+1)}}{v_{(gof_h)|\Phi}(A_0, A_+)}$$

If  $(A_0, A_+)$  does not satisfy the sign restrictions, set its importance weight to 0.

3. Repeat Step 1 until the required number of draws is obtained.
4. Using importance weights, conduct sampling with replacement.

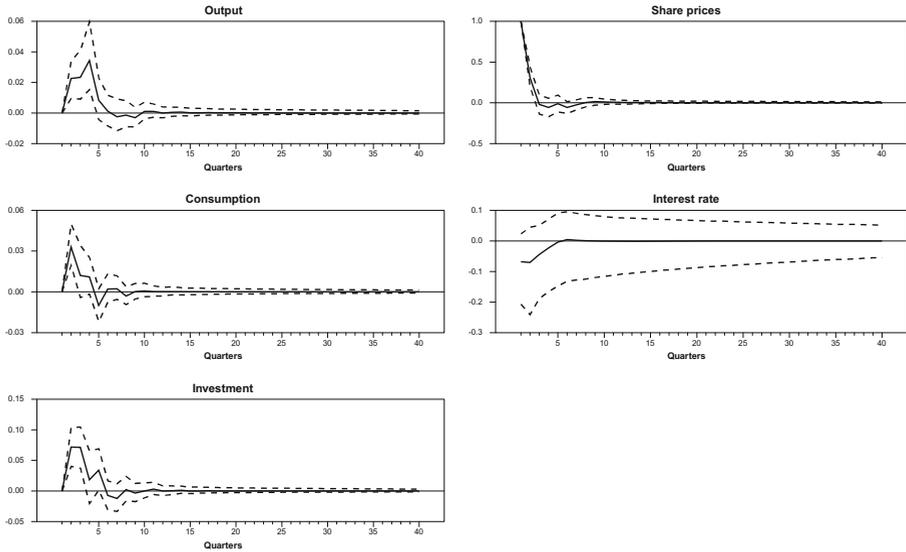
For more details and proofs, see Arias et al. (2018) and the respective supplementary materials.

## 4 Empirical Evidence

### 4.1 Based on Zero Restrictions

We start with the evidence based on the Bjørnland and Leitemo (2009) short- and long-run restrictions approach. In Figs. 1–7 we plot the impulse responses of the real GDP, real consumption, real investment, real share prices, and the domestic interest rates of each of the G7 countries to a share price shock. The respective impulse responses are plotted with probability bands represented as 0.16 and 0.84 fractiles, following Doan (2004), Bjørnland and Leitemo (2009), Uhlig (2005), and Beaudry et al. (2011), and Arias et al. (2018). This is a methodology of Bayesian inference simulation constructed by Monte Carlo integration with sufficient draws for our just identified model extracted from the posterior distribution of our VAR coefficients. The shocks are normalized such that the share price shock increases the real share prices by one per cent in the first quarter.

Looking at the results for Canada in Fig. 1, we see that an unanticipated increase in the price of shares leads to a gradual increase in the output. Output reacts in a hump-shaped pattern, reaching a maximum of a 3.5 basis points increase at the end of the



**Fig. 1** Impulse responses for Canada based on the short- and long-run restrictions approach

first year following the shock. By the end of the first year, the effect essentially dies out. Consumption spending also increases in response to the positive shock in real share prices. The positive effect on consumption is statistically significant in the first three quarters. Consumer spending reaches a maximum of 3.5 basis points increase in the middle of the first year following the shock. Real investment increases, reaching a maximum of 7 basis points increase in the second quarter following the initial shock. The positive effect remains statistically significant till the end of the first year. We find that increase in real share prices has no statistically significant effect on interest rates in Canada.

Figure 2 shows the impulse responses for France. Output increases gradually, reaching a maximum of 1.25 basis points increase at the end of the first year following the initial shock to the real share prices. The positive effect remains statistically significant for the first five quarters. Consumption increases, reaching a maximum near the end of the first year following the shock. The positive effect becomes statistically insignificant by the beginning of the second year. Real investment increases, reaching a maximum of 4 basis points increase in the third quarter. The positive effect on investment lasts for the first five quarters after the initial shock to the real share prices. We also find that the increase in real share prices has no statistically significant effect on the interest rate in France.

Figure 3 plots the impulse responses for Germany. An unanticipated increase in real share prices leads to an increase in output. The increase reaches a maximum of 3.5 basis points after three quarters following the initial shock. The positive effect on output persists for the first one and half years. The effect on consumption is initially negative in the second quarter, but positive in the fifth and eighth quarters. We conclude that share price shocks have little or no effect on consumption in Germany.

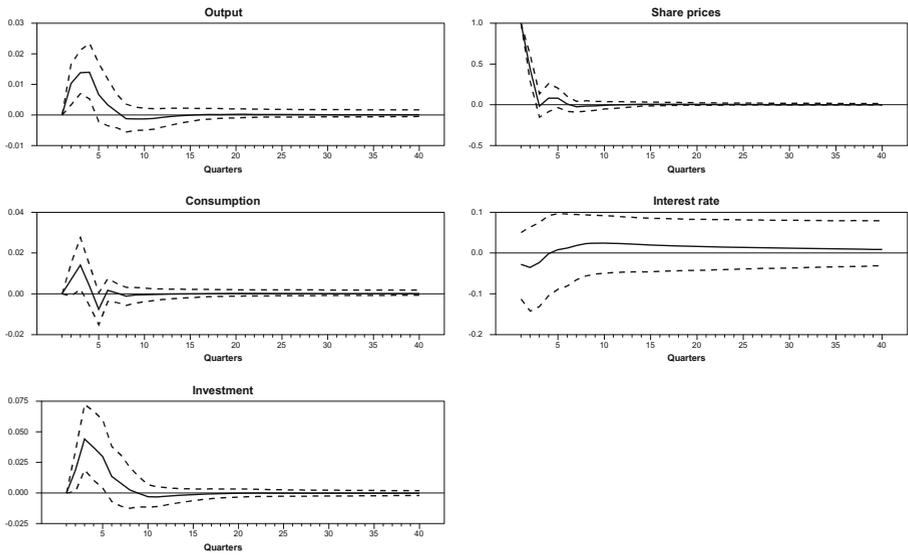


Fig. 2 Impulse responses for France based on the short- and long-run restrictions approach

Investment rises more slowly than output, reaching a maximum of a 6 basis points increase at the end of the first year following the initial shock. The positive effect remains till the middle of the next year. We find evidence that the increase in real

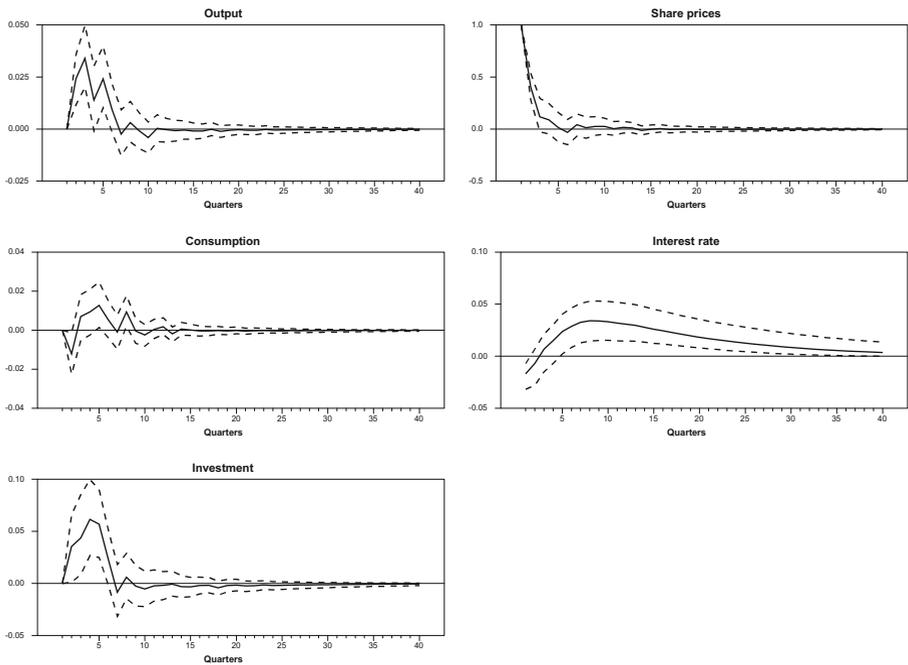
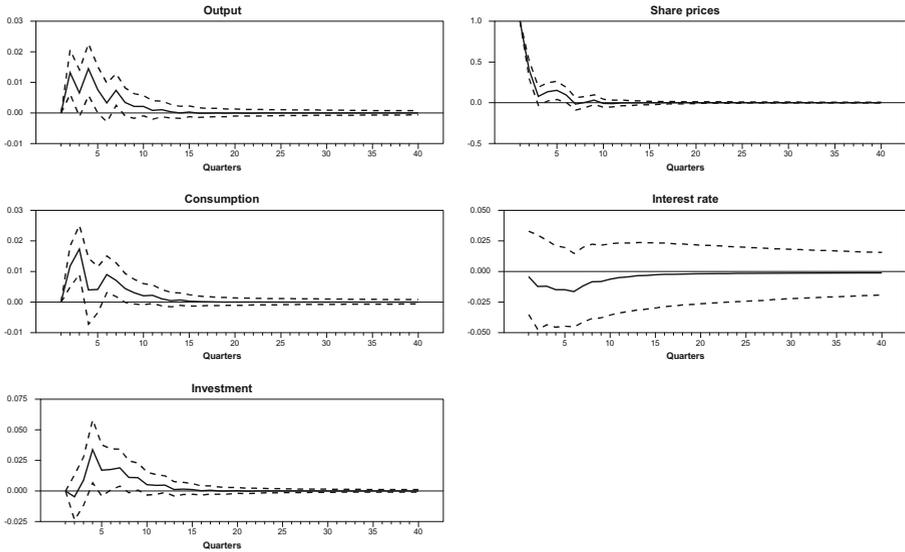


Fig. 3 Impulse responses for Germany based on the short- and long-run restrictions approach



**Fig. 4** Impulse responses for Italy based on the short- and long-run restrictions approach

share prices increases the domestic interest rate in Germany, at the beginning of the second year following the initial shock.

Looking at Fig. 4, we see that output, consumption and real investment all increase in response to an unanticipated increase in real share prices in Italy. Output increases, reaching a maximum of a 1.3 basis points increase in the middle of the first year following the shock. Consumption increases, reaching a maximum of a 1.75 basis points increase in the third quarter. Investment, on the other hand, increases at a slower pace, reaching a maximum of 3.5 basis points increase near the end of the first year following the initial shock to the real share prices. We find that positive shocks to real share prices do not have any statistically significant effect on the interest rate in Italy.

Figure 5 plots the impulse responses for Japan. We observe that a positive shock to the real share prices in Japan leads to an increase in output, which reaches a maximum of 5 basis points at the third quarter following the initial shock. Consumption also increases, reaching a maximum of a 4 basis points increase after two quarters following the initial shock. The positive effect essentially dies out at the beginning of the second year. Investment increases gradually, reaching a maximum of a 6 basis points increase after six months following the shock. Interest rates, on the other hand, react negatively to the increase in real share prices, reaching a minimum of seven basis points decrease in the second quarter. The results are not surprising, since the primary monetary authority in Japan, the Bank of Japan, adopted a negative interest rate policy at the beginning of 2016 to boost economic growth and combat inflation in an economy that is heavily reliant on exports.

Looking at the impulse responses for the United Kingdom in Fig. 6, we observe that output increases gradually in response to a positive shock in the real share price.

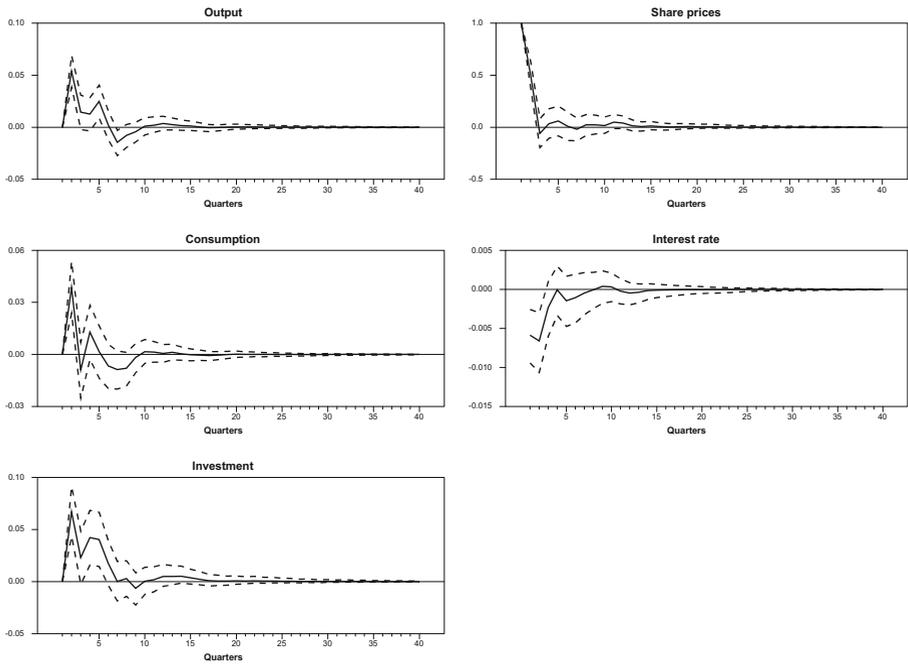


Fig. 5 Impulse responses for Japan based on the short- and long-run restrictions approach

Output reaches a maximum of a 3.5 basis points increase at the end of the first year following the shock. The positive effect also persists for the first two quarters of the second year. Investment also increases but at a much slower pace than output and the

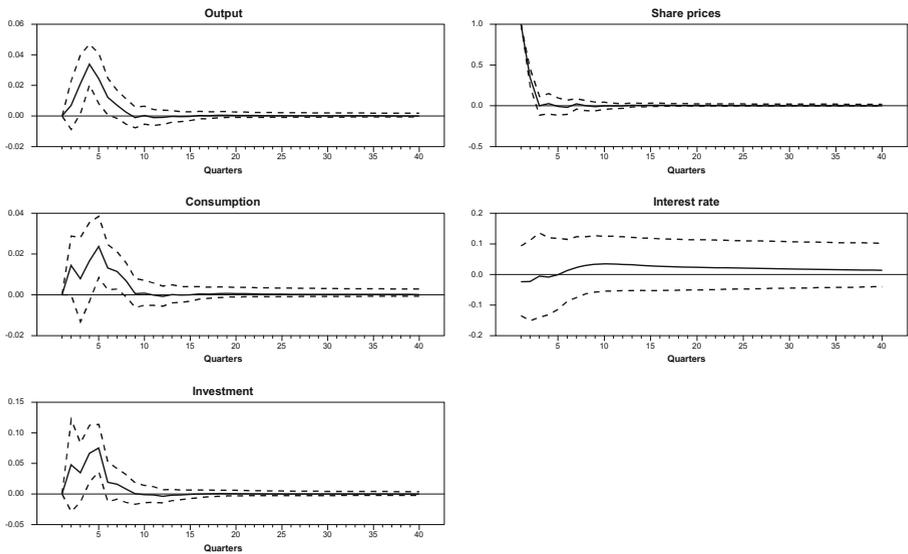


Fig. 6 Impulse responses for the United Kingdom based on the short- and long-run restrictions approach

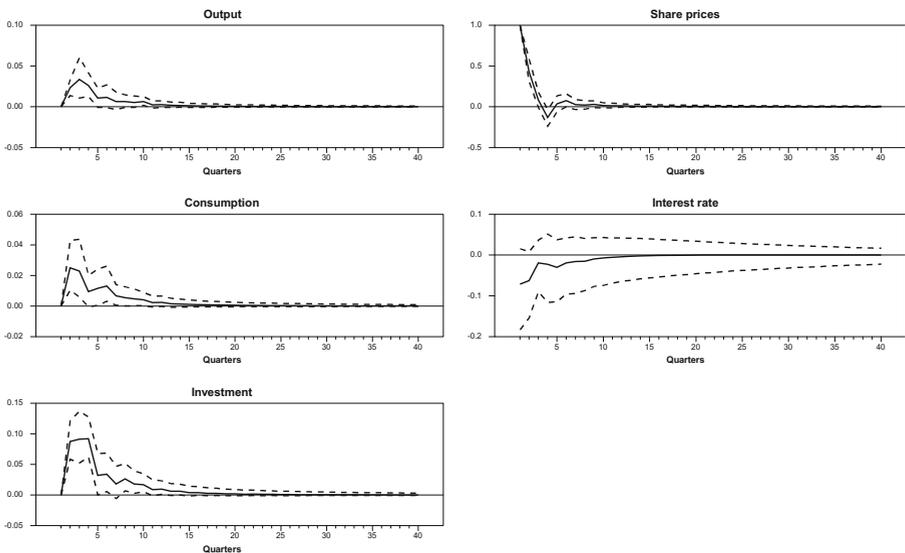
positive effect reaches a maximum of a 4 basis points increase in the fifth quarter. The positive effect essentially diminishes after that. Consumer spending increases at a slow pace, in response to the increase in real share prices, reaching a maximum of a 2.5 basis points increase after 5 quarters. The positive effect also persists for most of the second year. We find that the increase in real share prices has no statistically significant effect on interest rates in the United Kingdom.

Finally, Fig. 7 plots the impulse responses of the different macroeconomic aggregates in the United States to an increase in domestic real share prices. We observe that output increases at a slow pace, but reaches a maximum of 3.5 basis points at the third quarter following the shock to the system. Consumption reaches a maximum of a 2.5 basis points increase after six months. The positive effect is statistically significant for the first seven quarters. Investment also increases gradually, reaching a maximum of 9 basis points after three quarters. We find that the increase in real share prices has no statistically significant effect on the effective federal funds rate (interest rate) in the United States.

Summarizing our key findings, we observe that an unanticipated increase in real share prices leads to

- an increase in real output in the short run
- an increase in real consumption expenditure in the short run
- an increase in real investment in the short run

Our results are consistent with the established view in the literature that increases in real share prices increase consumption expenditure through the wealth (or income) effect and investment spending through a Tobin  $q$  effect. As a result, aggregate demand, in our case real GDP, also increases. In this regard, the wealth effect on



**Fig. 7** Impulse responses for the United States based on the short- and long-run restrictions approach

consumption predicts that an increase in asset prices, such as stock prices and house prices, increase overall household wealth, essentially making households ‘richer.’ Tobin’s  $q$  theory predicts that a rise in the valuation of firms should be positively correlated with the rise in the incentive to invest — see Gilchrist and Leahy (2002). Our results are consistent with the findings of Bjørnland and Leitemo (2009) who report that an increase in real stock prices leads to an increase in output in the United States in the short run. We find that an unanticipated increase in real share prices leads to an increase in real output, real investment and real consumption in all G7 countries. In other words, increases in real share prices temporarily boost optimism in the economy, and through the wealth effect on consumption and Tobin’s  $q$  effect on investment lead to higher consumer expenditure and investment spending in the short run.

### 4.2 Based on Sign Restrictions

Figures 8, 9, 10, 11, 12, 13 and 14 show the impulse responses from the pure-sign-restrictions approach with  $K = 1$ . That is the impulse responses of the real share prices, real consumption expenditure, and real investment have been restricted to not be negative for the first 2 quarters following the shock. Again, we have fitted a VAR with 4 lags in growth rates of all the variables except for the interest rate. We have not included a constant or a time trend as in Uhlig (2005). Looking at the results for Canada in Fig. 8, we see that share prices respond largely and positively, typically

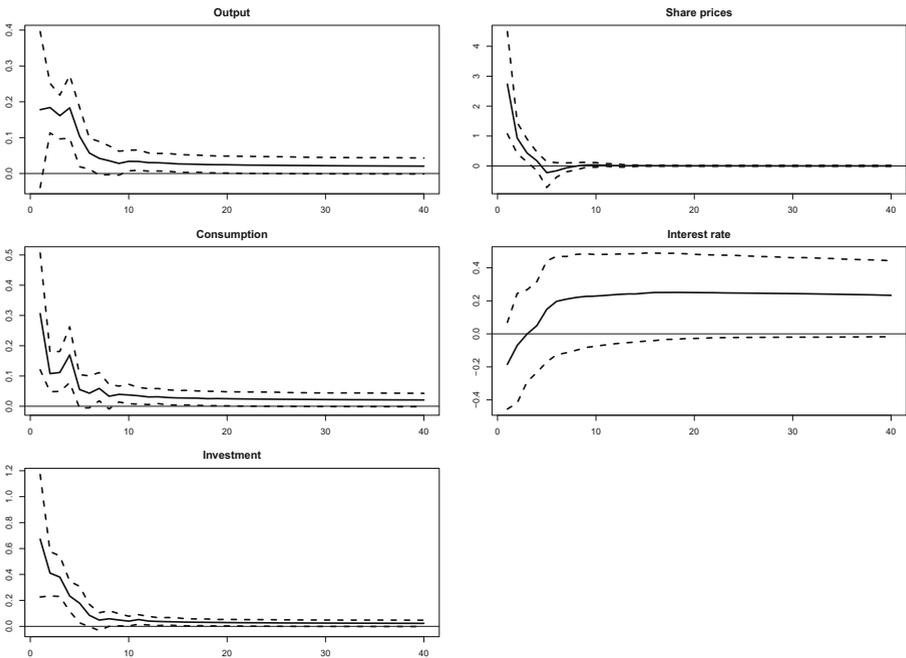


Fig. 8 Impulse responses for Canada based on the pure-sign restrictions approach

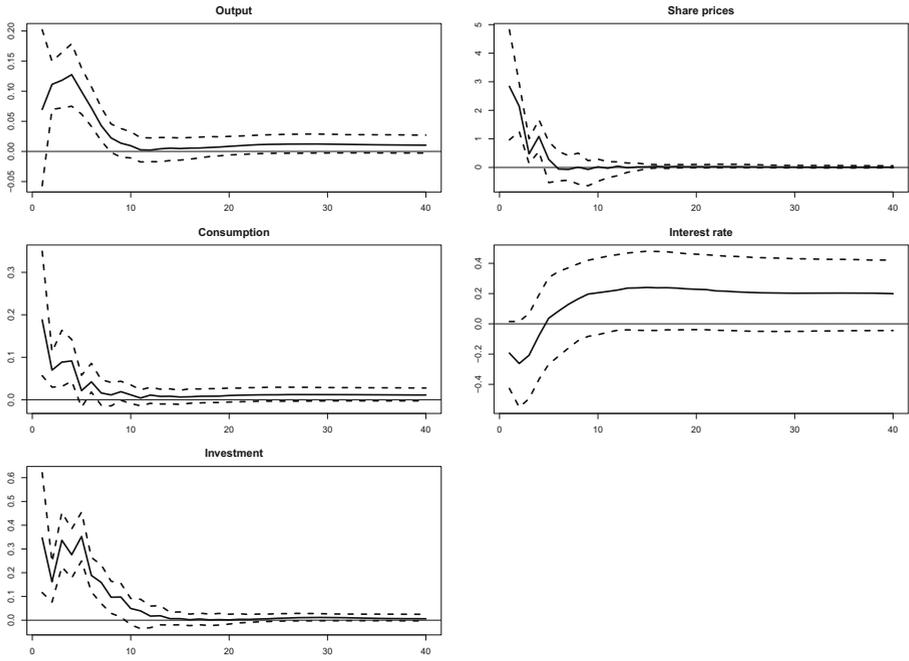


Fig. 9 Impulse responses for France based on the pure-sign restrictions approach

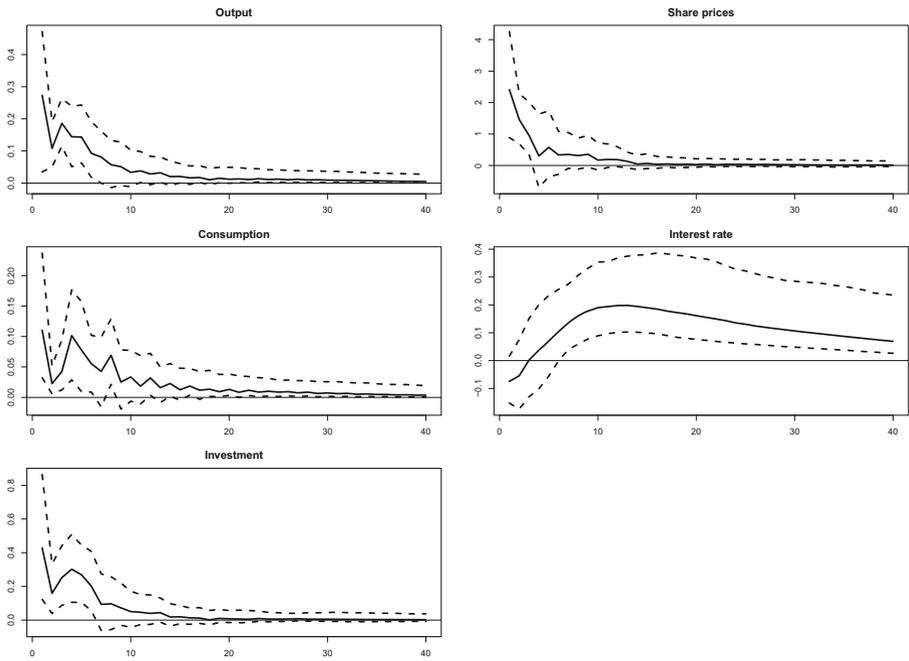


Fig. 10 Impulse responses for Germany based on the pure-sign restrictions approach

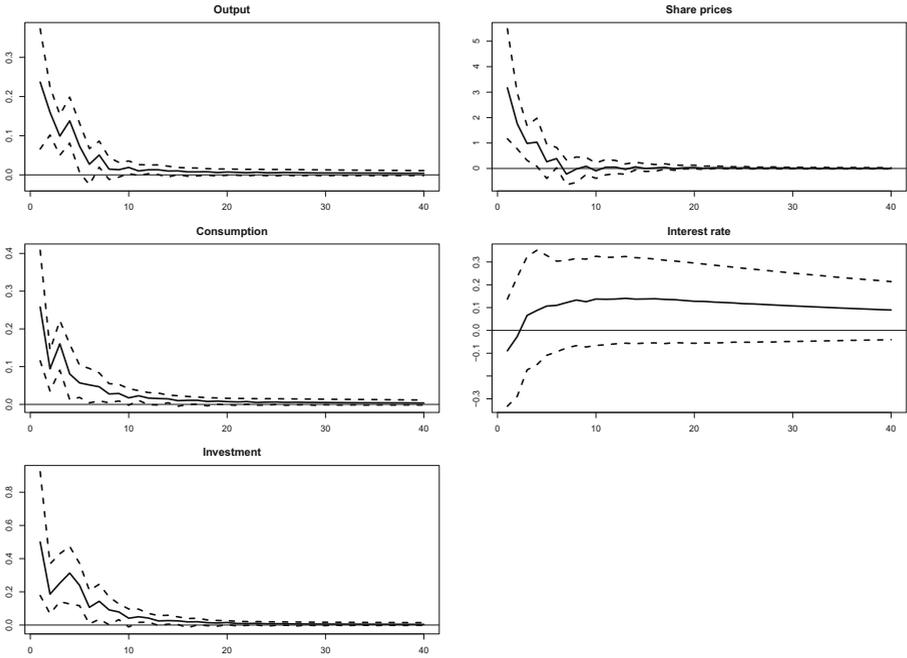


Fig. 11 Impulse responses for Italy based on the pure-sign restrictions approach

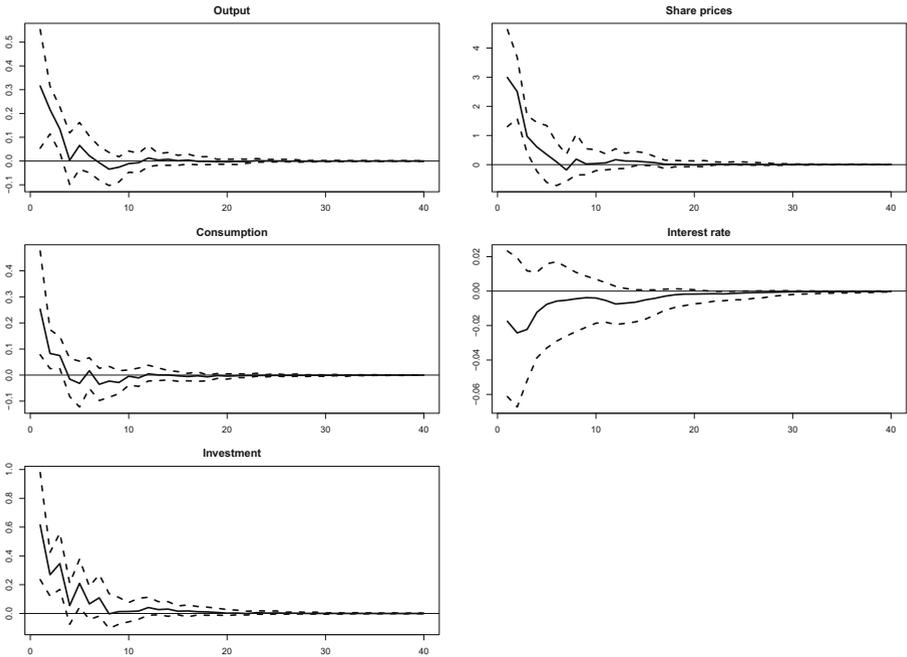


Fig. 12 Impulse responses for Japan based on the pure-sign restrictions approach

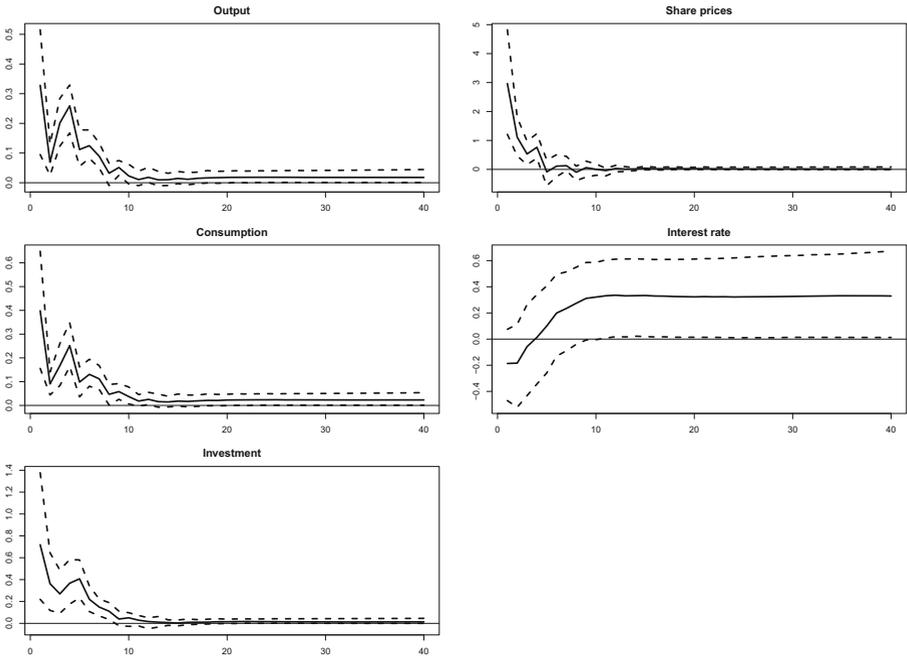


Fig. 13 Impulse responses for the United Kingdom based on the pure-sign restrictions approach

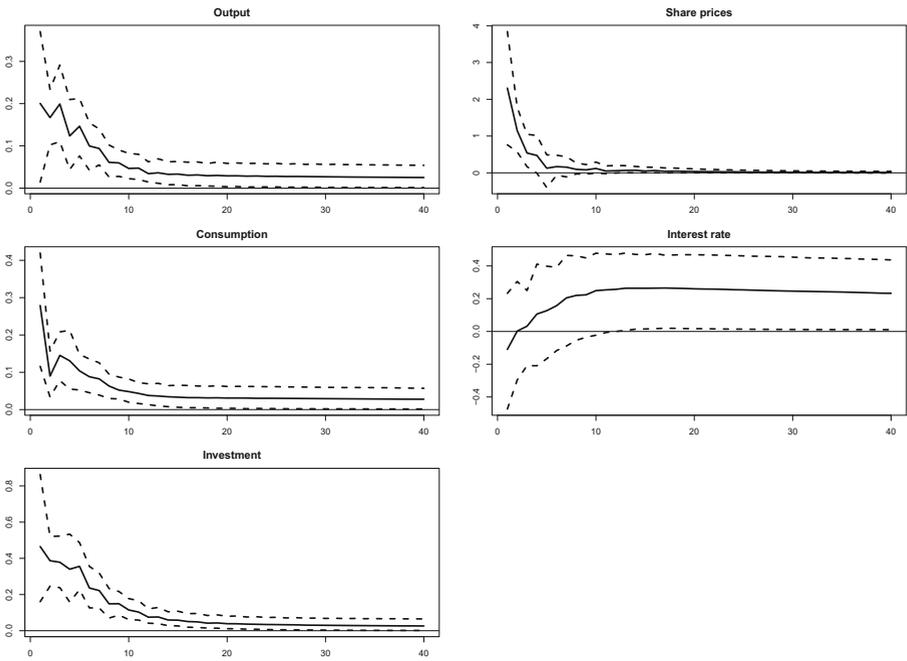


Fig. 14 Impulse responses for the United States based on the pure-sign restrictions approach

rising by 2.5 per cent and then reversing course by the end of the first year. We see that real output increases slowly, reaching a maximum of 18 basis points in the second quarter following the shock. The positive response remains statistically significant until the end of the second year following the initial shock. Real consumption increases by 30 basis points, on the first quarter. Real investment increases by 65 basis points on impact. The positive response remains statistically significant in the first five quarters and then again from the 8th to the 14th quarter. We find that a one standard deviation shock to the real share prices has no statistically significant effect on interest rates in Canada.

Figure 9 displays the impulse responses for France. We observe that a one standard deviation increase in the real price of shares leads to an increase in output that reaches a maximum of 12.5 basis points at the beginning of the second year following the shock. The positive effect persists until the end of the second year. Consumption increases immediately upon impact, reaching its highest value in the first period, an 18 basis points increase from its initial steady-state value. Real investment increases by 35 basis points on impact. The positive effect on investment remains statistically significant for nine quarters. We observe that a one standard deviation shock to the real share prices has no statistically significant effect on interest rates in France.

Figure 10 depicts the impulse responses of the different macroeconomic aggregates of Germany to a one standard deviation increase in the real price of shares. We see that share prices increase immediately, reaching a maximum of a 2.4 per cent increase. By the beginning of the second year, the positive effect dissipates. Output increases in the first quarter following the initial shock and reaches a maximum of a 28 basis points increase from its initial steady-state value at the end of the first year. By the beginning of the seventh quarter, the positive effect becomes statistically insignificant. Real consumption expenditure increases on impact, reaching a maximum of a 11 basis points increase from the initial steady-state level. Real investment increases on impact by 42 basis points, and the positive effect remains statistically significant for the first seven quarters following the initial shock. We observe than an unanticipated increase in the real price of shares leads to an increase in the interest rate in Germany in the seventh quarters. The positive effect is statistically significant for the remaining quarters in the analysis.

Looking at the impulse responses for Italy in Fig. 11, we see that an unanticipated increase in the real prices of shares leads to an increase in output, which reaches a maximum of 24 basis points. The positive effect remains statistically significant for the first 5 quarters, and again is positive in the seventh quarter. Consumption increases by 26 basis points upon impact. The positive effect lasts for the first 10 quarters. Investment reacts largely and immediately, increasing by 50 basis points upon impact, after which the effect dissipates. The positive effect on investment persists for the first 10 quarters. We find that a positive shock to real share prices has no effect on interest rates in Italy.

Figure 12 plots the impulse responses for Japan. We observe that the share prices react largely and positively to the initial shock, rising by 3 per cent upon impact. By the beginning of the second year, the variable reverses course. Output also increases, reaching a maximum of a 32 basis point increase in the first quarter following the initial shock. The positive effect becomes statistically insignificant after the end of

the first year. Consumption increases by 25 basis points upon impact, and the positive effect lasts till the end of the first year. Real investment increases on impact by 60 basis points. We find that the unanticipated shock to the real prices of shares has no impact on the interest rate in Japan.

Looking at the results for the United Kingdom in Fig. 1, we see that a one standard deviation shock to the real prices of shares leads to an increase in output in the first quarter, where it reaches a maximum of a 33 basis points increase. The positive effect on output persists for the first two years. Real consumption increases by 40 basis points on impact, it's maximum. The positive effect remains statistically significant for the first two years. Real investment also increases upon impact and reaches a maximum of 70 basis points. The positive effect lasts until the end of the second year following the initial shock. We observe that the interest rate increase 10 quarters following the initial shock to the real price of shares. The positive effect remains statistically significant for the remaining quarters.

Finally, Fig. 14 plots the impulse responses for the United States. Output increases by 20 basis points at the end of the first quarter following the one standard deviation positive shock to the real prices from shares. Consumption increases by 28 basis points on impact. The positive effect on output and consumption lasts for the first five years after the initial shock. The effective federal funds rate increases after three years following the initial shock and remains positive for the remaining period in our analysis. Real investment increases by 45 basis points upon impact and the effect remain positive for the first six years.

Summarizing our key findings with the pure sign restrictions approach to identification, we observe than an unanticipated increase in the real prices of shares leads to a temporary increase in output in all member countries of the G7. We find evidence, that consumption and investment increase as well, albeit in the short run. Our findings are consistent with the results obtained in the previous section, using the short- and long-run restrictions approach to identification.

### 4.3 Based on Both Zero and Sign Restrictions

In this section, we present the results using the sign and zero restrictions approach to identification developed by Arias et al. (2018). Four parameters — a scalar  $\bar{v}$ , symmetric and positive definite matrices  $\bar{\phi}$  and  $\bar{\Sigma}$  of dimensions  $n \times n$  and  $m \times m$ , respectively, and a  $\bar{\psi}$  matrix of dimension  $m \times n$  — help to characterize a normal-inverse-Wishart distribution that lies over the respective reduced-form parameters, and are set as follows

$$\bar{v} = \bar{\phi} = \bar{\Sigma}^{-1} = \bar{\psi} = 0.$$

As already noted, our model in this section consists of five variables, real output,  $y$ , real consumption,  $c$ , real investment,  $i$ , unit labour costs,  $l$ , and real share prices,  $s$ . All the variables enter the VAR as percentage changes (logarithmic first differences times 100). The structural VAR estimation is carried out with four lags and a constant term, as in Beaudry et al. (2011) and Arias et al. (2018).

Following Nam and Wang (2019), we identify optimism shocks as booms in the stock market (captured by a positive sign restriction on the real share prices variable),

increases in private consumption, and a zero restriction on unit labour costs at horizon 0, as follows

Shock/Variable	$\Delta l_t$	$\Delta s_t$	$\Delta y_t$	$\Delta c_t$	$\Delta i_t$
Restriction	0	$> 0$		$> 0$	

We only impose these restrictions on the three variables on impact (horizon zero). Our variables of interest are output and investment, and we impose no sign restrictions on these two variables, that is we remain agnostic about the response of output and investment. Figures 15, 16, 17, 18, 19, 20 and 21 displays the impulse responses for each member of the G7. The solid curves in each of the figures correspond to the point-wise posterior medians, while the shaded regions represent the 68 per cent equal-tailed point-wise probability bands.

Looking at the results for Canada in Fig. 15, we observe that an optimism shock boosts consumption and share prices, while unit labour costs remain unchanged in period 0 consistent with our imposed sign and respective restrictions. Share prices increase by 4 per cent upon impact and return to their baseline steady-state level by the end of the first year. Consumption increases by 25 basis point upon impact and returns to its long-run equilibrium level by the beginning of the second year. We find that output reacts slowly and positively, reaching a maximum of a 20 basis points increase in the second quarter. The positive effect on output persists for the next three quarters. Investment also rises, increasing by 40 basis points in the middle of the first year. The positive effect on investment lasts until the end of the year. We find that optimism shocks have no statistically significant effect on unit labour costs in Canada.

Figure 16 plots the impulse responses for France. Share prices and consumption increase while unit labour costs remain unchanged at period 0 as per our imposed

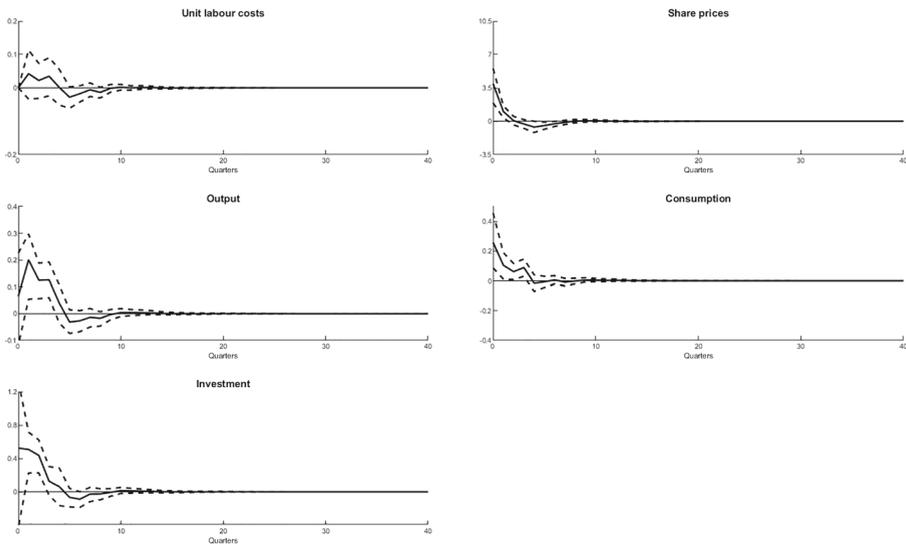


Fig. 15 Impulse responses for Canada based on the sign and zero restrictions approach

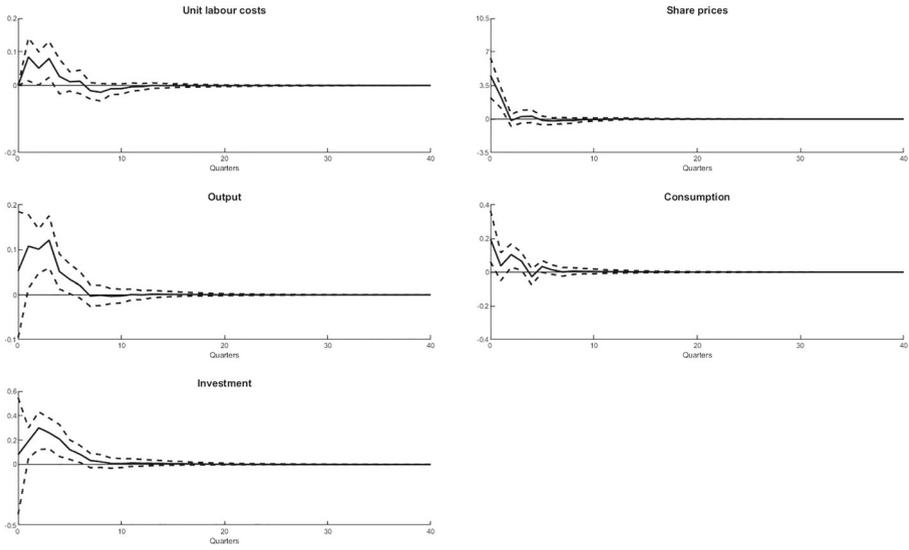


Fig. 16 Impulse responses for France based on the sign and zero restrictions approach

restrictions. However, we find that after period 0, unit labour costs rise and the positive effect lasts till the end of the first year following the initial shock. Output rises slowly, in the second quarter, and reaches the maximum of a 12.5 basis points increase in the fourth quarter; the positive effect lasts till the middle of the second year following the initial shock. Investment also rises slowly in response to the optimism shock, reaching a maximum of a 30 basis points increase in the middle of the

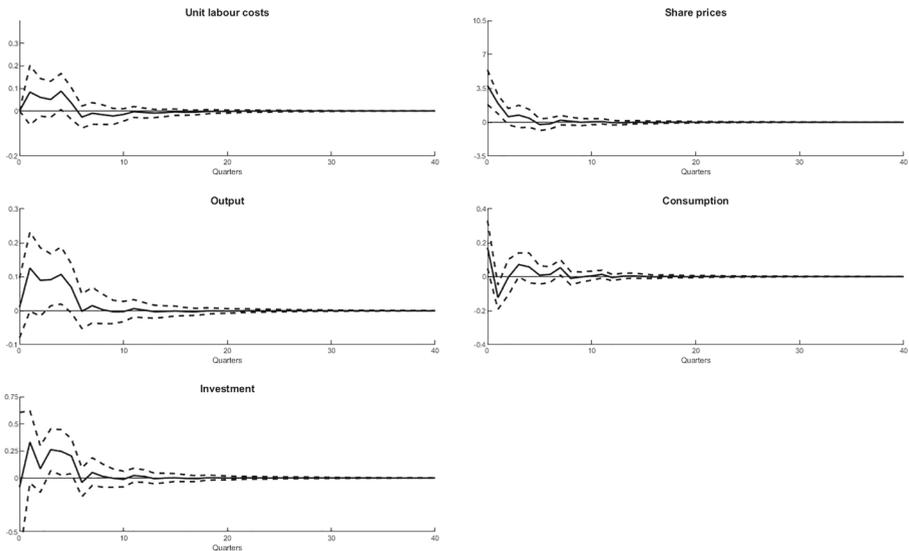


Fig. 17 Impulse responses for Germany based on the sign and zero restrictions approach

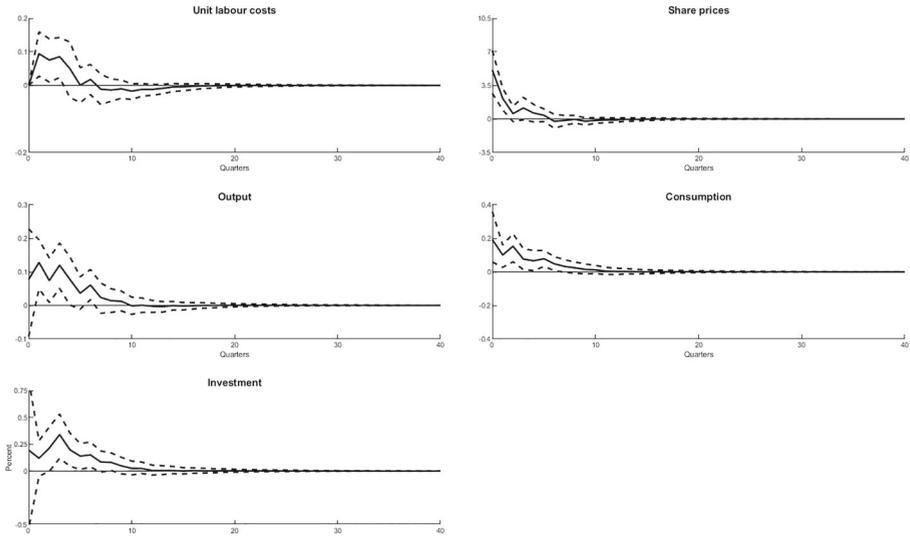


Fig. 18 Impulse responses for Italy based on the sign and zero restrictions approach

first year following the shock. Figure 17 graphs the impulse responses for Germany in response to an optimism shock. We see that output increases slowly and reaches a maximum of a 10 basis points increase in the middle of the first year following the initial shock. The positive effect on output lasts for the next three quarters. Investment responds similarly to output and reaches a maximum of a 25 basis points increase in the beginning of the second year following the shock. The positive effect lasts for

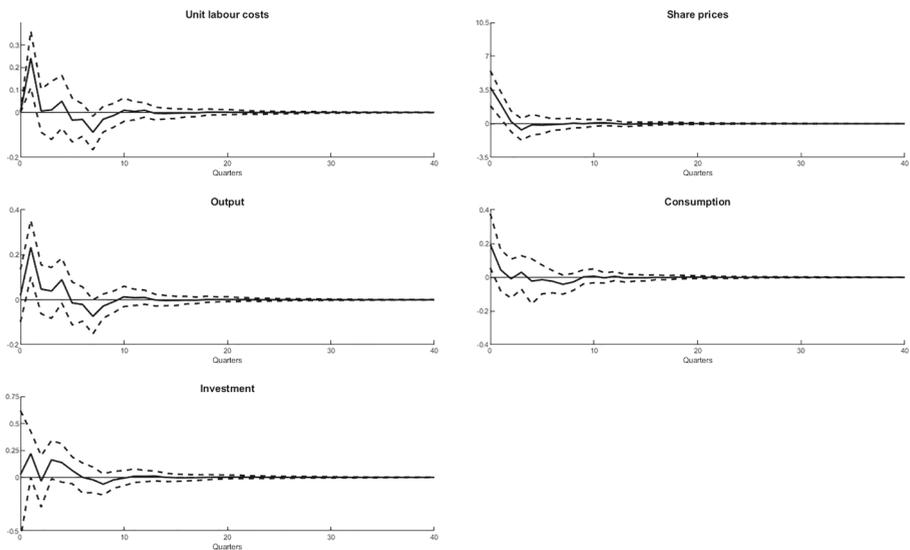
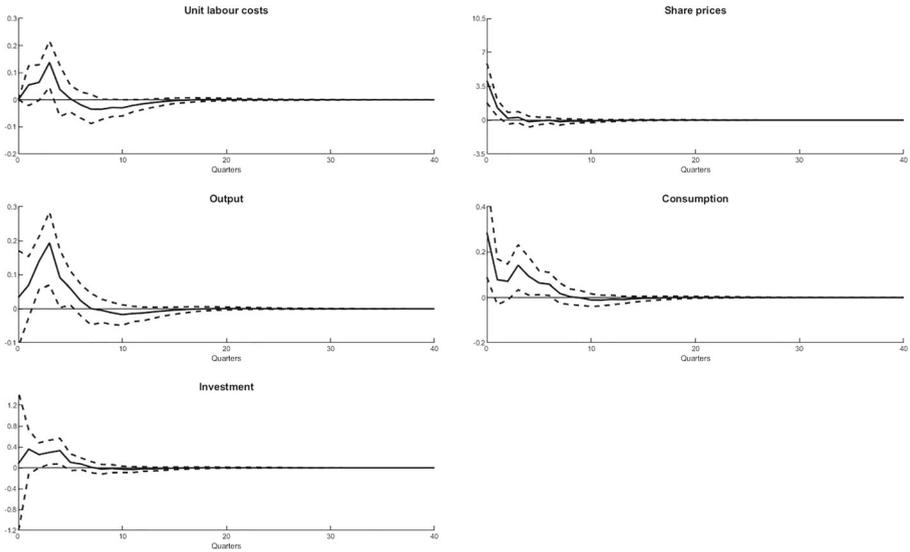


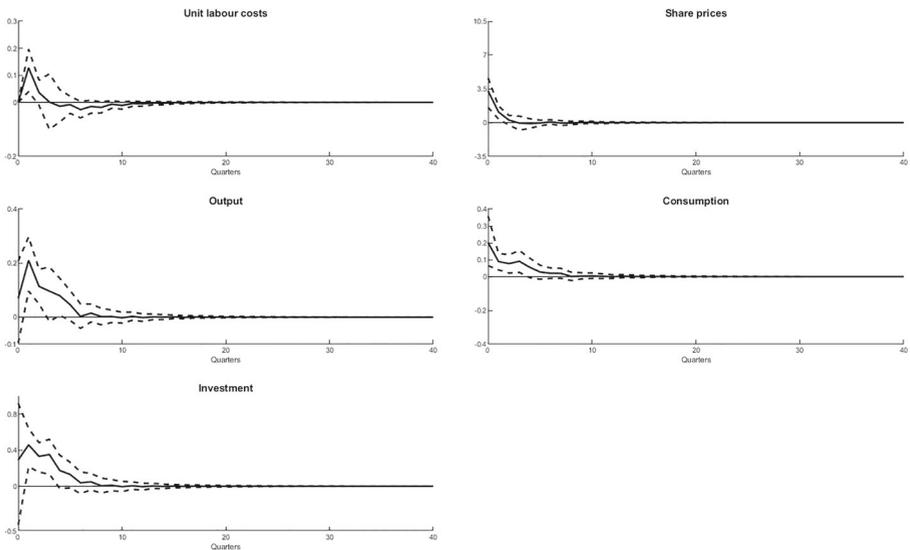
Fig. 19 Impulse responses for Japan based on the sign and zero restrictions approach



**Fig. 20** Impulse responses for the United Kingdom based on the sign and zero restrictions approach

three quarters after that. We also find that the optimism shock does not affect unit labour costs in Germany.

Looking at the impulse responses for Italy in Fig. 18, we see that in response to the optimism shock, share prices and consumption both rise. Consumption returns to its steady state level by the end of the second year following the initial shock. Unit labour costs remain unaffected in period 0 (due to our zero restriction), but



**Fig. 21** Impulse responses for the United States based on the sign and zero restrictions approach

increase subsequently, with the positive effect lasting until the end of the first year. Output increases gradually, reaching a maximum of a 14 basis points increase in the middle of the first year following the initial optimism shock. Investment also reaches a maximum of a 30 basis points increase, by the end of the first year. Figure 19 graphs the impulse responses for Japan. We observe that share prices and consumption both increase, while unit labour costs remain constant at quarter 0. Unit labour costs then increase, reaching a maximum of a 25 basis points increase in the second quarter following the shock. The effect dissipates by the end of the following quarter. Output increases gradually, reaching a maximum of a 25 basis points increase in the second quarter. Investment does not respond to the optimism shock.

Looking at the results for the United Kingdom in Fig. 20, we observe that unit labour costs do not change at horizon zero after a shock to optimism, as per our restriction. However, in the third quarter, unit labour costs rise, eventually reaching a maximum of 14 basis points. We observe that output increases at a slow pace, reaching a maximum of 20 basis points at the start of the second year following the shock. Investment rises at an even slower pace than output and reaches a maximum of 10 basis points in the fifth quarter following the shock. The positive response of output and investment is short-lived. Share prices and consumption both increase in response to the optimism shock. Finally, Fig. 21 plots the impulse responses for the United States. We observe that consistent with our restrictions, share prices and consumption increase while unit labour costs remain constant on impact. After horizon 0, unit labour costs increase, reaching a maximum of 12 basis points in the second quarter. Output increases sluggishly, reaching a maximum of 21 basis points, in the middle of the first year following the initial shock. The positive effect on output lasts until the beginning of the second year. Investment rises, reaching a peak of 45 basis points in the second quarter following the shock. The positive effect on investment lasts until the middle of the second year.

In general, we find that our identified optimism shock increases output and investment in the short run. However contrary to the findings of Nam and Wang (2019), the effects on output and investment are not persistent for the member countries of the G7. Although, both the macroeconomic aggregates increase for all the member countries of the G7, the optimism shocks do not induce a broad economic boom. The economic growth that is induced is only present in the short run. The results are consistent with the evidence by Bjørnland and Leitemo (2009), who find that positive stock price shocks in a structurally identified VAR, lead to increases in output in the short run.

We find that in general, unit labour costs increase in the short run in response to the optimism shock. Recall that unit labour costs measure the average cost of employing labour per unit of real output produced, showing the inverse relationship between labour productivity (the denominator in the calculation of unit labour costs) and unit labour costs. Higher unit labour costs might imply lower labour productivity. We find that optimism shocks lead to a fall (rise) in labour productivity (unit labour costs) in the short run, a result consistent with the findings of Nam and Wang (2019). However, contrary to the findings of Nam and Wang (2019), we document that in the G7, there are no long-run effects of optimism shocks on labour productivity. Another possible

explanation for the increase in unit labour costs in the short run might be attributed to the fact that higher optimism induces higher firm-level investment, increasing the demand for labour. For a given labour supply, the labour demand curve shifts to the right, pushing up the real wage rate. At the same time, in the short run, labour productivity is inelastic in its response to optimism shocks. This might be due to the fact that the income effect dominates or cancels out the substitution effect after a real wage increase. As a result, with the numerator increasing at a greater rate than the denominator, unit labour costs rise in the short run. Our results are also consistent with the work of Enders et al. (2017), who report that optimism shocks have an expansionary effect on output, but the effect is short-lived.

#### 4.4 Robustness

We repeat our investigation of the impact of positive shocks to share prices on real output in each of the G7 countries using industrial production data (instead of GDP data) retrieved from the OECD (<https://data.oecd.org/industry/industrial-production.htm>). Using the three different methodological approaches to identification, we observe that our main findings reported throughout this paper hold up well with the alternative measure of output (these results are not reported here, but are available upon request). That is, positive shocks to share prices, lead to temporary increases in industrial production. Thus, our results are robust to plausible and alternative structural VAR models and data.

### 5 Conclusion

In this paper, we investigate the impact of shocks originating from the stock market on the level of economic activity in the seven largest industrialized economies of the world, the G7. We investigate if periods of optimism, proxied by unanticipated increases in share prices, stimulate macroeconomic activity. To answer our research agenda, in the context of a structural VAR framework we use three different identification schemes. The first scheme achieves identification via short-run and long-run restrictions, the second based on sign restrictions, and the third uses a state-of-the-art method that combines both sign and zero restrictions. We observe that positive shocks to real stock prices

- lead to increases in consumption, through improved consumer sentiment and a wealth effect.
- lead to increases in investment spending, by boosting investor confidence in the economy, consistent with the predictions of Tobin's  $q$  theory.
- lead to rise in output; with two of the components of aggregate demand increasing, real GDP also increases in the short run.

Thus a bullish market, promotes higher economic growth in the short run.

## Appendix

**Table 2** Data sources

Country	Variable	Source
Canada	Gross Fixed Capital Formation	<a href="https://fred.stlouisfed.org/series/NAEXKP04CAQ661S">https://fred.stlouisfed.org/series/NAEXKP04CAQ661S</a>
	Total Gross Domestic Product	<a href="https://fred.stlouisfed.org/series/NAEXKP01CAQ661S">https://fred.stlouisfed.org/series/NAEXKP01CAQ661S</a>
	Private Final Consumption Expenditure	<a href="https://fred.stlouisfed.org/series/NAEXKP02CAQ661S">https://fred.stlouisfed.org/series/NAEXKP02CAQ661S</a>
	Unit labour costs	<a href="https://fred.stlouisfed.org/series/ULQELP01CAQ661S">https://fred.stlouisfed.org/series/ULQELP01CAQ661S</a>
	Interest rate	<a href="https://www.bis.org/statistics/cbpol.htm">https://www.bis.org/statistics/cbpol.htm</a>
	Consumer Price Index	<a href="https://fred.stlouisfed.org/series/CPALCY01CAQ661N">https://fred.stlouisfed.org/series/CPALCY01CAQ661N</a>
France	Gross Fixed Capital Formation	<a href="https://fred.stlouisfed.org/series/NAEXKP04FRQ661S">https://fred.stlouisfed.org/series/NAEXKP04FRQ661S</a>
	Total Gross Domestic Product	<a href="https://fred.stlouisfed.org/series/NAEXKP01FRQ661S">https://fred.stlouisfed.org/series/NAEXKP01FRQ661S</a>
	Private Final Consumption Expenditure	<a href="https://fred.stlouisfed.org/series/NAEXKP02FRQ661S">https://fred.stlouisfed.org/series/NAEXKP02FRQ661S</a>
	Unit labour costs	<a href="https://fred.stlouisfed.org/series/ULQELP01FRQ661S">https://fred.stlouisfed.org/series/ULQELP01FRQ661S</a>
	Interest rate	<a href="https://fred.stlouisfed.org/series/IR3TIB01FRQ156N">https://fred.stlouisfed.org/series/IR3TIB01FRQ156N</a>
	Consumer Price Index	<a href="https://fred.stlouisfed.org/series/FRACPIALLQINMEI">https://fred.stlouisfed.org/series/FRACPIALLQINMEI</a>
Germany	Gross Fixed Capital Formation	<a href="https://fred.stlouisfed.org/series/NAEXKP04DEQ661S">https://fred.stlouisfed.org/series/NAEXKP04DEQ661S</a>
	Total Gross Domestic Product	<a href="https://fred.stlouisfed.org/series/NAEXKP01DEQ661S">https://fred.stlouisfed.org/series/NAEXKP01DEQ661S</a>
	Private Final Consumption Expenditure	<a href="https://fred.stlouisfed.org/series/NAEXKP02DEQ661S">https://fred.stlouisfed.org/series/NAEXKP02DEQ661S</a>
	Unit labour costs	<a href="https://fred.stlouisfed.org/series/ULQELP01DEQ661S">https://fred.stlouisfed.org/series/ULQELP01DEQ661S</a>
	Interest rate	<a href="https://fred.stlouisfed.org/series/IR3TIB01DEQ156N">https://fred.stlouisfed.org/series/IR3TIB01DEQ156N</a>
	Consumer Price Index	<a href="https://fred.stlouisfed.org/series/DEUCPIALLQINMEI">https://fred.stlouisfed.org/series/DEUCPIALLQINMEI</a>
Italy	Gross Fixed Capital Formation	<a href="https://fred.stlouisfed.org/series/NAEXKP04ITQ661S">https://fred.stlouisfed.org/series/NAEXKP04ITQ661S</a>
	Total Gross Domestic Product	<a href="https://fred.stlouisfed.org/series/NAEXKP01ITQ661S">https://fred.stlouisfed.org/series/NAEXKP01ITQ661S</a>
	Private Final Consumption Expenditure	<a href="https://fred.stlouisfed.org/series/NAEXKP02ITQ661S">https://fred.stlouisfed.org/series/NAEXKP02ITQ661S</a>
	Unit labour costs	<a href="https://fred.stlouisfed.org/series/ULQELP01ITQ661S">https://fred.stlouisfed.org/series/ULQELP01ITQ661S</a>
	Interest rate	<a href="https://fred.stlouisfed.org/series/IR3TIB01ITQ156N">https://fred.stlouisfed.org/series/IR3TIB01ITQ156N</a>
	Consumer Price Index	<a href="https://fred.stlouisfed.org/series/ITACPIALLQINMEI">https://fred.stlouisfed.org/series/ITACPIALLQINMEI</a>
Japan	Gross Fixed Capital Formation	<a href="https://fred.stlouisfed.org/series/NAEXKP04JPQ661S">https://fred.stlouisfed.org/series/NAEXKP04JPQ661S</a>
	Total Gross Domestic Product	<a href="https://fred.stlouisfed.org/series/NAEXKP01JPQ661S">https://fred.stlouisfed.org/series/NAEXKP01JPQ661S</a>
	Private Final Consumption Expenditure	<a href="https://fred.stlouisfed.org/series/NAEXKP02JPQ661S">https://fred.stlouisfed.org/series/NAEXKP02JPQ661S</a>
	Unit labour costs	<a href="https://fred.stlouisfed.org/series/ULQELP01JPQ661S">https://fred.stlouisfed.org/series/ULQELP01JPQ661S</a>
	Interest rate	<a href="https://fred.stlouisfed.org/series/IR3TCD01JPQ156N">https://fred.stlouisfed.org/series/IR3TCD01JPQ156N</a>
	Consumer Price Index	<a href="https://fred.stlouisfed.org/series/CPALTT01JPQ661S">https://fred.stlouisfed.org/series/CPALTT01JPQ661S</a>
United Kingdom	Gross Fixed Capital Formation	<a href="https://fred.stlouisfed.org/series/NAEXKP04GBQ661S">https://fred.stlouisfed.org/series/NAEXKP04GBQ661S</a>
	Total Gross Domestic Product	<a href="https://fred.stlouisfed.org/series/NAEXKP01GBQ661S">https://fred.stlouisfed.org/series/NAEXKP01GBQ661S</a>
	Private Final Consumption Expenditure	<a href="https://fred.stlouisfed.org/series/NAEXKP02GBQ661S">https://fred.stlouisfed.org/series/NAEXKP02GBQ661S</a>
	Unit labour costs	<a href="https://fred.stlouisfed.org/series/ULQELP01GBQ661S">https://fred.stlouisfed.org/series/ULQELP01GBQ661S</a>
	Interest rate	<a href="https://www.bis.org/statistics/cbpol.htm">https://www.bis.org/statistics/cbpol.htm</a>
	Consumer Price Index	<a href="https://fred.stlouisfed.org/series/GBRCPIALLQINMEI">https://fred.stlouisfed.org/series/GBRCPIALLQINMEI</a>

**Table 2** (continued)

Country	Variable	Source
United States	Gross Fixed Capital Formation	<a href="https://fred.stlouisfed.org/series/NAEXKP04USQ661S">https://fred.stlouisfed.org/series/NAEXKP04USQ661S</a>
	Total Gross Domestic Product	<a href="https://fred.stlouisfed.org/series/NAEXKP01USQ661S">https://fred.stlouisfed.org/series/NAEXKP01USQ661S</a>
	Private Final Consumption Expenditure	<a href="https://fred.stlouisfed.org/series/NAEXKP02USQ661S">https://fred.stlouisfed.org/series/NAEXKP02USQ661S</a>
	Unit labour costs	<a href="https://fred.stlouisfed.org/series/ULQELP01USQ661S">https://fred.stlouisfed.org/series/ULQELP01USQ661S</a>
	Interest rate	<a href="https://fred.stlouisfed.org/series/BOGZ1FL072052006Q">https://fred.stlouisfed.org/series/BOGZ1FL072052006Q</a>
	Consumer Price Index	<a href="https://fred.stlouisfed.org/series/CPALCY01USQ661N">https://fred.stlouisfed.org/series/CPALCY01USQ661N</a>
G7	Total share prices	<a href="https://data.oecd.org/price/share-prices.htm">https://data.oecd.org/price/share-prices.htm</a>

## References

- Angeletos G-M, La'O J (2013) Sentiments. *Econometrica* 81:739–779
- Arias JE, Rubio-Ramirez JF, Waggoner DF (2018) Inference based on structural vector autoregressions identified with sign and zero restrictions: Theory and applications. *Econometrica* 86(2):685–720
- Baker M, Stein JC, Wurgler J (2003) When does the market matter? Stock prices and the investment of equity-dependent firms. *Q J Econ* 118(3):969–1005
- Beaudry P, Nam D, Wang J (2011) Do mood swings drive business cycles and is it rational? NBER Working Paper 17651
- Bjørnland HC, Leitemo K (2009) Identifying the interdependence between US monetary policy and the stock market. *J Monet Econ* 56(2):275–282
- Christiano LJ, Eichenbaum M, Evans CL (1999) Monetary policy shocks: What have we learned and to what end? *Handb Macroecon* 1:65–148
- Christiano LJ, Eichenbaum M, Evans CL (2005) Nominal rigidities and the dynamic effects of a shock to monetary policy. *J Polit Econ* 113(1):1–45
- Doan T (2004) RATS Manual, version 6. Estima, Evanston
- Enders Z, Kleemann M, Müller GJ (2017) Growth expectations, undue optimism, and short-run fluctuations. Discussion Papers 11/2017, Deutsche Bundesbank
- Friedman M (1968) The role of monetary policy. *Am Econ Rev* 58:1–17
- Fry R, Pagan A (2011) Sign restrictions in structural vector autoregressions: a critical review. *J Econ Lit* 49:938–60
- Gilchrist S, Leahy JV (2002) Monetary policy and asset prices. *J Monet Econ* 49(1):75–97
- Kydland FE, Prescott EC (1982) Time to build and aggregate fluctuations. *Econometrica* 51:1345–1370
- Lucas Jr, RE (1972) Expectations and the neutrality of money. *J Econ Theory* 4:103–124
- Nam D, Wang J (2019) Mood swings and business cycles: Evidence from sign restrictions. *J Money Credit Bank* 51(6):1623–1649
- Phelps ES (1970) The new microeconomics in employment and inflation theory. In: Phelps ES (ed) *Microeconomic foundations of employment and inflation theory*. Norton, New York
- Rigobon R, Sack B (2004) The impact of monetary policy on asset prices. *J Monet Econ* 51(8):1553–1575
- Rubio-Ramirez JF, Waggoner DF, Zha T (2010) Structural vector autoregressions: Theory of identification and algorithms for inference. *Rev Econ Stud* 77(2):665–696
- Serletis A (2016) Introduction to Macroeconomic Dynamics special issue on complexity in economic systems. *Macroecon Dyn* 20:461–465
- Tobin J (1969) A general equilibrium approach to monetary theory. *J Money Credit Bank* 1(1):15–29
- Uhlig H (2005) What are the effects of monetary policy on output? Results from an agnostic identification procedure. *J Monet Econ* 52(2):381–419
- Von Furstenberg GM (1977) Corporate investment: Does market valuation matter in the aggregate? *Brook Pap Econ Act* 2:347–397
- Wolf CK (2020) SVAR (Mis-) Identification and the real effects of monetary policy shocks. *American Economic Journal: Macroeconomics* (forthcoming)

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.