The Decline in US Output Volatility: Inventory Investment and Systematic Monetary Policy

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1. Introduction

The U.S. economy has experienced a reduction in volatility since the mid-1980's. Kim and Nelson (1999), and McConnell and Perez-Quiros (2000), among others, have estimated a break in the variance of real GDP at the beginning of 1984. Various studies indicate that the reduction in volatility is not confined to aggregate output, but that it extends to other aggregate variables such as all the major components of GDP (McConnell, Mosser, and Perez-Quiros, 1999), aggregate unemployment (Warnock and Warnock, 2000), aggregate consumption and income (Chauvet and Potter, 2001), wages and prices (Sensier and Van Djik, 2001; Stock and Watson, 2002). Only interest rates, exchange rates, stock prices, money and credit series have experienced an upward shift in volatility (Sensier and Van Djik, 2001; Stock and Watson, 2002).

What accounts for this dramatic change in volatility? Broadly, explanations fall in three categories: better technology, better policy and good luck. The proponents of the first hypothesis emphasize the role of changes in the structure of the economy related to better inventory holding techniques (McConnell and Perez-Quiros (2000) Kahn, McConnell and Perez-Quiros, 2001), and innovations in financial markets (Blanchard and Simon, 2001). Those attributing the decline in output volatility to "better policy" contend that a significant change in the monetary policy rule during the Volcker-Greenspan period was the main source of this dramatic change in economic outcomes (Clarida, Gali, and Gertler, 2000; Boivin and Giannoni, 2002). A third explanation suggest that even though improved monetary policy may account for part of the moderation in output volatility, the majority of the moderation is accounted by a reduction in the size of shocks hitting the economy during the last two decades (Ahmed, Levin, and Wilson, 2002). These three explanations are not exclusive. Work by Herrera and Pesavento (2004) suggests that although the decline in the volatility of inventories is mainly accounted by materials and supply inventories, this structural change is not enough to account for the reduction in output volatility. Therefore, we are left with two possible candidate explanations for the shift in output volatility: "better policy" and "good luck".

The objective of this paper is to investigate the role of systematic monetary policy in accounting for changes in the response of output, inventories and sales to exogenous shocks. Given that increase in the crude price have been mostly due to events exogenous to the US economy, oil prices measured as the net oil price increase (Hamilton, 1996) are an ideal candidate to consider as exogenous shock. Using a modified VAR system, in the spirit Sims and Zha (1996), we attempt to separate the effect of exogenous shocks to the economy from the effect of systematic monetary policy (see Bernanke, Gertler and Watson, 1997) in two separate samples before and after 1980s. We find that, even if the size of the exogenous shock had been constant across subsamples, changes in the monetary policy rule may be partly responsible for the difference in responses of macro variables in the two sub-sample under consideration. The evidence is stronger for prices, durables inventories and sales, and in particular for input inventories. While the impulse responses indicates a significant impact of the endogenous monetary policy on the response of output, the systematic policy contributed to an increase in the variability of output of 25% in the pre-1979 period and 20% in the post-1985 period which is not sufficient to explain the observed 75% drop in output variability.

The remaining of this paper is organized as follows: section 2 describes the recent literature on the debate between the proponents of the good luck hypothesis and better policy hypotheses, sections 3 and 4 describe the industry level data and the VAR specification used; section 5 addresses the effect of exogenous monetary policy, oil shocks and systematic monetary policy, and the last section provides some concluding remarks.

2. Good Luck and Better Policy

The proponents of the "good luck" hypothesis have argued that a reduction in the size of the shocks hitting the economy have accounted for a large proportion of the decline in U.S. output volatility. Ahmed, Levin and Wilson (2002) identify smaller shocks with a reduction in the high frequency range of the spectrum of GDP growth, and monetary policy with the business cycle frequencies. They find that most of the reduction in the volatility of output can be accounted by a reduction in the size of the innovations. However, they recognize that this behavior can also be consistent both with "better monetary policy" that has acted to eliminate sun spot equilibria.

On the other hand, Stock and Watson (2002) find some role both for identifiable shocks -less volatile money, fiscal, productivity and oil shocks-, and improved monetary policy in the decline of U.S. output volatility. However, they conclude that "to the extent that improved policy gets some of the credit, then one can expect at least some of the moderation to continue as long as the policy regime is maintained. But because most of the reduction seems to be due to good luck in the form of smaller economic disturbances, we are left with the unsettling conclusion that the quiescence of the past fifteen years could well be a hiatus before a return to more turbulent economic times."

In this paper we address this issue from a new angle. Suppose we could identify an exogenous shock for which the variance did not decrease significantly after the mid-1980s. Then, the question of interest would be whether the response of monetary policy to that shock contributed to reduce the impact of the shock on the variance of GDP. Furthermore, could the response of monetary policy account for the reduction in the volatility of other series such as manufacturing sales and inventories? An ideal candidate for an exogenous shock appears to be oil price shocks. As noted by Stock and Watson (2002), there has been essentially no change in the variance of this oil price shock measure across subsamples. It is important that in this thought experiment for the shocks we consider to be of similar size across the periods if we want to disentangle the moderation in the output volatility due to smaller shocks from the moderation due to better monetary policy response to shocks.

There are two additional reasons why we use oil prices shocks as our exogenous shock. First, unless one considers the innovations from a structural VAR, it is difficult to identify any exogenous shock to the economy. Yet, in most cases increases in oil prices were caused by political disruptions in the Middle East, which, in turn, were exogenous to the U.S. economy. Second, this shock is the leading alternative to monetary policy as key source of post-World War II recessions, as well as the heightened volatility of the 1970s. Our aim thus, is to first establish whether oil price shocks and monetary policy contributed to the variance of GDP, manufacturing sales and inventories, and then to evaluate the role of monetary policy in moderating the effect of this shock in the later subsample.

3. Econometric Specification

Historically most oil price increases have been followed by a raise in the federal funds rate. In fact, Bernanke, Gertler and Watson (1997) - hereafter BGW- argue that the systematic component of monetary policy accounts for a large portion of the decline in GDP growth that follows an oil shock. Although, the magnitude of the effect of the systematic component is a matter of debate (see Hamilton and Herrera, 2004, and Bernanke, Gertler and Watson, 2004), there is no doubt that identifying the effect of systematic monetary policy is central to understanding the dynamic response of the economy to shocks. In order to understand the role of the monetary policy in the economy response to shocks we extend the modified VAR framework of Bernanke, Gertler, and Watson (1997), to analyze the effect of oil price shocks across the two periods of interest. We estimate a quarterly structural VAR describing the behavior of y_t, which contains three blocks of variables: macro, monetary policy, and industry block. The first block includes the following macroeconomic variables, y_t: the growth rates of GDP (y_{GDP_t}), log of the CPI ($y_{CPI,t}$), log of commodity prices ($y_{PCOM,t}$), and a measure of net oil prices ($y_{OIL,t}$). The following blocks contains the federal funds rate ($ff_{,t}$), our indicator of the monetary policy, and the last block is an industry block, i_t,which includes sales ($y_{S,t}$) and inventories by stages of production (finished goods, y_{FIt} , work-in-process, y_{WIt}, and materials $y_{MI,t}$). We assume that the structural VAR for y_t has a linear moving average representation

$$y_t = B(L)\,u_t, \qquad B(0) = B_0 \tag{1}$$

where $B(L)$ is an infinite order matrix lag polynomial, and $u_t = [u_{gdp,t},\ u_{p,t},\ u_{pc,t},\ u_{ot},\ u_{ff,t},\ u_{s,t},\ u_{fi,t},\ u_{wi,t},\ u_{mi,t}]^{\prime}$ is a vector of white noise structural innovations. We identify the response function $B(L)$ and the structural disturbances u_t by placing restrictions on certain elements of B_0 and $B(L)$. The restrictions we impose on B_0 are given by

$$b_{gdp,p}(0) = b_{gdp,pc}(0) = b_{gdp,o}(0) = b_{gdp,ff}(0) = 0 \tag{2a}$$

$$b_{p,pc}(0) = b_{p,o}(0) = b_{p,ff}(0) = 0 \tag{2b}$$

$$b_{pc,o}(0) = b_{pc,ff}(0) = 0 \tag{2c}$$

$$b_{o,ff}(0) = 0. \tag{2d}$$

The identification restrictions in (2) are common in the VAR literature on the effects of monetary policy: Ordering the federal funds rate after the other macro variables and oil prices follows the conventional assumption that monetary policy cannot instantaneously affect the other macro variables while the variable on commodity prices is included in the VAR to control for information that the Fed may have about future inflation that is not captured by the other variables in the system. The ordering of net oil prices after the macroeconomic variables and before the federal funds rates impose the reasonable restriction that oil prices do not contemporaneously affect the GDP and prices while it contemporaneously affect the monetary policy equation.

As for the identification of the industry block, we also make the assumption that the matrix B_0 corresponding to the industry block is lower triangular imposing the restrictions that sales respond to changes in inventories only with a lag, finished goods inventories respond to input (work-in-process, materials and supplies) inventories with a lag, and work-in-process are Wold causally prior to materials and supplies inventories. Note that in order to evaluate the effect of oil price and monetary policy shocks on the macro and industry level variables we could use an alternative -and possibly more reasonable- identification scheme. That is, we could allow for non-zero correlation among the shocks to the industry blocks, thus imposing a block recursive structure with two blocks: macro-policy and industry. This block recursive nature of the system, with the upper 5×5 block of B_0 being lower triangular would suffice to identify the contribution of oil price shocks and systematic monetary policy. In this case we would not attempt to attain identification at the interior of the industry block. This other identification scheme will be used in a later version of the paper.

In addition, we impose the following restrictions on the elements of $B(L)$

$$b_{i,s}(l) = b_{i,fi}(l) = b_{i,wi}(l) = b_{i,mi}(l) = 0 \text{ for all } l \text{ and } i = gdp, p, pc, o, ff, \tag{3}$$

where $b_{i,j}(l)$ denotes the ij element at lag l of $B(L)$. Under these zero restrictions and (2) the industry specific variables are constrained to affect the macro variables only indirectly through their effect on the aggregate economy. Thus, our estimated VARs can be described as a near-VAR specification that guarantees that the effects of oil price and monetary policy shocks, as well as the other unspecified macro shocks, will be identical across manufacturing aggregates. Thus, even though we estimate separate VARs for durable and nondurable manufactures, the implied effects of the shocks of interest on the macro variables are identical. At the same time this specification allows the response of sales and inventories to vary freely across durables and nondurables manufacturing goods.

4. Data

In this paper we use quarterly data, in the spirit of Bernanke, Gertler and Watson (2004), instead of the monthly data used by Hamilton and Herrera (2004) and Bernanke, Gertler and Watson (1997). In this manner we are able to include 4-quarterly lags in our VAR specification, which is consistent with previous literature on the effect of oil price shocks (see for instance Hamilton, 1983; Mork, 1989; Raymond and Rich, 1997, and Hamilton, 2000), and reduce the number of parameters to be estimated, relative to the monthly model. In addition to allow us to include year of lags in the estimation while reducing the number of parameters to be estimated, using quarterly data allows us to make our results comparable to previous literature on output volatility.

The data comprise both macroeconomic variables and industry level series from the first quarter of 1959 to the first quarter of 2000. The macroeconomic variables include the log real GDP growth, the log of the CPI, the log of an index of commodity prices, a measure of oil price changes, and the federal funds rate. Data for real GDP, and the federal funds rate were obtained from the FRED database of the Federal Reserve Bank of St. Louis. The CPI is the Consumer Price Index for all urban consumers from the Bureau of Labor Statistics, while the commodity price index was obtained from the DRI-Ward Database and excludes oil prices. As a measure of oil price changes we use the net oil price increase (Hamilton, 1996) which records the percentage change in the price of oil from the maximum value observed in the preceding three years. Thus, when the value of the value of the current quarter exceeds that of the previous three year's maximum, the variable is set equal to the percentage change over the previous maximum; if the price of oil is lower than the previous maximum, then value of the variable is zero. This transformation is intended to filter out changes in prices during periods of high volatility, as well as increases in the price of oil that operate as a correction over a previous fall in the price.

At the industry level we use sales and inventories series for total manufacturing, as well as nondurable and durable manufacturing goods from the Bureau of Economic Analysis. The inventory data are disaggregated by stages of production into materials, work in process and finished goods inventories. The data are seasonally adjusted and measured in chained dollars of 1996. The original series are available at a monthly frequency, however for we transform them into quarterly data by aggregating monthly sales and using end of quarter inventories.

5. VAR Analysis

As mentioned in the previous section, the data spans the period between 1959 and 2000. As initially documented by Kim and Nelson (1999), and McConnell and Perez-Quiros (2000) there is strong evidence of a structural break in volatility of GDP growth at the beginning of 1984. More recent work has confirmed the presence of a break anywhere between the fourth quarter of 1982 and the third quarter of 1985[1] with 67% probability (Stock and Watson, 2002). In our analysis we split the sample in two sub-samples: 1959:1-1979:4 and 1985:1-2000:1. We have two reasons to split the sample at those particular dates. First, because we want to study whether the economy's response to an exogenous shock has changed, we need to eliminate the period in which the break is possibly located. Second, this particular split eliminates the nonborrowed reserve targeting experiment from the second sample (see also Boivin and Giannoni, 2002). The exclusion of the possible break provides the additional advantage of not having to model a structural break in the variance covariance matrix during the estimation of our VAR. For each manufacturing aggregate we estimate the nine equations in (1) by OLS, equation by equation, which differ in the sample period (1959:1-1979:4 or 1985:1-2000:1) and the industry (total, non durables or durables manufacturing). We fix the lag length p to 4 in accordance with previous studies on the effects of oil price shocks.

5.1. Oil Price Shocks. To study changes in the dynamic response to oil price shocks we first calculate the effect of an exogenous 10% increase in the oil price during the two sample periods. The responses for the macro variables in the VAR are plotted as the solid lines in Figure 1. The responses for the pre-1980 are reported in the left panel and while the right panel displays the responses for the post-1985 period.

Figure 1 shows that in the 1959:1-1979:4 sample, an oil prices shock results in a slow down in economic activity that exhibits a through five quarters after the shock, and a persistent increase in prices. During the first year the Federal funds rate increases one and half basis points, resulting in higher short and long term rates.[2] In contrast, during the post-1985 period, the same percentage increase in oil prices

[1]Similarly, Herrera and Pesavento (2004) estimate the 90% confidence interval for a brak in the conditional variance of GDP to be 1982:4-1989:1.

[2]Notice that without error bands around the impulses responses in hard to quantify if the increase in output is statistically significant. Confidence intervals for the impulse responses and the variance decomposition will be included in a later version of the paper.

results in a same size but longer initial drop in output and a permanent decrease in prices. In both periods, the effect of the shock on output disappears after about 2 years. The resulting increase in the Fed funds rate -and consequently on the short and long term rates- is insignificant in the second period.

Figures 2-4 report the responses of the aggregate (total manufacturing) and disaggregate data (durables and non durables manufacturing) for sales and inventories. Each set of responses are obtained by running a different VAR with the same macro variables and different industry blocks. The comparison in the Figures 2-4, reveals differences across periods and across industries in the response of manufacturing sales and inventories to the oil shock.

First, for total manufacturing sales the responses to the oil shocks (Figure 2) are similar across the two periods with a peak in the response of 0.005 forsales after about 1 year and half[3]. In the first period the pick is followed by a drop of the same size that is not present in the second period. These results suggest that oil price shocks result in accumulation of manufacturing finished goods inventories across periods. Second, the results for disaggregated data (Figures 3 and 4) suggest that the larger response in the pre-Volcker period for work-in-process inventories is mostly due to durable manufactures as the response for nondurables work-in-process inventories pre-1979 is of a smaller order of magnitude. This result is consistent with the fact that work-in-process inventories of durable manufactures represent a larger proportion of manufacturing work-in-process inventories. At the disaggregate level we find a smaller response in the second period possibly reflecting the contribution of better inventory holding techniques to the smoother and faster adjustment of work-in-process inventories to exogenous shocks, as well as reductions in production cycles (Milgrom and Roberts, 1990)

5.2. Systematic Monetary Policy. The differences across periods in the response of the economy to oil shocks of the same size suggest the question of whether this change in the dynamics is a result of a shift in the monetary policy rule. To answer this question we use the methodology proposed by Sims and Zha (1996)[4] to separate the effects of systematic (or anticipated) and unsystematic portion of the monetary policies . Following Sims and Zha (1996) we use the historical data summarized by the VARs to analyze what would have happened if the tightening response of the monetary policy would have been delayed. As in Bernanke, Gertler, and Watson (2004), the counterfactual scenario we analyze is one in which exogenous monetary

[3]Notice that the responses are displayed in graphs of different scale to allow the smaller response to be visible.

[4]For a discussion on the advantages and disadvantages of this methodology see Bernanke, Gertler and Watson (1997), Hamilton and Herrera (2004) and Bernanke, Gertle and Watson (2004).

policy is aimed at maintaining the Fed funds rate unchanged for one year in face of an oil shock. We interpret this scenario as shutting down the response of systematic monetary policy. We calculate the consequences of this policy by computing the value of $v_{FED,t+s}$ that would keep the value of $y_{FED,t+s}$ at zero for four quarters, and add this shock in before calculating $y_{SR,t+s}$ at each step $s = 0, 1, 2, 3, 4$ of the simulation for the oil price shock. As pointed out by Bernanke, Gertler, and Watson (2004) it seems plausible that a purely transitory deviation from the usual policy rule would not significantly affect the structure of the economy thus partially protecting our exercise from the Lucas critique.

The dashed lines in Figures 1 to 4 plot the response of the economy to oil shocks of the same size when the monetary policy is not allowed to systematically respond for one year. The difference between the solid and the dotted lines can be interpreted as the effect of the systematic monetary policy. Since the parameters governing the response of the macro variables in each subsamples are left unchanged, the difference between the solid and the dotted lines are due simply to differences in the responses of the anticipated monetary policy and not to differences in the response of the economy.

Figure 1 shows that, if the monetary policy had not responded the oil shock for one year, the pre-Volcker period would have experienced a sligtly smaller drop in output and a less persistent increase in prices that would have disappeared after about 2 years. In contrast, the contribution of systematic monetary policy during the post-1985 period has been very moderate as apparent from the smaller differences between the solid and dotted lines. It appears that not only the response of the economy to monetary policy innovations has changed as documented by Boivin and Giannoni (2002), but also the systematic response to exogenous shocks. During the pre-Volcker era, the monetary policy response to oil shocks contributed in a large extent to the slowdown of economic activity, as well as to higher price levels.

As in the case of the macro variables, the more substantial differences between the solid and dotted lines in Figures 2-4 are in the pre-1979 period in particular for work-in-process inventories. For finished goods inventories and materials the systematic component of monetary policy before and after 1984 does not appear to have changed significantly, as it is the case with their variance (see Herrera and Pesavento (2004)). The results for the disaggregated data suggests that the durables components of manufacturing is mostly responsible for these differences.

Taken all together the results from Figures 1-4 suggest that changes in the monetary policy rule may be partly responsible for the difference in responses of macro variables in the two sub-sample under consideration. The evidence is stronger for prices and durables inventories and sales and in particular for input inventories. Both at the aggregate and the industry level, the negative effect of a 10% increase in the oil price would not have been reinforced by such a tight monetary policy as during the 1970s. We find some evidence that the response of output to a oil shock was more affected by the endogenous response of the monetary policy in the pre-Volcker era. There is a chance that if the monetary policy rule is maintained, it might be able to moderate the impact of exogenous shocks, as it appears to have done in the case of oil prices.

5.3. Variance Decomposition. The impulse responses in Figure 1 to 4 evidence the relevance of anticipated monetary policy in the pre-Volcker era. To better understand the role of monetary policy in explaining the decrease in the variability of most macro variables since the 1980 we estimate some measures of the mean square error of the 16 periods head forecast and of the contribution of the oil shock to the mean square error of our variables as implied by our estimated VAR. We can interpret the mean square error as an approximation of the unconditional variance. As in the previous section we report our estimates for the two periods under consideration with or without a systematic response of the monetary policy.

Table 1 reports the estimated variances of each variable as estimated from the parameters of the VAR[5]. The first three columns of the table report the results from the standard structural VAR for the three different periods in consideration. The last three columns report the decomposition when we shut down the systematic response of the monetary policy for one year. As documented in the literature almost all the variables show a significant drop in the unconditional variance after 1985: The variance of US GDP is 75% lower in the post 1985 than in the pre 1979 period. The only exceptions are oil prices, and total finished goods inventories. The disaggregate results show an increase in the variance of non durables sales and durables and total work-in-process inventories. These results are consistent with the findings in Herrera and Pesavento (2004) that materials and supplies inventories account for most of the reduction in the volatility of total inventories during the 1980's and that while input inventories are more volatile than output inventories pre-1979, it is not clear that this is the case after 1985.

Shutting down the systematic response of monetary policy lowers the estimated variances in most cases. When we look at the entire period 1959-2000 the differences in the variances estimated with and without immediate systematic response of the policy maker are not very large with the exception of federal funds rates and durable sales. Splitting the sample in two reveals different dynamic in the two samples. The drop in the variance of CPI that was observed in Figure 1, is confirmed by the estimated 82% drop in the variance in the pre-1979 period and the 61% drop in the later period. Interestingly, the significant impact of the endogenous monetary policy on the response of output observed in the impulse response functions is confirmed by

[5]We report the estimated variance multiplied by 10000 for all variables except oil and federal funds rates for which the reported numbers are the actual estimates divided by 10.

the estimate that the systematic policy contributed to a 25% increase in the variance of output volatility in the pre-1979 period and to a 20% increase in the later period. Similar drops in variability can be observed in the disaggregate data. As before, the systematic monetary policy has the stronger effect on durables goods and in particular for durables sales, and input inventories. These results are consistent with recent work by Humphreys, Maccini and Schuh (2001) that suggests that the response of inventories to demand shocks differ across durable and nondurable industries, as well as by stages of production. The stylized facts they present indicate that input inventories are twice as large as output inventories, three times more volatile, and particularly important in the durable goods industries. According to their estimates, the response of output inventories to demand shocks would lag the response of input inventories, and it would be smaller in magnitude. Thus, in the pre-Volcker era, a combination of high oil prices and a monetary policy rule that allowed for increases in anticipated inflation could have led to high variability in inflation, sales, and inventories at all stages of production. Possibly, with a smaller increase in volatility for finished goods inventories.

Table 2 reports the percent of the total variance after 4 years of each of the variables in our VAR due to an oil shock. Comparing the results for the full sample we can see that the contribution of an oil shock to the variability of GDP is around 7%. When we don't allow the policy maker to systematically respond an exogenous, the oil shock contributes 8.9% of the total variance, just little over 8%. The contribution to the variance of prices is less than 5% in both scenarios. Looking at total manufacturing sales and inventories, the larger differences in the contribution of the oil shock can be found in total manufacturing sales for which the variance decomposition almost doubles. The disaggregated date reveals that the increase in the contribution of the shock is mostly due to durables sector where it goes from 3.9% to 6.6%. Given that the unconditional variance of both the macro and most sectoral data did not change (the denominator in the variance decomposition) we can estimate that what changed was the response of the variables to the oil shocks. For durables sales, where we found that the unconditional variance went from 0.136 to 0.097, we can expect that the increase in the variance decomposition is mostly due to the decline in the unconditional variance rather than a change in the response of sales to the oil shock.

Splitting the sample in the two periods reveals also some interesting results. In the pre-Volcker period the contribution of the oil shock to the variance of GDP is around 10% when we don't allow the policy maker to respond for one year, of which about only 50% is due to the systematic response (from 4.78% to 10.77%). In contrast, the contribution of the shock to prices is almost 15% (14.4%), 80% of which is due to the systematic response of the monetary policy. The endogenous response of the monetary policy contributed to a lower contribution of the oil shock to the variance of federal funds rates of about 60%, some of which is due to lower overall variance

(Table 1). The contribution of the exogenous shock to the variance of manufacturing sales and inventories is higher when we only consider the pre-Volcker period. When we don't allow the policy to respond, the variance decomposition almost doubles for both sales and inventories. As in the case for the full sample, the industry level data reveals that the systematic policy mostly affected durables inventories and in particular inventories.

When computed using only data post 1985, the contribution of the shock to the variance of CPis up to 15.5% but it still doubles when we don't allow the policy to respond. Interestingly, in the second period shutting down the systematic policy does not significantly affect the variance decomposition for commodity prices and the federal funds rates consistently with the smaller decline observed in the total variance in Table 1. In this later period, the data suggests that, while the systematic policy has helped in lowering the effect of the oil shock on durables sales (from 23.7% to 19%), it has not helped in dampening the effect of the oil shock for total finished goods inventories and material inventories and it has increased the effect of the oil shock on total work in process and materials inventories. Once more we see that the larger effect of the systematic response is for durables inventories. At the same time, while the contribution of the oil shock on the variance of durables is larger in the second period than the first, the component of the variance decomposition due to the systematic policy is smaller.

Given the 70% drop in output variability between the two subsamples, one would be tempted to say that the monetary policy only contributed to a small fraction of the decline. Given that both the responses of the output to an oil shock and the monetary policy rule are allowed to change in the two sub-sample we need to be careful in making such strong conclusions. All we can say from this experiment is that the systematic part of the monetary policy did indeed contributed to a fraction of the higher variability of most macro variables in the 1970's.

6. Final Remarks

We have analyzed an event that has been documented and studied in recent macroeconomic literature: the decline in US output volatility. We find that, even if the size of the exogenous shock had been constant across subsamples, changes in the monetary policy rule may be only partly responsible for the difference in responses of macro variables in the two subsamples under consideration. The evidence is stronger for prices and durables inventories and sales and in particular for input inventories. In the pre-Volcker era, a combination of high oil prices and a monetary policy rule that allowed for increases in anticipated inflation would have lead to high variability in inflation, sales, and inventories, with a higher volatility in input than output inventories. In contrast, the stronger anti-inflationary stance during the Greenspan-Volcker period contributed largely to a more stable economic environment. We also find that, while the impulse responses indicates a significant impact of the endogenous monetary policy on the response of output, the systematic policy contributed to an increase in the variability of output of 25% in the pre-1979 period and 20% in the post-1985 period, which is not sufficient to explain the observed 75% drop in output variability.. Our results reinforce the results in Herrera and Pesavento (2004) that the decline in the variance is a phenomena that extends not only to manufacturing inventories but also to sales. Furthermore, we show that materials and supplies, not finished goods, account for most of the reduction in the variance of total inventories in the 1980's.

All in all, we agree with Stock and Watson (2002) conclusion that to the extend that better monetary policy can account for some of the moderation in the volatility of output, we can expect that at least some of the lower volatility might continue if the monetary rule is maintained. This conclusion is reinforced by our finding that systematic monetary response to shocks of the magnitude of the pre-1984 period (e.g., oil price shocks) has been able to moderate the variation in output, sales and, particularly, finished goods inventories. At the same time, we find that difference in the systematic monetary policies in the two period are not enough to explain the sharp decline in output variability observed since the 1980s. Thus, although it is possible that systematic monetary policy might be able to moderate the effect of other exogenous shocks on the economy, we are still not able to explain 50% of the decline in output volatility.

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Table 1: Variance of each variable as implied by the VAR estimates.

		With Systematic Response			No Systematic Response		
		1959-2000	1959-1979	1985-2000	1959-2000	1959-1979	1985-2000
	GDP	0.015	0.020	0.005	0.012	0.015	0.004
	CPI	0.914	0.459	0.075	0.991	0.082	0.029
	PCOM	8.240	3.406	2.137	12.418	3.557	1.680
	OIL	35.476	31.313	37.996	36.353	27.290	38.774
	FFR	9.067	6.683	2.077	2.189	2.977	0.410
Total	SALES	0.065	0.112	0.033	0.047	0.078	0.028
	FGI	0.024	0.026	0.027	0.021	0.021	0.026
	WIP	0.040	0.062	0.075	0.037	0.039	0.074
	MAT	0.037	0.063	0.026	0.038	0.053	0.026
Non Durables	SALES	0.038	0.057	0.029	0.031	0.046	0.030
	FGI	0.042	0.045	0.031	0.039	0.042	0.025
	WIP	0.042	0.067	0.083	0.036	0.059	0.076
	MAT	0.027	0.048	0.037	0.026	0.050	0.033
Durables	SALES	0.136	0.209	0.055	0.097	0.146	0.054
	FGI	0.042	0.054	0.029	0.040	0.052	0.023
	WIP	0.052	0.096	0.071	0.049	0.048	0.054
	MAT	0.085	0.158	0.034	0.086	0.126	0.030

Table 2: Contribution to the variance of each variable due to a oil shock for both scenarios and various periods.

		With Systematic Response			Without Systematic Response		
		1959-2000	1959-1979	1985-2000	1959-2000	1959-1979	1985-2000
	GDP	7.20	4.78	7.29	8.90	10.77	7.26
	CPI	4.75	2.46	15.53	4.47	14.40	23.45
	PCOM	11.45	7.08	1.02	8.40	4.16	0.96
	OIL	64.50	50.50	41.82	63.48	61.41	41.70
	FFR	11.03	6.51	2.95	36.63	15.40	2.80
Total	SALES	5.12	12.55	22.80	7.98	24.95	22.06
	FGI	4.36	20.37	10.94	4.33	20.07	7.74
	WIP	7.46	5.03	5.67	8.44	15.45	3.26
	MAT	7.23	8.17	11.10	7.48	15.00	7.77
Non Durables	SALES	7.51	10.50	24.42	9.80	13.93	28.19
	FGI	4.21	19.10	10.03	3.41	20.09	11.91
	WIP	3.42	14.99	7.33	4.63	10.51	8.01
	MAT	5.41	11.44	7.20	5.49	17.18	9.81
Durables	SALES	3.91	9.86	18.99	6.57	19.34	23.71
	FGI	5.10	12.77	12.56	6.33	11.05	15.02
	WIP	9.18	2.94	4.46	10.20	17.61	6.06
	MAT	6.10	6.49	7.68	6.62	14.59	9.73

Figure 1. IRF for effect of systematic monetary policy response to a 10% oil price increase

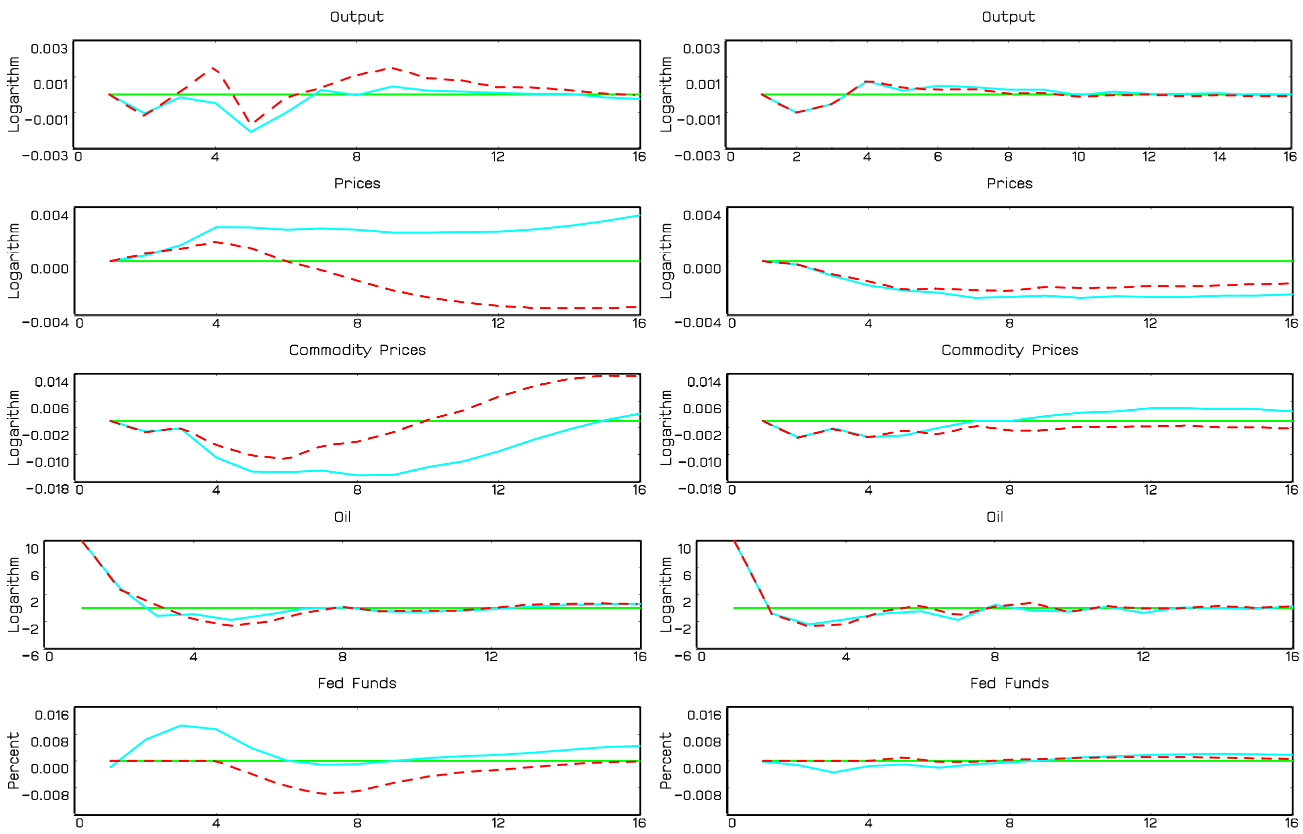

Figure 2. IRF for effect of systematic monetary policy response to a 10% oil price increase

Manufacturing

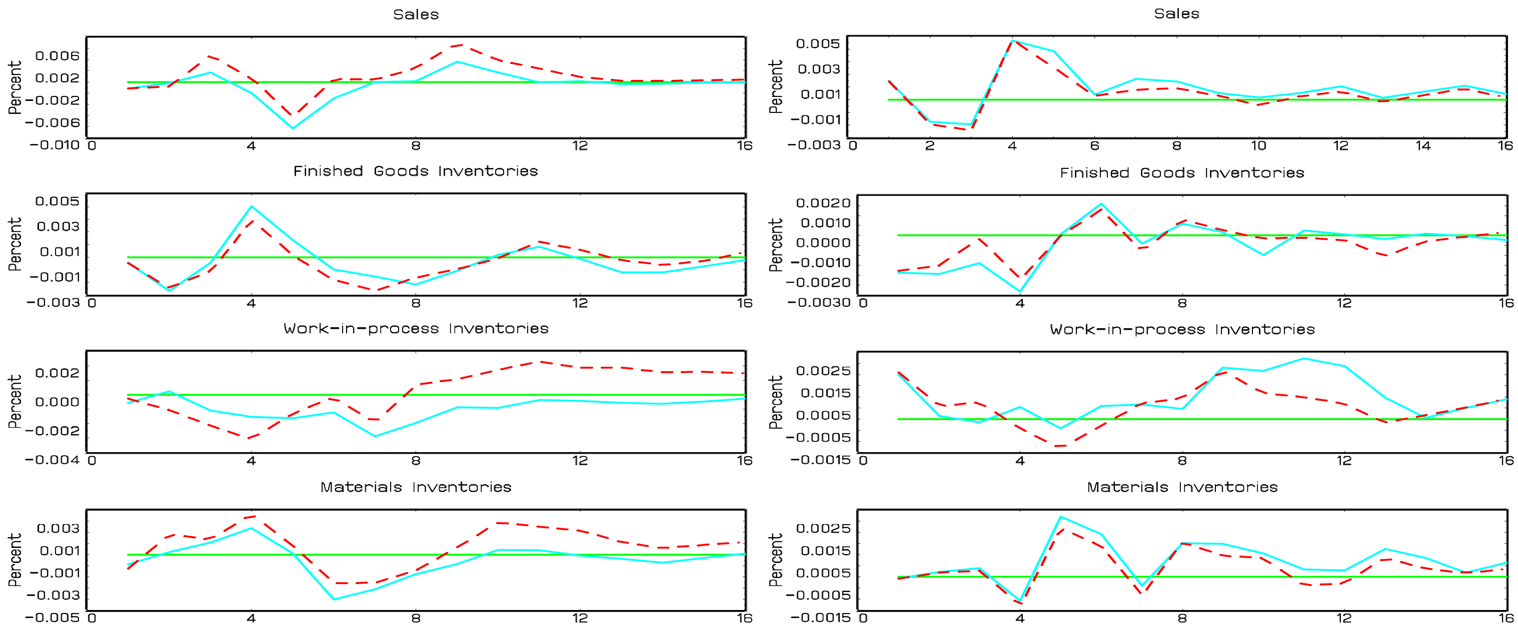

Figure 3. IRF for effect of systematic monetary policy response to a 10% oil price increase

Non Durables

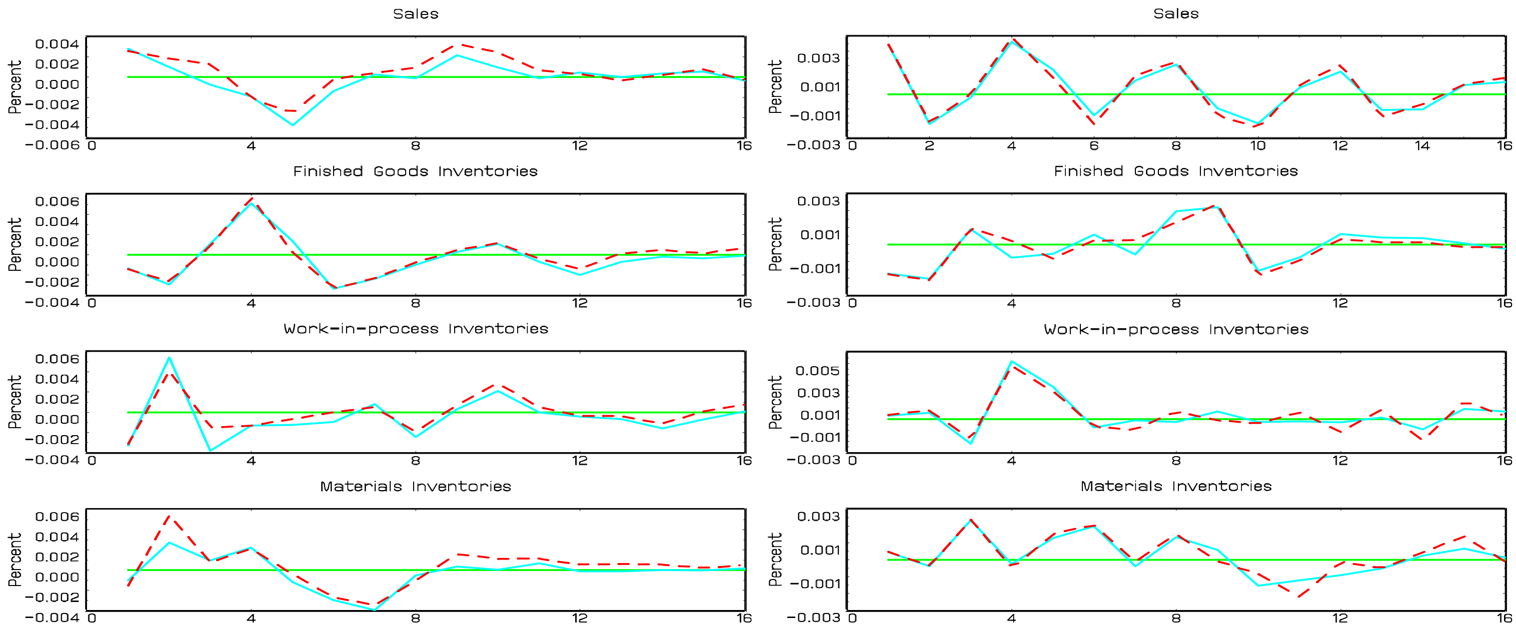

Figure 4. IRF for effect of systematic monetary policy response to a 10% oil price increase

Durables