The Changing Macroeconomic Response to Stock Market Volatility Shocks*

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ABSTRACT

It is empirically well documented that an increase in stock market volatility is followed by a slowdown of output growth. Using U.S. data since 1950 we show that the macroeconomic response pattern to volatility shocks has changed during the second part of the sample since 1984. While during this first sub-period both a slowdown in consumption and investment growth contribute to a slowdown of GDP growth, during the second sub-period, only a substantially-weakened investment reaction contributes to the GDP slowdown. A variance decomposition for consumption growth shows that, going from the first to the second sub-period, the contribution of stock market volatility becomes negligible, while the corresponding decomposition for investment growth reveals an increase in the role of stock market volatility.

Keywords: Dow Jones index, stock market volatility, economic growth.
JEL Codes:

1. Introduction

The global financial crisis that started in the U.S. sub-prime housing has been followed to almost unprecedented stock market volatility and a very severe global recession in the real economy. This course of recent events suggests the presence of strong linkages between the financial sector and the real economy. It is obvious importance that policymakers try to better understand those linkages, because a better understanding may provide them with leads for the design of supervisory frameworks that on the one hand mitigate financial turbulence, but on the other hand do not hamper the real economy too much for example by interrupting the extension of credit to the private sector.

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It may also have implications for monetary policy. For example, it is sometimes argued by the policy of low interest rates, and hence cheap money, since the previous recession at the beginning of this century has stimulated the formation of bubbles in the housing and stock markets. Fast-rising prices may make markets nervous and increase turbulence that affects the underlying economy in an unfavourable way.

In this paper we investigate empirically the role of U.S. stock market volatility in predicting subsequent GDP growth. There may be various channels through which enhanced volatility in the stock market affects growth negatively (Guo, 2002). One channel is that an increase in stock market volatility raises the compensation that shareholders demand for bearing systematic risk. Hence, the cost of equity increases and investment and output are negatively affected. Others argue that higher stock market volatility reflects enhanced uncertainty about future cash flows and discount rates reflecting resource-consuming structural changes that depress GDP growth (see Campbell et al., 2001).

Two strands of the literature are of particular relevance for this paper. One is the part of the finance literature that explores the link between output growth and stock market growth, see, in particular, the work by Campbell et al. (2001) and Guo (2002). We deviate from this work in a number of respects. First, we employ a multivariate methodology and analyse the aforementioned linkages in a VAR that also controls for monetary policy and inflation. Differently from Guo (2002) and Campbell et al. (2001) who rely on output growth equations with restricted dynamics, the VAR methodology allows for a richer lag structure and feedback effects among the endogenous variables. Second, we delve deeper into the transmission channel from stock market volatility to growth by exploring the behaviour of investment and consumption and investment in response to a change in stock market volatility. Third, we explore the stability of the relationships across sample periods and we do some further robustness analysis. Finally, our sample period runs from 1950s until very recently, also including part of the Great Recession. Our paper is most closely related to the recent work by Bloom (2009). The main differences are that we do not focus on large shocks only, that we explore the effects of stock market volatility on GDP rather than on industrial production and that we explicitly explore how the components of GDP respond to shocks to stock market volatility. The latter advancement allows us to probe deeper into the channels driving the reaction of GDP to volatility shocks. Other studies have studied the effect of uncertainty shocks on consumption and investment (Alexopoulos and Cohen, 2009; and Knotek II and Khan, 2011). We extend this literature by exploring how the responses of GDP and its components have changed over time.[1]

[1] The current paper is also sideways related to the literature that investigates the effects of macroeconomic volatility on growth (for example, Ramey and Ramey, 1995).

Our baseline shows that an increase in U.S. stock market volatility is followed by a slowdown of U.S. real GDP growth. The main channel driving the result is a slowdown of investment growth, although also consumption growth deteriorates after a volatility shock. Further, and reassuringly, we find that both inflation and the federal funds rate tend to fall after the shock. Our results are robust to using alternative measures of the stock market index (e.g. dropping or using only the most extreme volatility observations), and altering the VAR ordering and specifications. The stock market return reacts negatively to the volatility shock, which suggests that this may be the main channel through which stock market volatility affects output growth. However, a counterfactual experiment in which we shut off the feedback from volatility onto the return confirms that the volatility measure has an independent, although reduced, effect on output growth. The key findings of the paper are when we look at sample splits. In particular, we find that the macroeconomic response pattern to volatility shocks has changed during the second part of the sample since 1984. During the first sub-period both a slowdown in consumption and investment growth contribute to the GDP slowdown, although the investment slowdown is much larger. During the second sub-period, only an investment slowdown contributes to the GDP slowdown. A variance decomposition for consumption growth shows that, going from the first to the second sub-period, the contribution of stock market volatility becomes negligible, while the corresponding decomposition for investment growth reveals an increase in the role of stock market volatility.

The remainder of this paper is structured as follows. In the next section, we present our baseline empirical specification, discuss the impulse responses that it produces, and test the robustness of the volatility – growth relationship. Section 3 considers the split of the sample into the period up to and including 1983 and the period after that. Section 4 delves deeper into the potential transmission channels of stock market volatility by exploring how the components of GDP growth are affected by a stock market volatility shock. Finally, Section 5 concludes this paper.

2. Baseline results and robustness

2.1. Baseline specification and results

While Guo (2002) explores the relation between GDP growth and stock market volatility in a single-equation framework, it may be potentially important to control for feedback effects and, in particular, to control also for monetary policy, which may be more or less accommodative to developments in the stock market. Therefore, our baseline quarterly VAR-specification is given by

$$Bx_t = \alpha + \beta d_t + A(L)x_{t-1} + \varepsilon_t, \qquad (1)$$

where $x_t = \left[x_t^{macro}{}', x_t^{stockmarket}{}'\right]'$, $x_t^{macro} = \left[YGROWTH_t, INFL_t, FFR_t\right]'$ is a block of macro-economic variables and $x_t^{stockmarket} = \left[VOLDJ_t, RDJ_t\right]'$ is a block of stock market variables. Here, $YGROWTH_t$ is real per capita U.S. GDP growth, $INFL_t$ is the U.S. CPI inflation rate, FFR_t is the federal funds rate, $VOLDJ_t$ is the volatility of the Dow Jones index and RDJ_t is the return on the Dow Jones index. Variables $YGROWTH_t$, $INFL_t$, FFR_t and RDJ_t are all annualised, while $VOLDJ_t$ is the sample standard deviation of the daily returns over the quarter. We have also calculated our volatility measure on the basis of the stock market return in excess of the risk-free interest rate, that is, in excess for federal funds rate. However, it turns out that this alternative measure has a correlation of over 0.99 with $VOLDJ_t$ and, hence, we adhere to the use of $VOLDJ_t$ as our measure of volatility. Specification (1) also includes a vector of constants α and a vector d_t of seasonal dummies. Finally, β is a vector of parameters and B and $A(L)$ are matrices of parameters, where L is the lag operator. Below we report the results of the VAR estimated with four lags. Below, we will show that the results are robust to the inclusion of additional lags.

Our identifying assumption is based on matrix B being triangular, i.e. it is based on a Choleski decomposition. Hence, we assume that within a given period each variable does not react to the ensuing ones in the ordering x_t, while a given variable is allowed to react to those that precede it. Because stock market variables can react instantaneously to developments in the “real” economy, we order the stock market block after the macro-economic block.[2] Specifically, we also order FFR_t before the stock market block, because it is well-known that everything else equal monetary policymakers to stabilise their policy instrument (for example, see Clarida *et al.*, 1998), in this case their target for the federal funds rate. In particular, they want to avoid losing their credibility or bring financial markets in disarray by erratically moving their instrument. Notice that the ordering within the macro-economic block is immaterial since all these variables are ordered before the stock market volatility, which is the variable whose impulse responses we want to study (see Christiano *et al.*, 1999). Within the stock market block we position $VOLDJ_t$ directly before RDJ_t, because theory suggests that stock market volatility has a contemporaneous (negative) effect on the returns, but not the other way round. This is also consistent with Guo (2002) who regresses stock market returns on the contemporaneous volatility.

[2] Bloom (2009), instead, positions the stock market index first, followed by the stock market volatility, the federal funds rate and, finally, macro-economic variables. Later, we will show that changes in the ordering of our VAR leave our results essentially unchanged.

The sample period for this benchmark specification is 1950Q2 – 2011Q2. The Appendix describes the data construction process in more detail. Figure 1 depicts our stock market volatility measure $VOLDJ_t$. Volatility is found to be particularly high in 1987Q4, the period in which Black Monday occurred and in 2008Q4, the period after the collapse of Lehman Brothers. In contrast to Campbell et al. (2001), our baseline keeps these extreme observations in our sample without adjusting them. The reason is that it is not possible to establish that these observations are really outliers. If anything, these observations are the "most exogenous" ones in the sample, which means that it is of particular interest to keep them in our sample. This is exactly why Bloom selects the most extreme stock market volatility observations to identify his uncertainty shocks. However, we will show that our results are robust to adjustments in these extreme observations.

Figure 2 depicts the impulse responses to a shock in $VOLDJ_t$. Here, and in the sequel, we will always assume that the size of the shock is one standard deviation of the full sample series for $VOLDJ_t$.[3] This normalisation will allow us to directly compare the responses of output growth (and its components) across different specifications and sample periods. We will always use a 90% confidence interval and the responses of the other variables will always be expressed in percentage points on an annual basis.

Owing to the ordering in the VAR the contemporaneous responses of GDP growth, inflation and the federal funds rate are zero. One quarter after the shock, GDP growth drops below trend. This drop not only is statistically significant, it also is economically significant because GDP growth falls by roughly 1%-point on an annual basis. The deviation from trend remains significant until two quarters after the shock. Over the subsequent periods growth gradually converges to its trend level. Inflation falls by roughly 0.3% point in the period after the shock. The fall in inflation is only significant one quarter after the shock. Further, in line with the slowdown of growth and the drop in inflation monetary policy is relaxed. The fall in the federal funds rate is also marginally significant during the first five quarters after the shock and reaches a maximum of approximately 30 basis points one year after the shock.[4] Finally, we observe that the increase in stock market volatility produces a highly negative market return of roughly minus 18% points on an annual basis. The fall in the stock market index makes room for the higher future return demanded by investors because of the increase in systematic stock market risk.

2.2. Investigation into the transmission channel

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[3] The standard deviation (mean) of the stock market volatility over the whole sample is 0.0043 (0.0084) and for the two sub-samples 1950Q2 – 1983Q4 and 1984Q1 – 2011Q2 it is 0.0027 (0.0073), and 0.0054 (0.0099) respectively.

[4] Notice that if the monetary authorities had chosen not to lower their policy target, the negative impact of stock market volatility on growth might have been even larger.

Earlier work by Schwert (1989) and Campbell *et al.* (2001) suggests that stock market volatility has significant predictive power for real GDP growth. However, Guo (2002) shows that the relationship between stock market volatility and economic activity is not fully robust to alternative model specifications. In particular, regressing GDP growth on contemporaneous stock market volatility, he finds a highly significant negative effect on GDP growth. However, once he controls for the current stock market return or for the current and past return jointly, the effect of volatility tends to weaken or it even becomes insignificant. Hence, the conclusion is that stock market returns drive out stock market volatility in forecasting output and, therefore, that beyond the return the volatility of the stock market provides no additional information about future output.

As in Bloom (2009) and Alexopoulos and Cohen (2009), our VAR model differs in two fundamental ways from the models of the aforementioned contributions. First, we allow for more lags in our model. Second, through the use of a VAR we also allow for feedbacks among the endogenous variables. The role of the feedback effect of stock market volatility via the stock market return can be explored by taking the stock market return RDJ_t out of the vector of endogenous variables x_t and enter it as an exogenous variable in equation (1). Hence, the stock market return is no longer allowed to react to the stock market volatility. This is equivalent to an experiment in which the impulse response of the stock market return is counterfactually constraint to remain to its baseline value in response to a volatility shock. Figure 3 shows that in this counterfactual case one-quarter after response of output growth to volatility is close to that when the stock market return is allowed to respond. The effects differ more after two and three quarters, although the response when the stock market return is made exogenous is still well within the original confidence band. This suggests that the so-called cost-of-capital channel is not the main driving factor in the transmission of the volatility shock to the economy.

To investigate the transmission channel further, Table 1 shows the variance decomposition of output growth. During the entire response period we consider, more than three-quarters of the variance in output growth is explained by output itself, while relatively small portions are explained by the other variables. The share explained by the other variables is slowly increasing with the amount of time after the impulse and after 10 quarters around 7% of the variance is explained by volatility in the stock market and slightly less by the return on the stock market. These figures are of the same order of magnitude as the share explained by the federal funds rate. It is interesting to notice that at a quarterly frequency the volatility shock seems to play a similar role for GDP variation to what found by the previous literature using monthly data. In particular, Alexopoulos and Cohen (2009) show that at a 36 month horizon, stock market volatility shocks explain roughly 6 percent of the variation of industrial production.

Table 1: Variance decomposition of output growth (in %)

After:	**1 Q**	**2Q**	**5Q**	**10Q**
Output growth	93.68	83.48	79.50	79.13
Inflation	0.34	0.61	2.26	2.49
Federal funds rate	0.23	5.38	5.65	5.73
Stock price volatility	5.30	6.54	6.57	6.61
Stock price return	0.45	4.00	6.01	6.04

2.3. Robustness

In this subsection we do a number of robustness checks on our baseline results. Figure 4 graphs the responses of GDP growth to a stock market volatility shock for the various cases. We do not show the responses of the other variables, because they are rather similar to the baseline responses.

The first robustness check involves the replacement of the Dow Jones index with the S&P 500 index. The disadvantage of using the S&P 500 index is that it starts only in 1965, thereby shortening our sample period by 15 years. However, the response of output growth is very similar to the baseline response, both qualitatively and quantitatively. In our second check, we add to our VAR system the volatility of the oil price $VOLOP_t$, measured as the standard deviation of monthly logarithmic price changes calculated over the past year including the current month. Oil price volatility can reasonably be considered the "most exogenous" variable. Hence, we place it first in our VAR ordering. Hence, $x_t = [VOLOP_t, YGROWTH_t, INFL_t, FFR_t, VOLDJ_t, RDJ_t]'$. The response of output growth after one quarter weakens somewhat to reduction by 0.8% point, but remains highly significant. Next, we extend the number of lags in our VAR to six, which yield an output growth response very similar to the baseline. The same is the case when we replace the two most extreme observations of $VOLDJ_t$, those of 1987Q4 and 2008Q4, by a dummy that takes a value of one in these periods and a value of zero otherwise. This is in line with Campbell *et al.* (2001) and Guo (2002), who replace (in their shorter sample) the volatility of 1987Q4 by the next-highest value in the sample. In our fifth check, we replace the volatility variable $VOLDJ_t$ with a variable that that takes on the actual value of $VOLDJ_t$ during quarters when Bloom (2009) identifies a high-volatility episode but is zero otherwise. The number of quarters selected in this way is rather small, but nevertheless output growth exhibits a (marginally) significant negative response one quarter after the shock, although quantitatively the output growth response is less than half that under the baseline. The next graph is based on a less conservative selection of high-volatility periods. Namely we assigned the variable the value of $VOLDJ_t$ whenever the stock market volatility exceeded its average by one standard deviation and a value of zero otherwise. The larger number of shocks included allows us to estimate more precisely the effect of volatility shocks on output. Now the output growth response is indeed quantitatively closer that under the baseline.

In our seventh check we change the ordering of the VAR and place the "macro-economic block" at the end, so that we have $x_t = [VOLDJ_t, RDJ_t, YGROWTH_t, INFL_t, FFR_t]'$. This ordering may be harder to justify theoretically, because it denies the fact that the volatility and the return on the stock market can be affected by contemporaneous economic conditions. Hence, this new ordering leaves the impact reactions of output growth, inflation and the federal funds rate to a volatility shock unrestricted. The impact response of output growth is negative and very close to significance. Output growth falls further one quarter after the shock, when the response becomes significant and is about the same size as that under the baseline. Finally, when we replace $VOLDJ_t$ with our dummy of high volatility in this ordering with the macro-economic block at the end, we observe a rather similar output growth response, which is quantitatively a bit smaller though after one quarter.

3. Sample split

This section splits the sample into the two sub-periods 1950Q2 – 1983Q4 and 1984Q1 – 2011Q2. The selected sample split is based on the rather generally accepted view that the first quarter of 1984 is the breakpoint of U.S. GDP (McConnell and Perez-Quiros, 2000). It is of interest to notice that the average stock market volatility is quite a bit larger during the second sub-period – recall Figure 1. However, in order to facilitate the comparison of the responses in the two subsamples, the size of the volatility shock is normalised to be the same value as in the baseline.

Figures 5a and 5b show the impulse responses for the respective sub-periods. The responses differ substantially between the two sub-periods. While for both sub-periods the response of GDP growth is significantly negative after one quarter, the response in the first sub-period is about five times larger than that in the second sub-period. The response of inflation is insignificant in the first sub-period, while it is significantly negative after one quarter in the second sub-period. Also, the federal funds rate behaves rather differently between the two sub-periods. In the first sub-period it becomes only significantly negative after two quarters, while in the second sub-period its response is significant (although marginally so) after one quarter. More important is the difference in the sizes of the responses, with that in the first sub-period around eight-fold larger at its peak than the maximum response in the second sub-period. The initial responses of the stock market return are rather similar for the two sub-periods, but differ substantially two and three quarters after the shock when in the first sub-period the return is substantial and significantly positive, while in the second sub-period the return is close to zero, indicating a persistent drop in the stock market index.

Table 2 shows the variance decomposition of output growth during the two sub-periods. Splitting the overall sample into the two sub-periods, we see that the role of output itself in explaining the output variance shrinks in the medium run when compared with the full sample decomposition. Comparing the two sub-periods, in the second sub-period the roles of the federal funds rate and the stock market volatility have shrunk substantially, while the role of the stock market return has become slightly more important and that of inflation has become substantially more important, rising to about 17% after 10 quarters.

Table 2: Variance decomposition of output growth for sub-periods (in %)

	1950Q2 – 1983Q4				**1984Q1 – 2011Q2**			
After:	**1 Q**	**2Q**	**5Q**	**10Q**	**1 Q**	**2Q**	**5Q**	**10Q**
Output growth	92.57	79.45	74.48	74.04	94.66	86.55	67.65	66.08
Inflation	0.65	1.29	2.85	2.89	0.58	4.88	16.31	16.76
Fed. funds rate	0.02	9.53	9.66	9.49	0.54	2.89	5.54	5.72
Stock price volatility	6.75	7.80	9.85	9.99	4.21	4.19	5.23	5.70
Stock price return	0.01	1.94	3.15	3.59	0.01	1.50	5.28	5.74

4. Transmission to the components of GDP growth

This section delves deeper into the potential transmission channels of stock market volatility by exploring how the components of GDP growth are affected by a volatility shock. In each variant we take the baseline VAR and replace GDP growth by the growth in one of its components from the national income identity. Figure 6 depicts the responses of real per capita private consumption and investment growth to a volatility shock of equal size during the full sample period and the two sub-sample periods. We only show the responses of these variables of interest and do not show the responses of the other variables in our VAR, because they are very similar to the original ones when GDP growth is included. We also do not show the effects of a volatility shock on government purchases and net exports.[5] Growth in government purchases and exports does not react to a volatility shock, while the pattern for growth in imports very closely follows that of output growth. The response for these variables can be found in the Additional Appendix.

In the case of the full sample period both consumption investment growth falls significantly one quarter after the volatility shock. However, the fall in investment growth is about ten times larger than the fall in consumption growth. Consumption growth falls by around 0.6% points. Investment growth drops by around 6% points. The fall in investment growth is also more protracted. Consumption growth loses its significance after two quarters, while investment growth loses its significance after three quarters. These findings suggest that the roles of the cost-of-capital channel and the option-to-wait channel may be larger than suggested earlier. If the latter channel is important, then a temporary increase in uncertainty would lead to a postponement of investment projects. Hence, investment growth would drop immediately after the shock, but rise above its trend level later as postponed projects get implemented. Figure 6 indicates that the option-to-wait channel may indeed be relevant. Investment growth becomes significantly larger than its trend growth level one-and-a-half years after the shock.

Splitting the full sample period into our two sub-periods yields useful insights. While consumption growth responds after one quarter with a statistically and economically significant fall in the first sub-period, in the second sub-period consumption growth does not react. The response of investment growth is significant and substantially larger than that of consumption growth in both sub-periods, although also for investment growth the magnitude of the response shrinks as we go from the first to the second sub-period.

Finally, we turn to the variance decomposition of consumption and investment growth. The results are reported in Table 3. In all instances, by far the largest part of the variance in consumption growth or investment growth is explained by the variance of the component itself. The role of stock market volatility is always (substantially) larger for the variance of investment growth than for the variance of consumption growth. Comparing the first and second sub-period, we see some interesting changes. Stock market volatility loses almost any of its relevance for the variance of consumption growth, while the federal funds rate loses much of its relevance, both in favour of an increased role for the stock market return, which after 10 quarters explains 15% of the variance. In the case of investment volatility, the federal funds rate becomes even less relevant, while the role of stock market volatility increases even further when compared with the first sub-period and explains about 18% of the variance after 10 quarters. This is in line with the substantially higher stock market volatility during the second sub-sample.

[5] For exports this is strictly speaking not true. In the second sub-period two quarters after the volatility shock exports become marginally significant.

Table 2: Variance decomposition of output components

	Consumption growth				Investment growth			
After:	**1Q**	**2Q**	**5Q**	**10Q**	**1Q**	**2Q**	**5Q**	**10Q**
	Full sample				**Full sample**			
Comp. growth	87.46	79.87	74.10	73.82	86.49	75.50	70.28	69.62
Inflation	6.92	5.99	9.44	9.62	3.30	3.81	5.89	6.00
Federal funds rate	1.27	6.18	6.70	6.68	1.47	5.37	6.33	6.31
Volatility DJ	2.92	2.96	3.70	3.79	8.57	11.94	11.47	12.01
Return DJ	1.43	5.00	6.06	6.09	0.18	3.38	6.02	6.05
	Period 1950Q2 – 1983Q4				**Period 1984Q1 – 2011Q2**			
Comp. growth	84.87	74.27	65.86	65.99	90.74	76.47	69.06	68.14
Inflation	6.75	6.03	11.02	10.90	2.47	6.27	7.56	7.49
Federal funds rate	2.50	14.10	13.59	13.52	1.05	5.40	6.89	6.91
Volatility DJ	5.87	5.21	8.49	8.55	5.05	7.22	10.27	10.69
Return DJ	0.01	0.38	1.05	1.05	0.69	4.64	6.22	6.78
	Period 1950Q2 – 1983Q4				**Period 1984Q1 – 2011Q2**			
Comp. growth	85.16	75.98	68.40	65.29	80.09	77.35	59.11	57.17
Inflation	9.95	9.78	13.92	15.23	2.76	3.08	17.13	17.60
Federal funds rate	0.81	1.63	3.77	3.52	0.03	0.06	0.94	2.21
Volatility DJ	0.23	0.36	0.56	0.76	16.65	19.02	17.52	17.84
Return DJ	3.86	12.25	13.35	15.20	0.48	0.49	5.30	5.17

Note: "Comp. growth" is growth in the component (consumption or investment) of GDP.

7. Concluding remarks

In this paper we have explored the role of stock market volatility for U.S. GDP growth over the period since the beginning of the 1950s until now. Our baseline model is a VAR that includes a macro block with GDP growth, inflation and the federal funds rate and a stock market block with the stock market return and its volatility. We find that an increase in U.S. stock market volatility leads to a slowdown of U.S. real GDP growth, an effect that is qualitatively robust to a split of the sample in a period before 1984 and the period 1984 until now. During the first sub-period both a slowdown in consumption and investment growth contribute to the GDP slowdown, although the investment slowdown is much larger. During the second sub-period, only an investment slowdown contributes to the GDP slowdown. A variance decomposition for consumption growth shows that, going from the first to the second sub-period, the contribution of stock market volatility becomes negligible, while the corresponding decomposition for investment growth reveals an increase in the role of stock market volatility.

The analysis of this paper can be extended into a number of directions. The most obvious direction is to extend it to more countries to see whether the consequences of an increase in stock market volatility found for the U.S. are also found in other countries and, in particular, whether the roles of the different transmission channels and the differences between the two sub-periods are confirmed for other countries as well. If that is the case, then a theory might be built that can replicate the most salient facts exposed in our empirical analysis.

References:

Alexopoulos M. and Cohen J. (2009). Uncertain Times, Uncertain Measures, *mimeo*.

Campbell, J.Y., Lettau, M., Malkiel, B.G. and Y. Xu (2001). Have Individual Stocks Become More Volatile? An Empirical Exploration of Idiosyncratic Risk, *Journal of Finance* 56, 1, 1-43.

Christiano, L., Eichenbaum, M. and Evans, C. (1999). 'Monetary policy shocks: what have we learned and to what end?' in *Handbook of Macroeconomics* (ed. J.B. Taylor and M. Woodford), pp. 65-148, Elsevier Science.

Clarida, R., Gertler, M. and J. Gali (1998), Monetary Policy Rules in Practice: Some International Evidence, European Economic Review 42, 1033-1067.

Diebold, F.X. and K. Yilmaz (2008). Macroeconomic Volatility and Stock Market Volatility, Worldwide, *PIER Working Paper* 08-031, University of Pennsylvania.

Giuliodori, M. (2005), The Role of House Prices in the Monetary Transmission Mechanism across European Countries, *Scottish Journal of Political Economy* 52, 4, 519-543.

Guo, H. (2002), Stock Market Returns, Volatility, and Future Output, *Federal Reserve Bank of St. Louis Review* 84, 75-86.

McConnell, M.M. and G. Perez-Quiros (2000), Output Fluctuations in the United States: What Has Changed Since the Early 1980's? *American Economic Review* 90, 5, 1464-1476.

Ramey, V.A. (1993). How important is the credit channel in the transmission of monetary policy? *Carnegie-Rochester Conference Series on Public Policy* 39, December, 1-45.

Ramey, G. and V.A. Ramey (1995). Cross-Country Evidence on the Link between Volatility and Growth, *American Economic Review* 85, 5, 1138-1151.

Figure 1: Quarterly variance of daily returns.

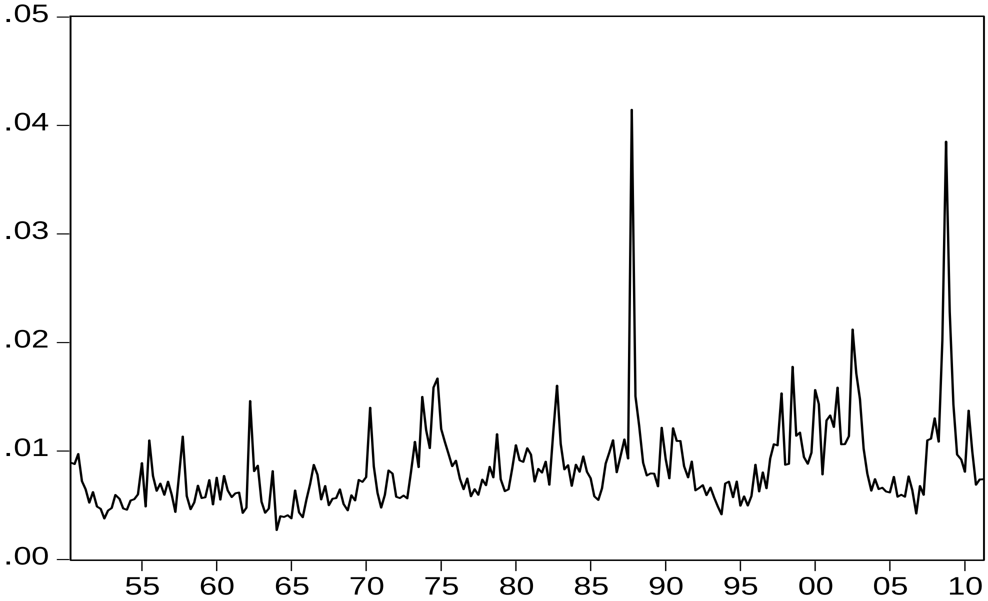
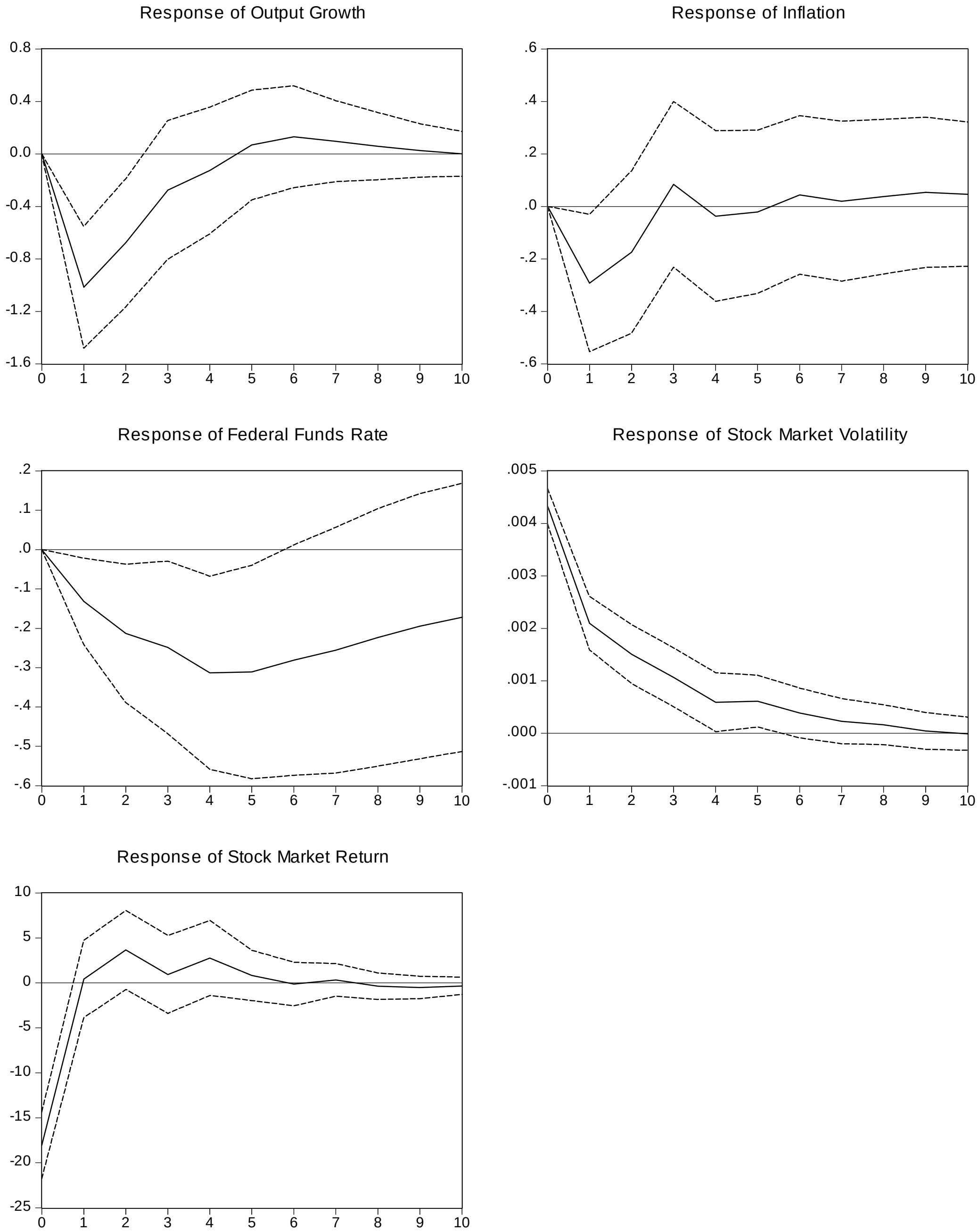
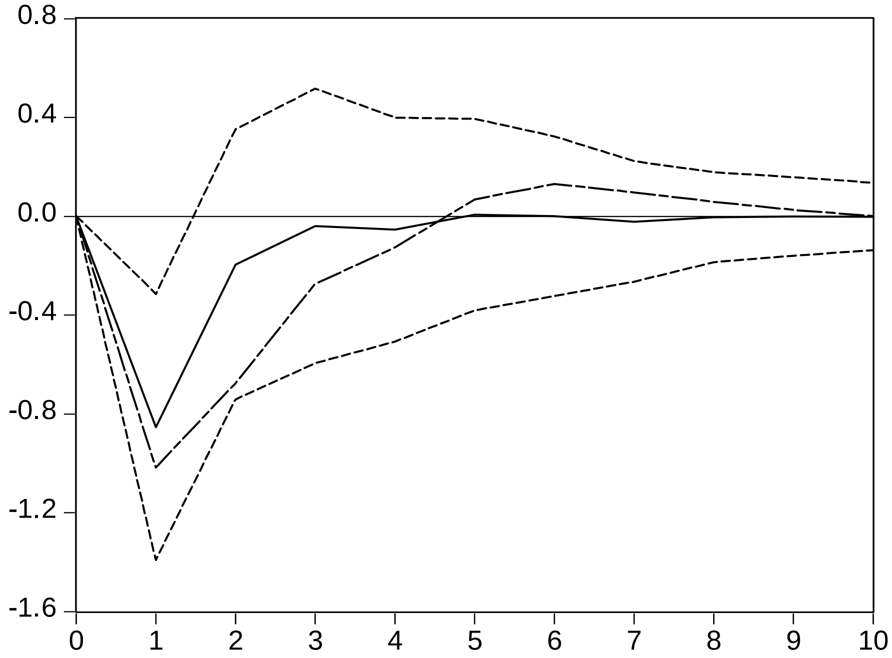


Figure 2: Baseline impulse responses



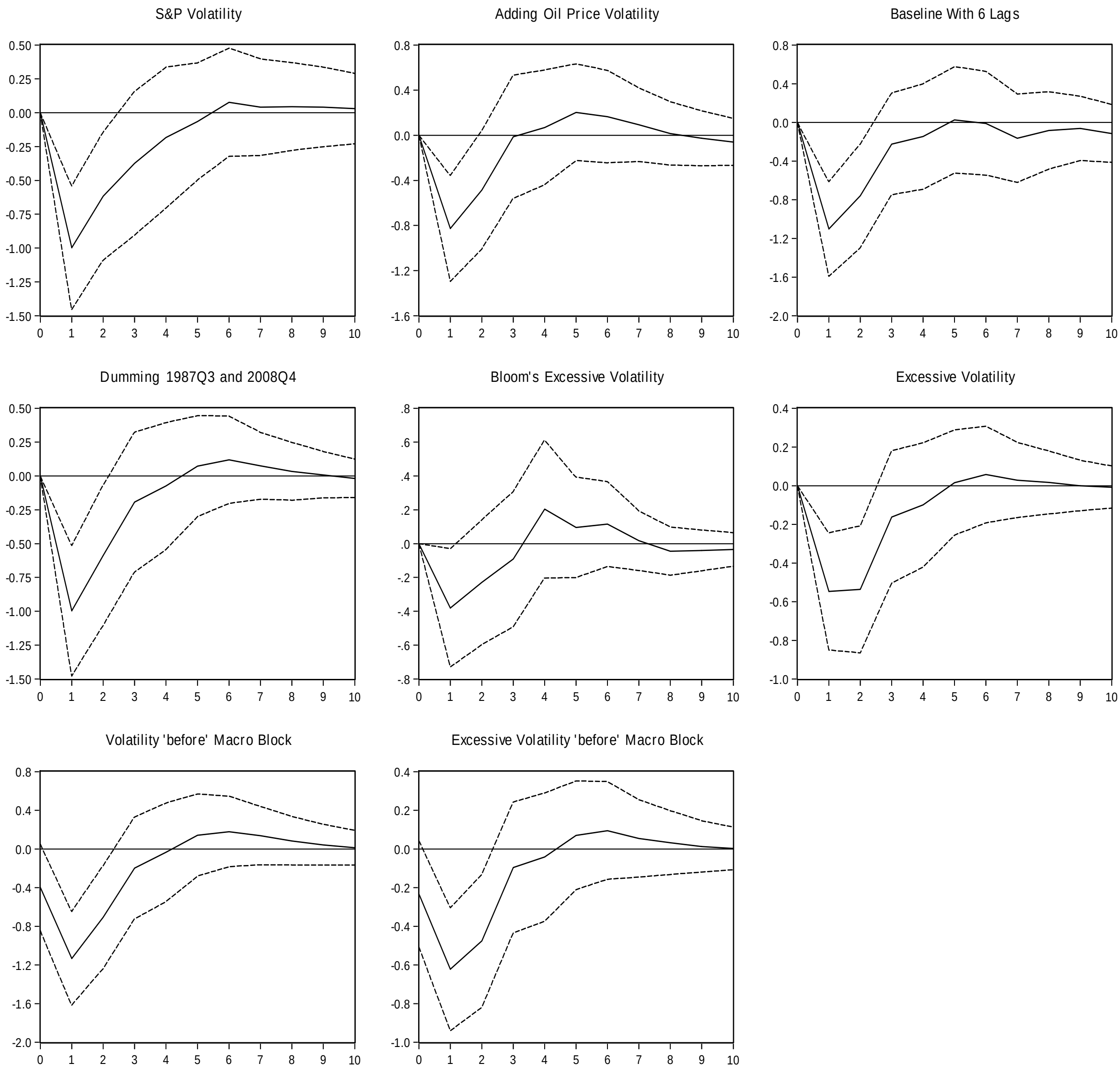
Notes: response of the endogenous variable to a stock market volatility shocks. Confidence bands are based on a 90% significance level.

Figure 3: Stock market return included as exogenous variable



Notes: the dotted line within the confidence bands shows the response of output growth in the baseline model where the stock market return is allowed to react to the volatility shock. Confidence bands are based on a 90% significance level.

Figure 4: Robustness



Notes: Each graph shows the response of output growth a stock market volatility shock under different variations of the baseline VAR model. Confidence bands are based on a 90% significance level.

Figure 5a: First subsample (1950Q2 - 1983Q4)

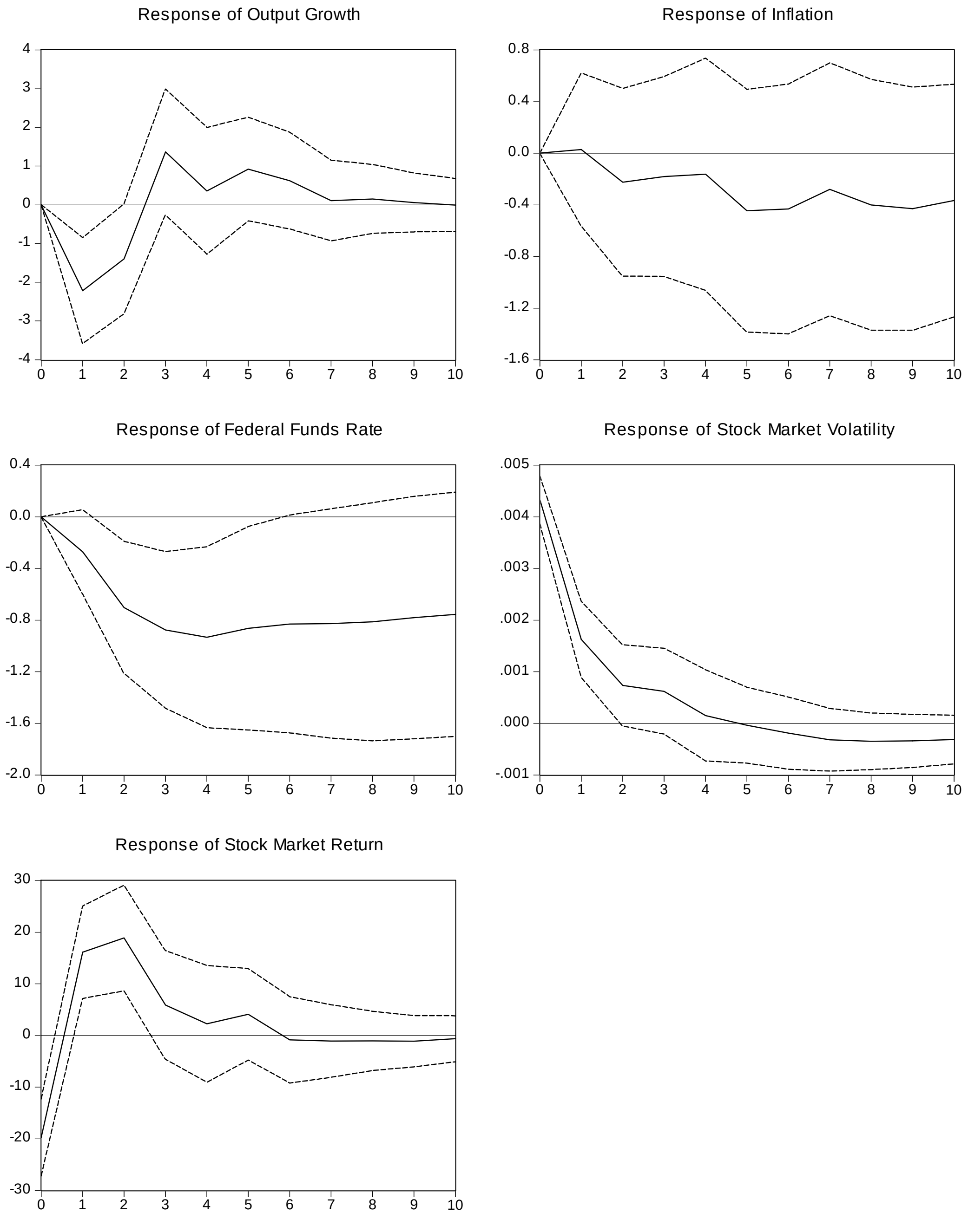


Figure 5b: Second subsample (1984Q1 - 2011Q2)

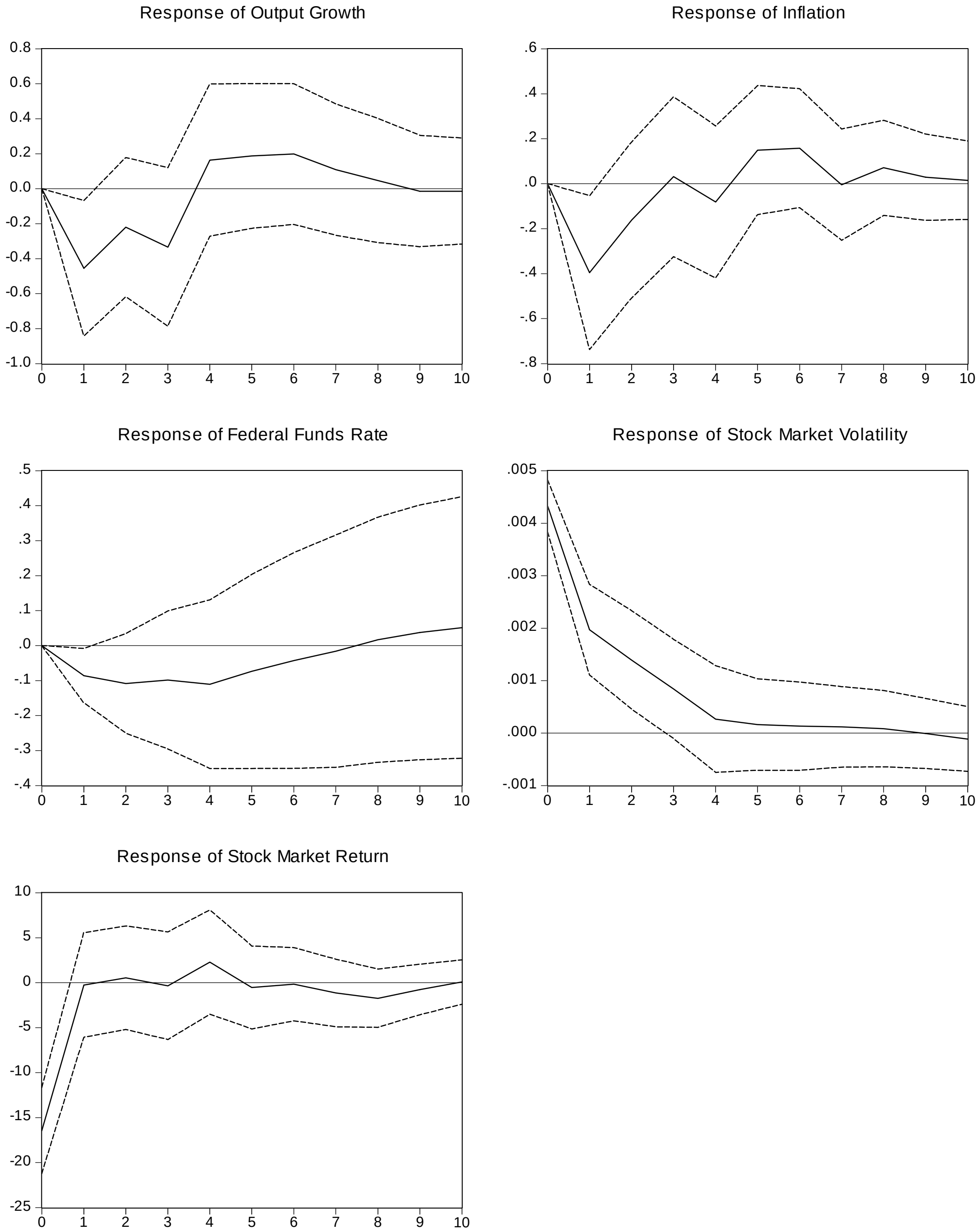
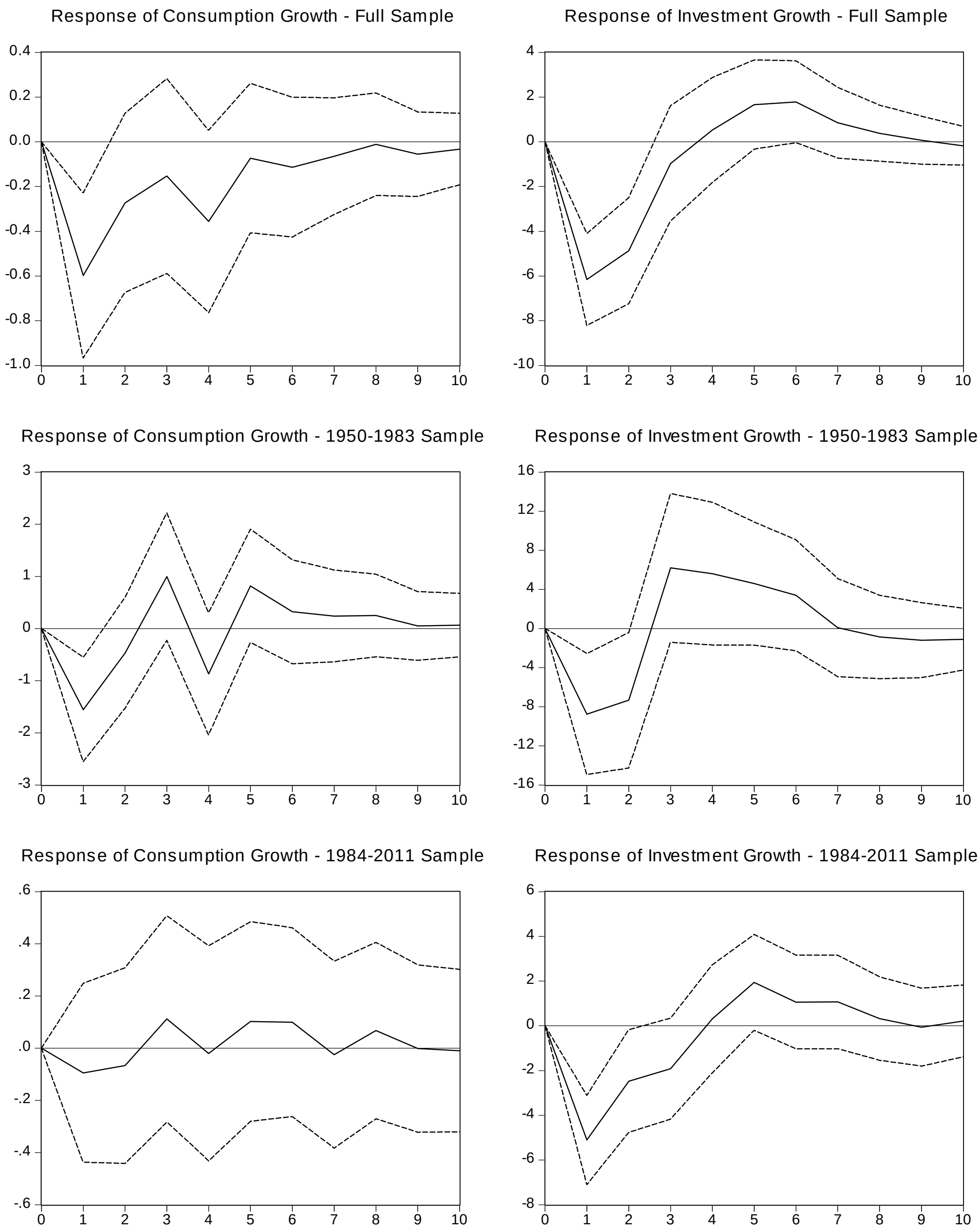


Figure 6: Responses of consumption and investment growth to volatility shocks



Additional Appendix:

Figure A.1a: Exports growth instead of GDP growth

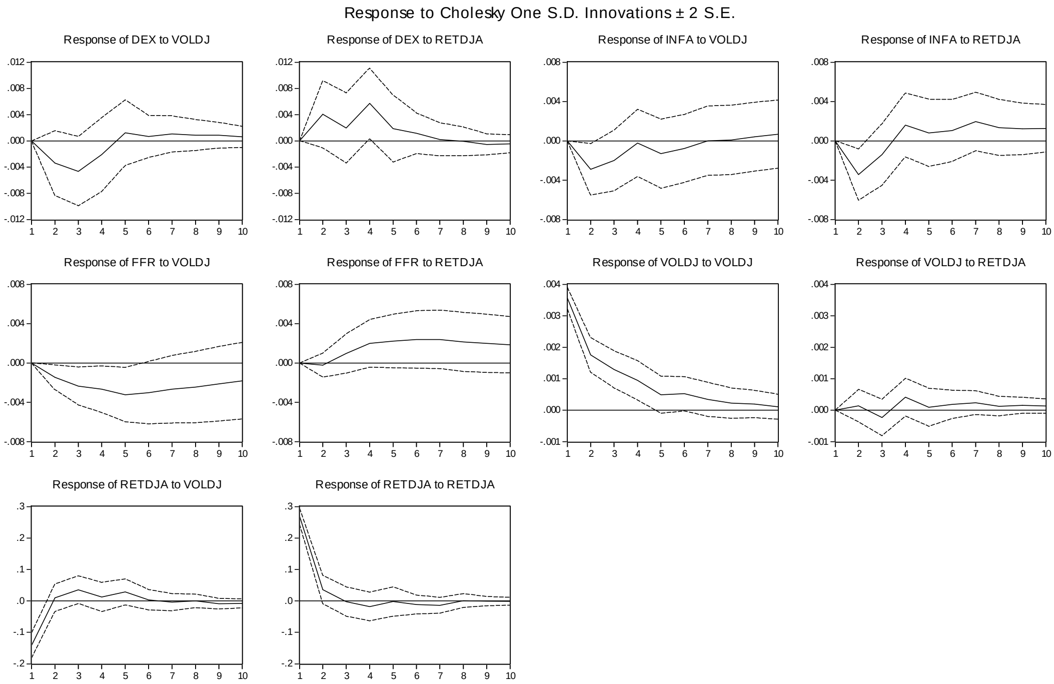


Figure A.1b: Exports growth instead of GDP growth – first sub-period

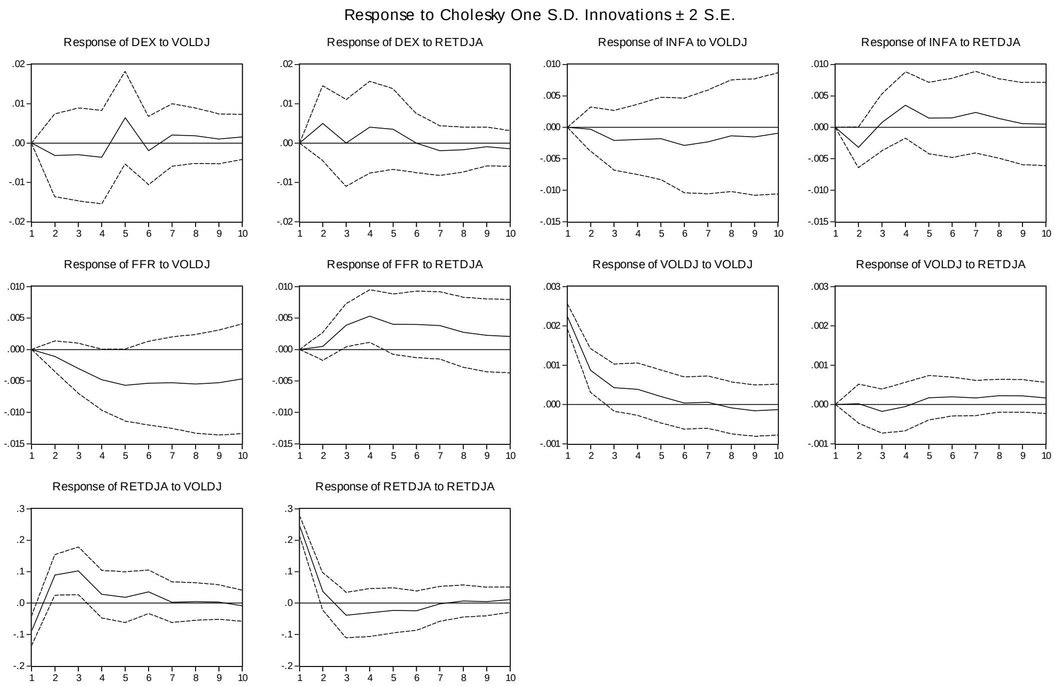


Figure A.1c: Exports growth instead of GDP growth – second sub-period

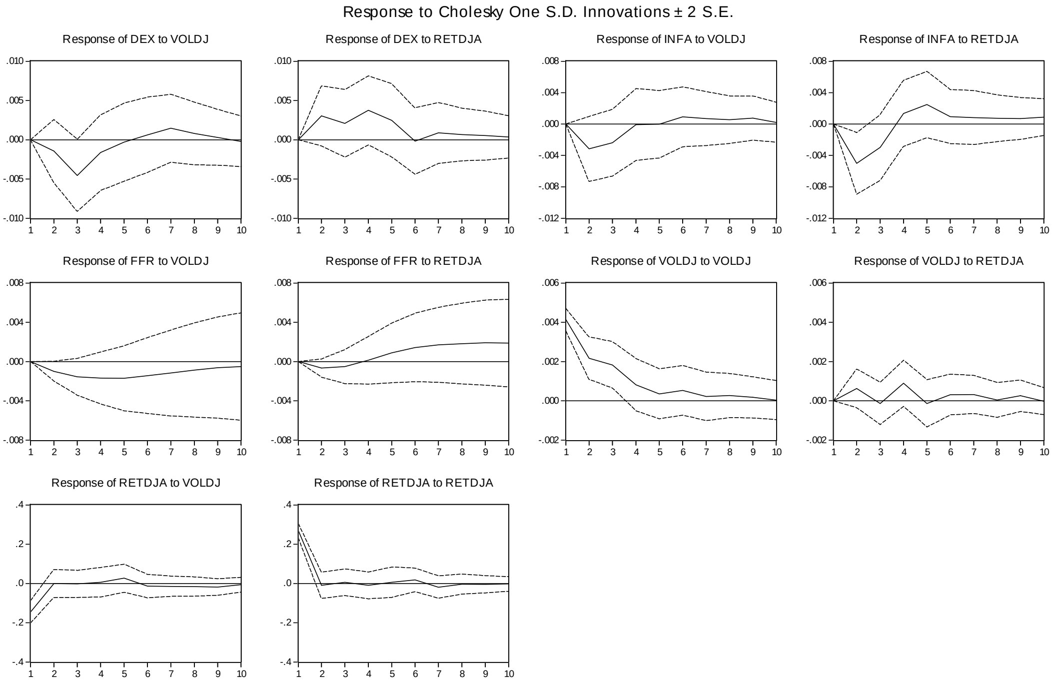


Figure A.2a: Imports growth instead of GDP growth

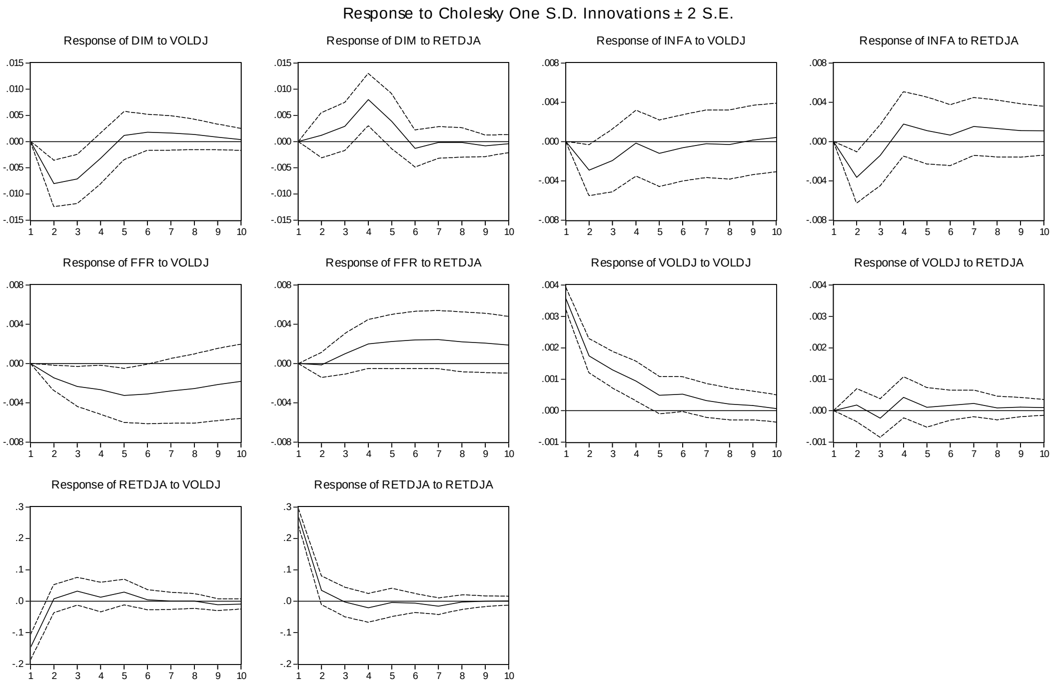


Figure A.2b: Imports growth instead of GDP growth – first sub-period

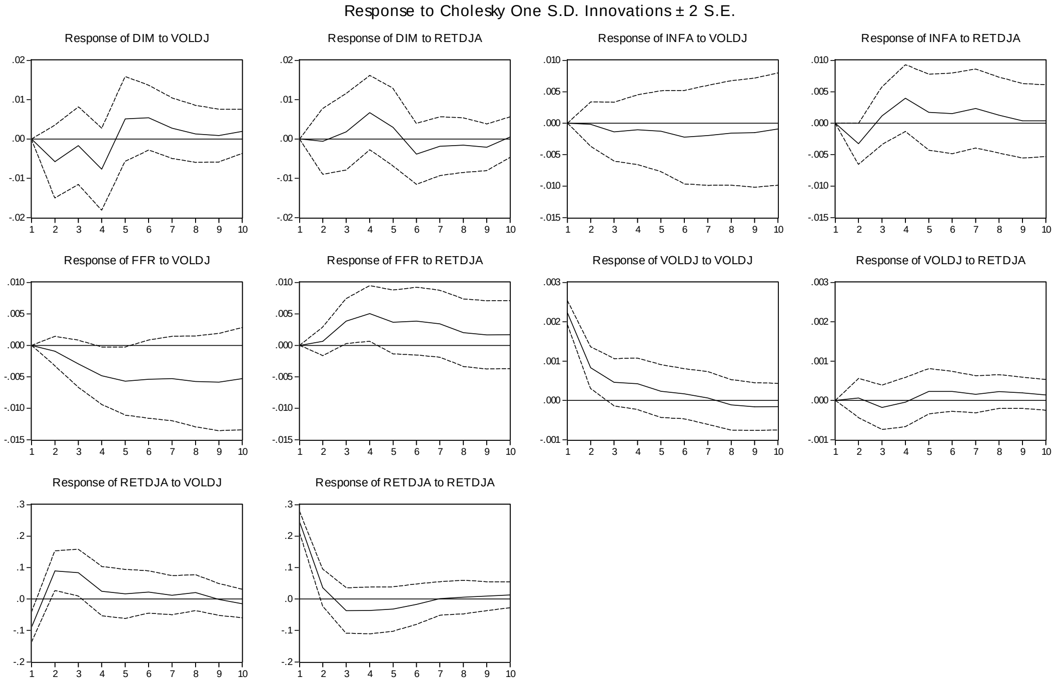


Figure A.2c: Imports growth instead of GDP growth – second sub-period

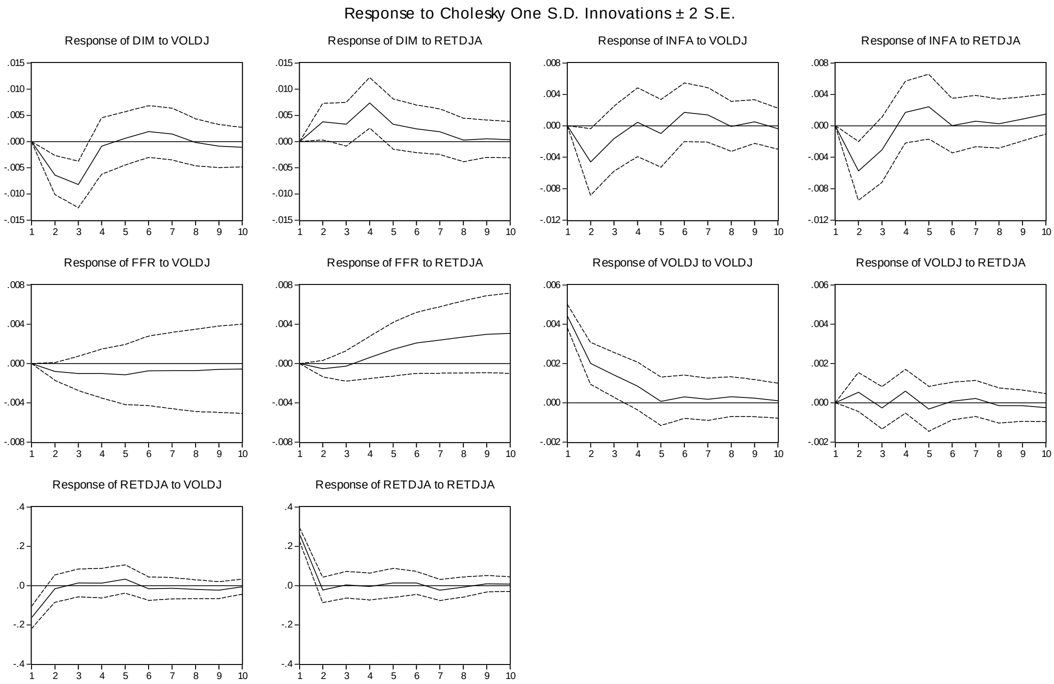


Figure A.3a: Government spending growth instead of GDP growth

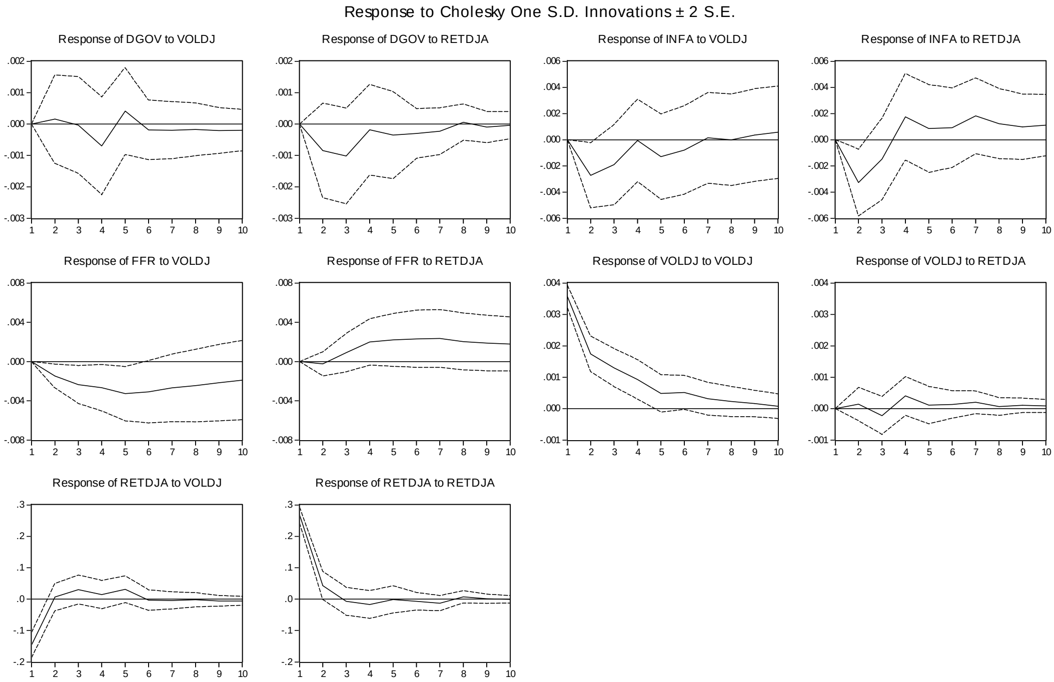


Figure A.3b: Government spending growth instead of GDP growth – first sub-period

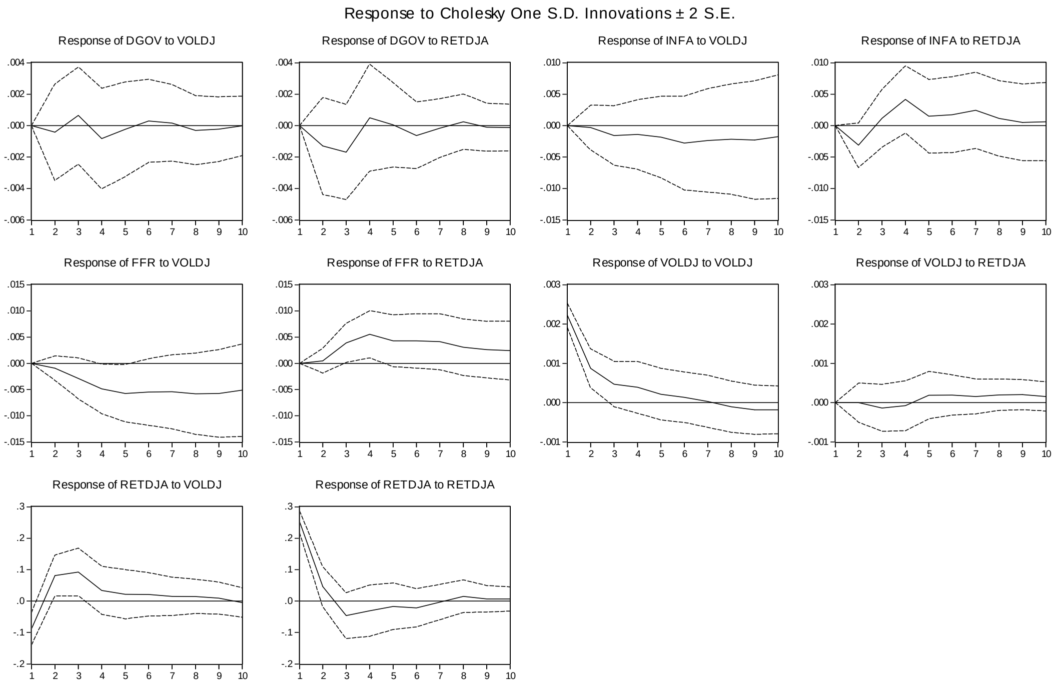


Figure A.3c: Government spending growth instead of GDP growth – second sub-period