

**MACRO SHOCKS AND REAL US STOCK PRICES WITH SPECIAL FOCUS ON  
THE “GREAT RECESSION”**

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**Abstract**

In this paper, we examine the effects of money supply, portfolio, aggregate spending, and aggregate supply shocks on real US stock prices in a structural vector autoregression framework using quarterly data for the period of 1947:1-2011:3. Overall, the empirical results indicate that each macro shock has important effects on real stock prices, with aggregate supply shocks playing an important role, besides portfolio shocks. The real stock price impulse responses to the various macro shocks conform to the standard present-value equity valuation model, and hence, our identification based on long-run restrictions can be viewed as appropriate. An historical decomposition indicates that the decline in the real stock prices during the “Great Recession” is mainly due to a slowdown in US productivity, after investors had decided to carry out exogenous portfolio shifts out of stocks. In general, we conclude that during the “Great Recession” the declining stock prices resulted due to a series of unfavourable shocks emanating from different sectors of the US economy.

JEL Classification: C32, E44, G12

Keywords: Real Stock Prices; Structural Vector Autoregression; Great Recession

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**1. Introduction**

The determination of the factors affecting the fluctuations in real stock prices is an important topic that admittedly has significant policy implications particularly in the recent problematic conditions. Especially the interaction between specifically macroeconomic forces and the stock market is a frequent topic in the literature. Macroeconomic forces influence asset prices through expected dividends that are dependent on macroeconomic policies and business cycle patterns (Araujo, 2009).

This study sets to examine the effects of various macro shocks, namely, money supply, portfolio, aggregate spending and aggregate supply on real US stock prices using a vector autoregression framework (VAR) covering the quarterly period of 1947:1-2011:3.

The main purpose is to measure the contribution made by these macro shocks to real stock prices fluctuations, with a special focus on the “Great Recession” during which the real stock prices experienced a decline, as depicted in Figure 1 in the Appendix of the paper. The paper proceeds as follows: firstly, Section 2 reviews the literature on the topic. Then, the following section presents the research method to be employed, with the description of the data used carried out in Section 4. The empirical results are discussed in the following section and finally section 6 concludes.

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## **2. Literature review**

The relationship between stock prices and various macroeconomic forces has attracted attention in the international literature. Challe and Giannitsarou (2011) state two important reasons why estimating of how stock prices react to policy shocks are of high meaning for macroeconomists and policy makers: a) the estimated reactions transfer important information on the transmission channels of policies, for instance how monetary policy affects financial variables directly but macroeconomic variables with a delay; and b) these estimations “raw stylised facts against which the quantitative predictions of alternative theoretical frameworks can be evaluated” (Challe and Giannitsarou, 2011: 3).

For these reasons, studies have been conducted since the late 1970s proving there is indeed a relationship between the stock market returns and economic announcements (Castanias, 1979; Hardouvelis, 1988; Ross, 1989). More recently researchers have shown evidence that stock market prices are impacted by macroeconomic indicators such as Gross Domestic Product (GDP), inflation, interest rates and others (Levine and Zervos, 1996; Gjerde and Sættem, 1999; Hooker, 2004; Chiarella and Gao, 2004; Huang and Guo, 2008; Michailidis, 2009; Shanmugam and Misra, 2009; Filis, 2010; Shubita and Al-Sharkas, 2010).

Real economic activity is found to be a major factor to fluctuations in stock market prices. For instance, Gjerde and Sættem (1999) found that there is a positive relationship between economic output and stock market returns for four countries: Canada, Australia, Sweden and Norway. This relationship has also been confirmed by more recent studies for other cases such as the New York Stock Exchange market (Shubita and Al-Sharkas; 2010) and India (Shanmugam and Misra, 2009). The magnitude of the reaction, however, of stock prices can be different from country to country (Errunza and Hogan, 1998). Also, the reaction of the stock market can be immediate or delayed (Gjerde and Sættem, 1999; Seshaiyah, 2009). For instance, Gjerde and Sættem (1999) found that the stock market response to changes in GDP is not immediate.

The impact of inflation to stock prices was also investigated in the literature. The general conclusion confirms that there is a negative relation between inflation and stock returns (Shanmugam, 2009; Shubita and Al-Sharkas, 2010). In addition, some studies examined the relationship between stock prices and oil prices as well as exchange rates (Seshaiyah, 2009; Chancharat et al., 2007).

A number of studies took into account the effect of monetary policy shocks on stock market returns (Lee, 1992; Thorbecke, 1997; Neri, 2004, Rigobon and Sack, 2004; Bernanke and Kuttner, 2005; Bjornland and Leitemo, 2009). Due to the fact that that stock prices are determined in a forward-looking way, monetary policy may influence stock market returns through the interest rate channel directly and indirectly through its influence on the dividends and their determinants.

Additionally, it was found that stock returns in various countries can get affected by bigger stock markets such as the ones in US and Japan (Ibrahim, 2006). Fujii (2005) examined the existence of intra and inter-regional causal linkages of emerging stock markets in Asia and Latin America. The findings showed that inter-regional causality exists, albeit not symmetrical and that the significance of the causality fluctuates over time.

To quantify the relative importance of various macro shocks, the majority of the studies conducted have employed vector autoregressive models (VARs) as statistical tools. Within this framework and based on economic theory or institutional conditions, additional restrictions on VARs to identify particular economic shocks. The imposition of long-run restrictions on VARs to identify particular economic shocks. The imposition of long-run restrictions was first developed by Blanchard and Quah (1989) that examined particularly the dynamic effects of aggregate demand and supply shocks. A number of papers extended this by including the case of financial variables (Hess and Lee, 1999; Rapach, 2001; Gallagher and Taylor, 2002; Du, 2006; and Fraser and Groenewold, 2006).

Our study aims to build on the study by Rapach (2001) by extending the sample period to the first decade of 2000s, which includes the period of the “Great Recession”, during which US stock prices experienced a sharp decline. The objective is to analyze which type of shocks played an important role in producing such a fall in stock prices during the financial crisis.

### 3. Research method

The research methodology here follows the paper by Rapach (2001) that also examined the effects of money supply, aggregate spending and aggregate supply shocks on real US stock prices in a structural VAR framework.

The reduced form of a general dynamic economic system can be presented in the following covariance-stationary VAR process:

$$C(L)\Delta x_t = e_t \tag{1}$$

where  $x_t$  is a  $n$ -vector of endogenous variables;  $L$  is the lag operator (that is  $L^k x_t = x_{t-k}$ );  $\Delta$  is the difference operator (that is  $\Delta = 1 - L$ );  $C(L) = C_0 - C_1L - C_2L^2 - \dots - C_pL^p$  and  $C_0 = I_n$ ;  $e_t$  is an  $n$ -vector of VAR innovations with  $E(e_t) = 0$ ,  $E(e_t e_t') = \Sigma_e$ ,  $E(e_t e_{t-s}') = 0$  for  $s \neq 0$ . With the assumption that vector  $x_t$  is  $I(1)$ , shocks have permanent effects on the endogenous variables. The dynamic relationship between the VAR shocks and the endogenous variables can be described in a moving average representation (MAR) as follows:

$$\Delta x_t = D(L)e_t = \sum_{s=0}^{\infty} D_s L^s e_t \tag{2}$$

Where  $D(L) = C(L) - 1$  and  $D_0 = I_n$ . Based on the assumption that the structural shocks emanate from separate sectors of the economy, we assume that  $e_t = G\varepsilon_t$  where  $\varepsilon_t$  is an  $n$ -vector of structural shocks and that  $E(\varepsilon_t \varepsilon_t') = \Sigma_\varepsilon$  is diagonal. The main diagonal of  $\Sigma_\varepsilon$  is set to unity through normalisation so that  $\Sigma_\varepsilon = I_n$ .

The structural shocks need to be identified hence,  $G$  needs to be identified. Following Rapach’s (2001) identification strategy, we base our identification on long-run restrictions.<sup>1</sup> We estimate eq(1) with  $x_t = (p_t, s_t, i_t, y_t)'$  where  $p$  is the price level,  $s$  is the

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<sup>1</sup> While, long-run theoretical restrictions are appealing, Faust and Leeper (1997) point to potential problems relating to the use of infinite-horizon identifying restrictions, especially in the sense that results obtained from the infinite-horizon restrictions may be unreliable for finite samples. For this reason, we follow Lastrapes (1998) and re-estimate the structural VAR with the identifying

stock price level,  $i$  is the interest rate level and  $y$  is the real output. The restrictions are expressed in a matrix of long-run multipliers ( $H$ ), as follows:

$$\lim_{k \rightarrow \infty} \begin{pmatrix} p_{t+k} \\ s_{t+k} \\ i_{t+k} \\ y_{t+k} \end{pmatrix} = H \varepsilon_t = \begin{pmatrix} h_{11} & h_{12} & h_{13} & h_{14} \\ 0 & h_{22} & h_{23} & h_{24} \\ 0 & zh_{22} & h_{33} & h_{34} \\ 0 & 0 & 0 & h_{44} \end{pmatrix} \begin{pmatrix} \varepsilon_{MS,t} \\ \varepsilon_{PO,t} \\ \varepsilon_{IS,t} \\ \varepsilon_{AS,t} \end{pmatrix} \quad (3)$$

Where  $\varepsilon$  denotes the shocks; MS is money supply, PO is portfolio, IS is aggregate spending and AS is aggregate supply. The restrictions are  $h_{21}=h_{31}=h_{41}=0$ ,  $h_{42}=h_{43}=0$  and where  $z$  is constant,  $h_{32}=zh_{22}$ . The first restriction shows that money supply shocks have no long-run effect on real stock prices, interest rates or real output. However, the structure allows for expansionary MS shocks to increase the price level in the long-run. This long run monetary neutrality is a “standard result in monetary theory” according to Rapach (2001).

The second restriction implies that portfolio and aggregate spending shocks have no long-run effect on output. This combined with the third restriction impose the natural rate hypothesis that only aggregate supply shocks can affect the real output in the long run. The last restriction establishes the long-run interest rate response to a portfolio shock with an assumed value for  $z = 0.025$  (Rapach, 2001).<sup>2</sup> IS shocks include fiscal policy and autonomous consumption changes. For example, an expansionary IS shock has no effect on real output in the long run but it permanently increases the interest rate.

#### 4. Data

The data employed for this study are in quarterly frequency from 1947:1 – 2011:3 (See Appendix for data plots). As in Rapach (2001), the price level ( $p_t$ ) is the implicit GDP price deflator. The nominal interest rate ( $i_t$ ) is the 3-month Treasury bill rate, while output ( $y_t$ ) is given by GDP in constant 2005 dollars. The real stock price is the nominal S&P 500 index deflated by the GDP deflator. All the variables, except for the nominal interest rate, are in log-levels and for more detailed information, see Table 1.

The powerful Ng-Perron (2001) unit root tests could not reject the null hypothesis that each endogenous variable is nonstationary ( $I(1)$ ) in levels and  $I(0)$  in first

restrictions imposed at horizons of 16, 28, and 40 quarters. The impulse responses were found to be very robust to imposing these restrictions at long but finite horizons. This indicated that the estimation result of our structural VAR do not depend crucially on the length of the horizon for which the identifying restrictions are imposed. These results are available upon request from the authors.

<sup>2</sup> As part of a sensitivity analysis, we explored the sensitivity of the estimation results by setting  $z = 0.01$  and  $z = 0.05$ . As noted, the impulse responses to the money supply and aggregate supply shocks are invariant to the choice of  $z$ . The impulse responses to the portfolio and aggregate spending shocks were largely unaffected for the two other alternative values of  $z$ . Note that the real stock price response to a portfolio shock is typically smaller (larger), while the response to an aggregate spending shock is larger (smaller), in absolute value, when  $z = 0.05$  (0.01) compared to the case of  $z = 0.025$ , since  $z$  determines the long-run interest rate response to a portfolio shock. These results are available upon request from the authors.

differences.<sup>3</sup> Sequential testing using the modified likelihood ratio statistic of Sims (1980), based on a maximum lag length of eight yielded a VAR of order 7. Ljung-Box Q statistics gave no indication of serial correlation in any of the VAR(7) equations. After allowing for differencing and lags, our sample period covered (1949:1-2011:3).<sup>4</sup>

**Table 1: Data**

Variable		Source	Unit and frequency
Price level ( $p_t$ )	GDP implicit price deflator	Federal Reserve Economic Database (FRED)	Quarterly and seasonally adjusted
Real stock prices ( $s_t$ )	S&P 500 nominal stock price index	Robert Schiller personal page: <a href="http://www.econ.yale.edu/~shiller/data.htm">http://www.econ.yale.edu/~shiller/data.htm</a>	In source, monthly data but quarterly observations are obtained by averaging over the three months comprising each quarter
Interest rate ( $i_t$ )	3-month Treasury Bill Rate	Federal Reserve Economic Database (FRED)	In source, monthly data but quarterly observations are obtained by averaging over the three months comprising each quarter
Output ( $y_t$ )	Real GDP	Federal Reserve Economic Database (FRED)	Billions of fixed 2005 dollars at an annual rate. The series is quarterly and seasonally adjusted

## 5. Empirical results

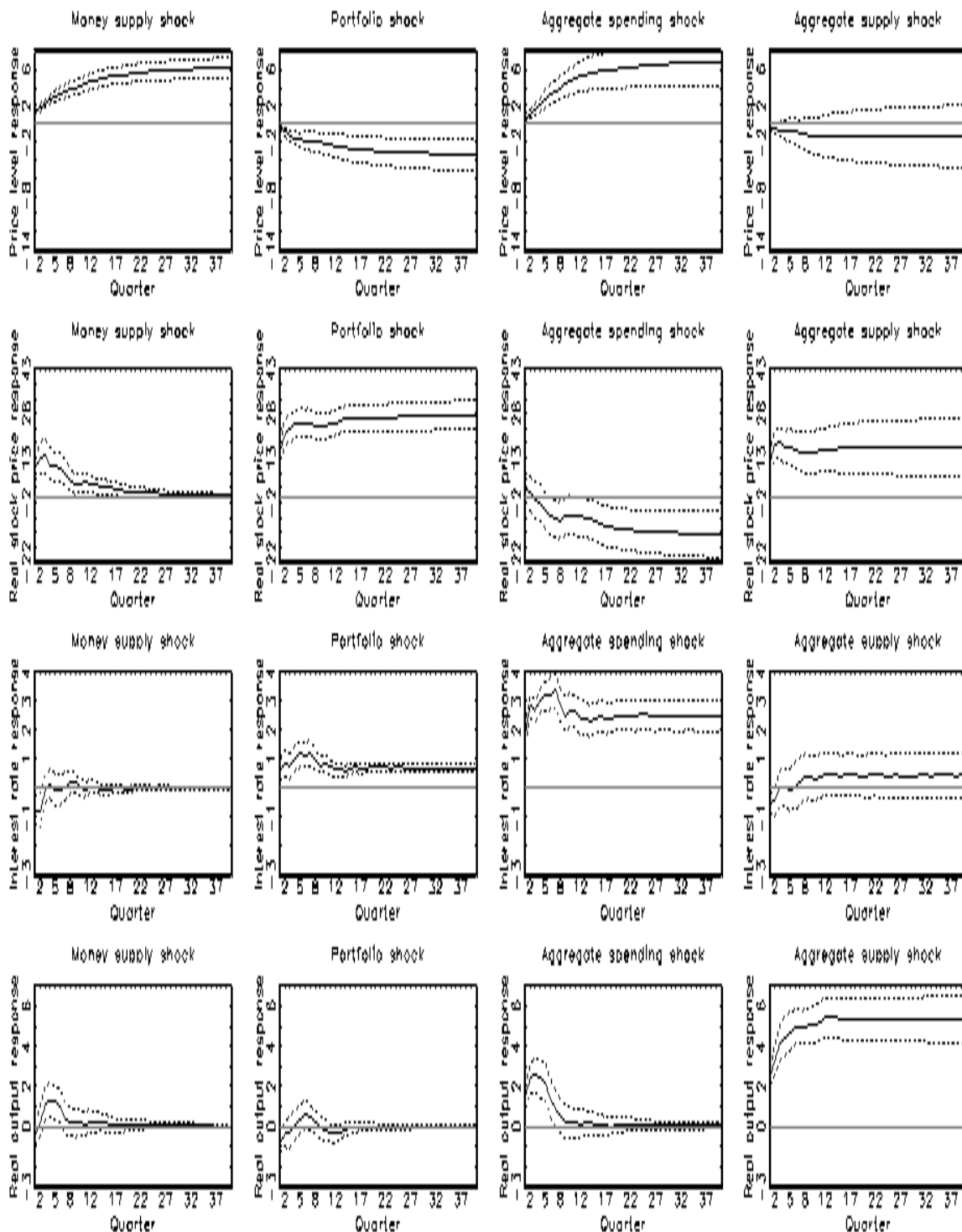
### a. Impulse response and variance decomposition analysis

In this section, the impulse responses of each variable to typical (one-standard-deviation) structural shocks are presented.<sup>5</sup> Figure 1 summarizes the impulse responses of each variable for all structural shocks included. The first column illustrates the impulse responses of an expansionary money supply shock. The price level response is small in the short-run but it increases significantly over the next ten quarters. The interest rate presents a downward response initially, indicating a liquidity effect. Real output also increases considerably during the first quarters. The stock market prices increase in the short-run before they reach again the previous equilibrium. This increase can be explained by the present-value equity valuation model which states that increases in real output will raise the expected real earning in the short-run.

<sup>3</sup> Standard unit root tests like the augmented Dickey and Fuller (1979), Phillips and Perron (1988) and the Kwiatkowski et al., (1992) tests, in general, also confirmed the findings associated with stationarity.

<sup>4</sup> All VAR equations included a constant. If the variables are cointegrated, then the VAR in first differences is misspecified, since it omits the error-correction terms. Given this, we tested for cointegration using the Johansen (1988) test. This tests gave no indication of cointegration based on both the Trace and Maximum Eigen Value tests, confirming no issue of misspecification in our framework. These results are available upon request from the authors.

<sup>5</sup> Since the variances of the structural shocks are normalized to one, these are the impulse responses to unit structural shocks. The standard error bands are obtained through 1000 bootstrap replications, to obtain a feel for the sampling error.



**Figure 1: Impulse responses to one-standard-deviation structural shocks.** (Dashed lines delineate standard-error bands)

The decline in the real output could also be related to the endogenous response of the Federal Reserve to the portfolio shock. The Fed may follow a tight monetary policy to prevent the stock market from getting overvalued. In the third column, the impulse responses of an expansionary aggregate spending shock are found. The impulse responses in this column are confirmed by standard macro theory and the changes in stock prices can be explained by the present value equity valuation model, as earlier. The price level and interest rates increase in the short run stabilising in higher levels than before the shock, while the real output show a temporary increase in the first five quarters. The stock prices do not react immediately to this shock but eventually they decrease due to the permanent increase of the interest rates combined with only a temporary increase in real output and earnings.

Finally, the fourth column of Figure 1 shows the impulse responses of an aggregate supply shock. An increase in the aggregate supply leads to decreases in the price level, increases in the real output and decreases in the interest rate. The increase in the stock price level can again be explained through the present-value equity valuation model: higher real output create opportunities for higher earnings and hence permanently higher stock prices while the lower interest rate also contributes to the higher stock prices.

**Table 2: Real stock price forecast error variance decompositions**

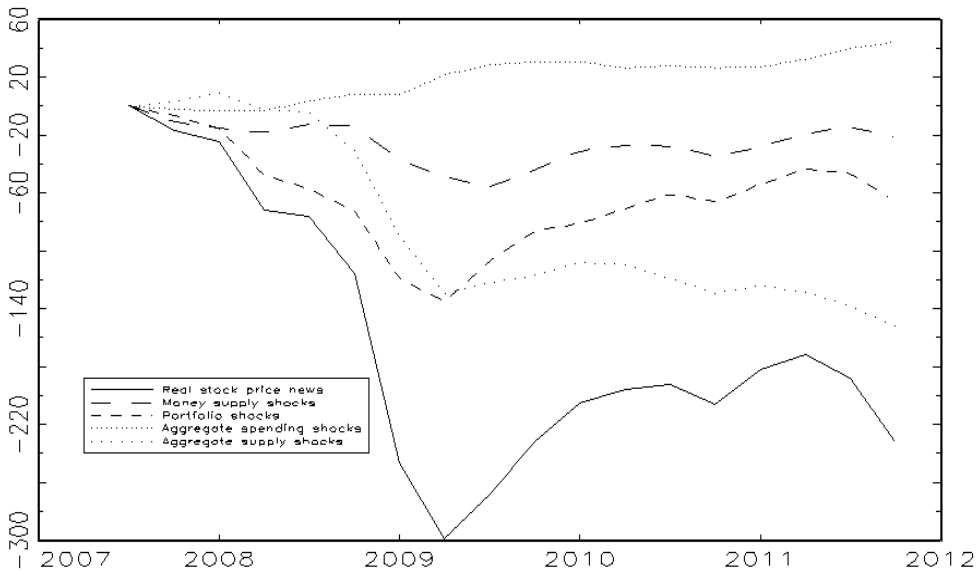
Quarters ahead	Percent of variance attributable to:							
	Money supply shock		Portfolio shock		Aggregate spending shock		Aggregate supply shock	
1	18.5	<b>14.4</b>	51.4	<b>18.2</b>	1.0	<b>5.5</b>	29.1	<b>15.1</b>
2	17.8	<b>14.0</b>	49.9	<b>18.1</b>	0.4	<b>5.0</b>	31.9	<b>15.3</b>
3	17.8	<b>13.7</b>	50.3	<b>17.9</b>	0.3	<b>4.9</b>	31.6	<b>15.2</b>
4	15.8	<b>12.7</b>	53.2	<b>17.5</b>	0.4	<b>5.0</b>	30.7	<b>15.0</b>
5	14.4	<b>11.9</b>	55.0	<b>17.3</b>	0.8	<b>5.3</b>	29.8	<b>14.8</b>
6	13.6	<b>11.3</b>	56.2	<b>17.0</b>	1.4	<b>5.6</b>	28.8	<b>14.6</b>
7	12.5	<b>10.7</b>	57.3	<b>16.8</b>	2.1	<b>6.0</b>	28.1	<b>14.6</b>
8	11.4	<b>9.9</b>	58.1	<b>16.6</b>	2.7	<b>6.4</b>	27.8	<b>14.6</b>
9	10.5	<b>9.2</b>	58.9	<b>16.5</b>	3.0	<b>6.7</b>	27.6	<b>14.7</b>
10	9.7	<b>8.5</b>	59.6	<b>16.4</b>	3.1	<b>6.8</b>	27.6	<b>14.9</b>
11	9.1	<b>7.9</b>	60.1	<b>16.4</b>	3.3	<b>6.9</b>	27.5	<b>15.1</b>
12	8.5	<b>7.4</b>	60.7	<b>16.3</b>	3.4	<b>7.0</b>	27.4	<b>15.3</b>
13	7.9	<b>6.9</b>	61.2	<b>16.3</b>	3.6	<b>7.1</b>	27.3	<b>15.5</b>
14	7.4	<b>6.4</b>	61.7	<b>16.4</b>	3.7	<b>7.2</b>	27.2	<b>15.7</b>
15	6.9	<b>6.0</b>	62.1	<b>16.4</b>	4.0	<b>7.4</b>	27.0	<b>15.8</b>
16	6.4	<b>5.7</b>	62.4	<b>16.5</b>	4.3	<b>7.5</b>	26.9	<b>16.0</b>
17	6.1	<b>5.3</b>	62.5	<b>16.6</b>	4.6	<b>7.7</b>	26.8	<b>16.2</b>
18	5.7	<b>5.0</b>	62.7	<b>16.7</b>	5.0	<b>7.9</b>	26.7	<b>16.3</b>
19	5.4	<b>4.7</b>	62.8	<b>16.8</b>	5.3	<b>8.0</b>	26.6	<b>16.5</b>
20	5.1	<b>4.5</b>	62.8	<b>16.9</b>	5.6	<b>8.2</b>	26.5	<b>16.6</b>
30	3.3	<b>2.8</b>	63.2	<b>17.6</b>	8.0	<b>9.5</b>	25.6	<b>17.7</b>
40	2.4	<b>2.0</b>	63.3	<b>18.1</b>	9.4	<b>10.4</b>	25.0	<b>18.3</b>

Notes: Standard errors in bold; numbers may not add upto 100 due to rounding.

Table 2 presents the real stock price forecast error variance decompositions. This information is the same as with Figure 1 but in a different format. The portfolio shocks are the dominant force changing the real stock prices. The aggregate supply shocks also play a significant role in explaining the variability of stock prices through the quarters. Due to the assumption of money neutrality in the long run, the importance of monetary supply shocks diminishes. Aggregate spending shocks play the least important role in explaining the variability of real stock prices.<sup>6</sup>

b. Real stock price historical decomposition

In order to identify the dominant factors affecting changes in real stock prices since the fourth quarter of 2007, historical decomposition analysis is carried out on our structural VAR. The choice of 2007:4 as the starting point of the analysis is to coincide with the NBER date of the beginning of the “Great Recession”. The solid line in Figure 2 illustrates the changes in real stock prices from 2007:4 until 2011:3 that could not be predicted using the VAR and data through 2007:3. In accordance with Rapach (2001), these movements are labelled as “news”. All the dotted lines in the figure represent part of the news that is explained by each of the structural shocks.



**Figure 2: Real stock price historical decomposition, 2007:4 -2011:3**

<sup>6</sup> When we compare our results with that of Rapach (2001), who used data on these same four variables over 1961:3-1999:1, the differences are only subtle. The impulse response functions look virtually alike. Rapach (2001), however, finds that, at shorter horizon portfolio shocks explain most of the variability in real stock prices, followed by money shocks. At the intermediate horizon, both these shocks begin to diminish, and the aggregate supply shock takes over, with it being the leading determinant of the variability of real stock prices, accounting for about 50 percent of the variation.



It can be seen that the real stock prices are much lower at the end of the sample than could have predicted from the model through 2007:3. As can be seen initially, negative portfolio shocks, i.e., exogenous shifts away from stocks on part of the investors, accounted for much of the decline in the real stock prices. Aggregate supply shocks are shown to be responsible for most of the decline in real stock prices from 2009 onwards. This fact shows that the fall in the stock prices when the financial crisis had reached its peak can be attributed to the negative growth in the potential output of the US economy. The contractionary money supply shocks, originating from falling inflation rates, initially dominates the aggregate supply shock till 2008:2, but then its importance fades away relative to the portfolio and aggregate supply shocks. Inflation rates, though low, started to increase slowly during the period under investigation. Also note that, the part of the decline in real stock prices due to contractionary money supply shocks is not sustainable, since money supply shocks are assumed to have no long-run impact on real stock prices. Since, the interest rates over this period was consistently declining towards the zero lower bound, the aggregate spending shocks, though marginal, was the only shock to have a positive influence on the stock prices. In general, the decline in the stock price during this period emanated from a series of unfavourable structural shocks originating from the different sectors of the US economy.<sup>7</sup>

## 6. Conclusion

In our study, we have employed long-run restrictions in a VAR framework to examine the impact of a number of macro shocks (aggregate spending shock, aggregate supply shock, monetary policy shock and portfolio shock) on real stock prices. The estimated impulse responses of all the endogenous variables (price level, stock prices, interest rates and real output) in the model to all shocks are plausible, suggesting that our long-run restrictions successfully identifies the structural shocks. The results indicated that all macro shocks have important effects on real stock prices, however, at longer-horizons aggregate supply shocks, besides portfolio shocks, appear to play an important role in explaining fluctuations in real stock prices. Additionally, all findings seemed to be in line with the present-value equity valuation model. Finally, when a historical decomposition analysis of the real stock prices over the “Great Recession” was carried out, we found that from 2009 onwards, i.e., during the depths of the financial crisis, aggregate supply shocks are shown to be the most important in explaining the majority of the decline in the real stock prices. While, the exogenous portfolio shifts were dominant in the early part of the crisis. Contractionary money supply and aggregate spending shocks too played a limited part. This indicates that the productive potential of the economy is a crucial determinant of fluctuations in the real value of equities.

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<sup>7</sup> Rapach (2001) used the historical decomposition analysis to analyze the surge in the real stock prices during the late 1990s. The author indicated that the growth in real stock prices during this period was largely due to growth in the potential output of the US economy, and, hence was not only due to exogenous shifts into stocks on part of the investors. Expansionary monetary policy too played its part, however, aggregate spending shocks had very little effect on the real stock prices during the late 1990s.

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Appendix: Data Plots:

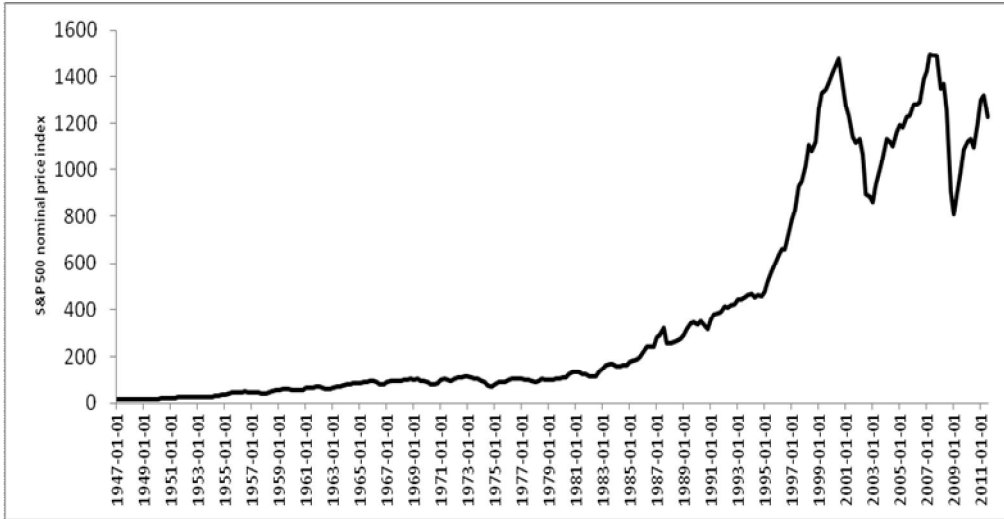


Figure 3: Real stock prices (from 1947:01 until 2011:3). Source: Robert Schiller personal page

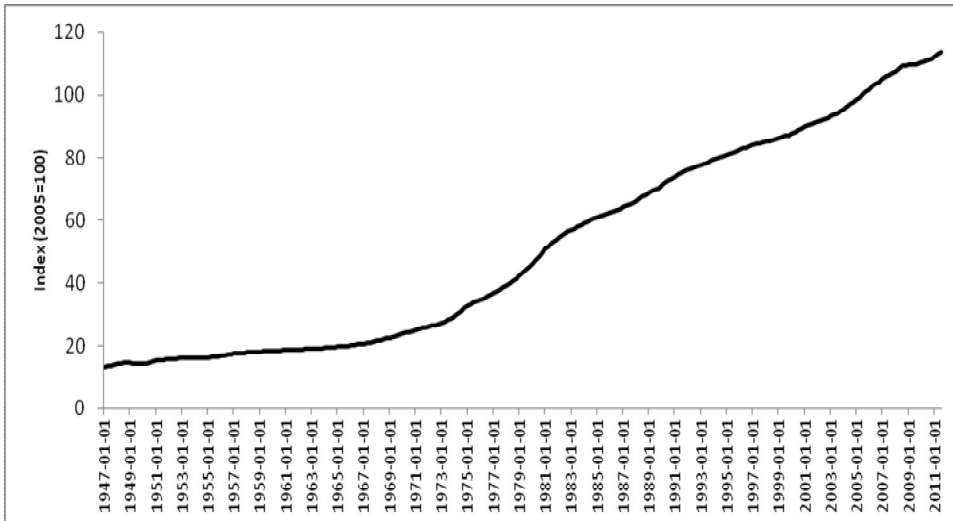


Figure 4: GDP deflator (from 1947:01 until 2011:3). Source: St. Louis, Federal Reserve

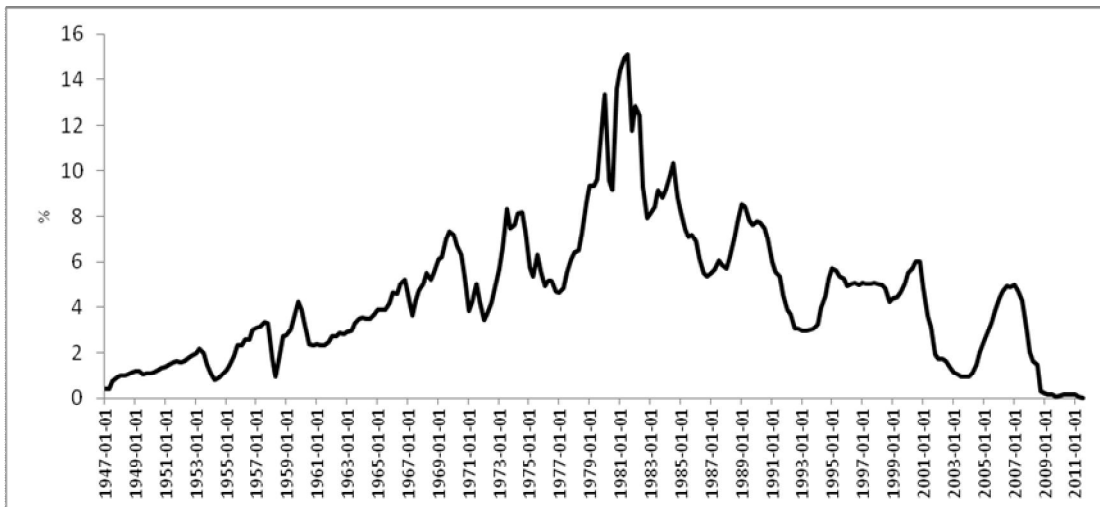


Figure 5: Treasury Bill rate (from 1947:01 until 2011:3). Source: St. Louis, Federal Reserve

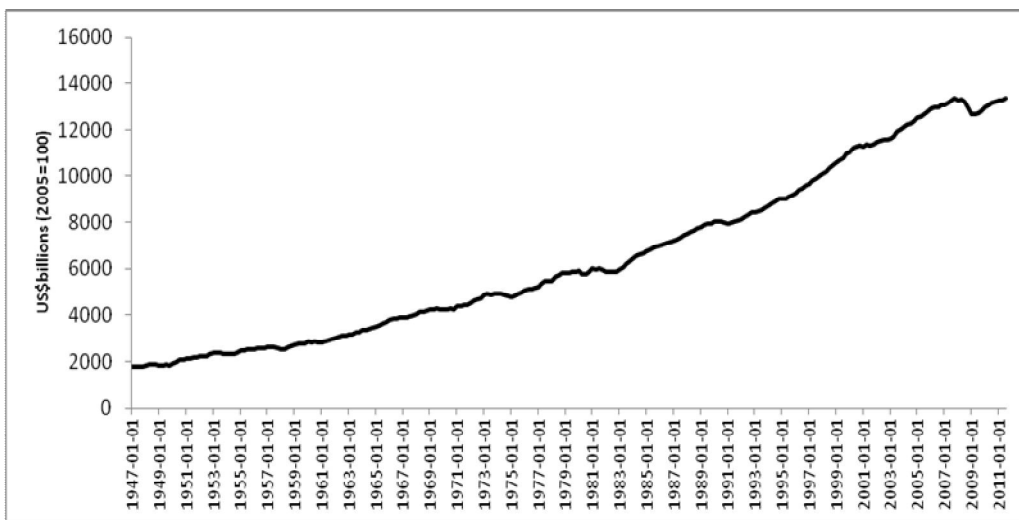


Figure 6: Gross Domestic Product (from 1947:01-2011:03). Source: St. Louis, Federal Reserve