Explaining the Great Moderation: Changes in the Volatility of Economic Activity at the Macro and Micro Levels

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Abstract

We review evidence on the Great Moderation in conjunction with evidence about volatility trends at the micro level. We combine the two types of evidence to develop a tentative story for important components of the aggregate volatility decline and its consequences. The key ingredients of the story are declines in firm-level volatility and aggregate volatility – most dramatically in the durable goods sector – but the absence of a decline in the volatility of household consumption and individual earnings. Our explanation for volatility reduction stresses improved supply chain management, particularly in the durable goods sector, and a shift in production and employment from goods to services. We also provide some evidence for a specific mechanism, namely shorter lead times for materials orders. The tentative conclusion we draw is that, although better supply chain management involves potentially large efficiency gains with first-order effects on welfare, it does not imply (nor is there much evidence for) a reduction in uncertainty faced by individuals.
The U.S. economy has experienced a Great Moderation in recent decades, a striking decline of volatility in real economic activity in output, employment, and productivity. Perhaps the most prominent candidate for explaining the reductions in the volatility of both real activity and inflation is improvements in monetary policy that began not long after Paul Volcker became chairman of the Federal Reserve in 1979 (for example, Clarida, et al., 2000). However, other explanations have been adduced as well. For example, financial innovation and increased global integration may play a role (Dynan et al., 2006). Technological change that gave enabled better inventory control methods (Kahn et al., 2002). Another line of research stresses macroeconomic “good luck” in the form of fewer and smaller exogenous shocks affecting the economy (Stock and Watson, 2002). As Bernanke (2004) remarks in his discussion of the Great Moderation: “Explanations of complicated phenomena are rarely clear cut and simple, and each … probably contains elements of truth.”

We begin with some facts about the Great Moderation, drawing mainly on U.S. data, and work towards a story with a few key themes. We begin by discussing the aggregate evidence. We will argue that elements of the Great Moderation began in the 1950s, and that the decline in volatility is especially apparent in the durable goods sector and in the behavior of inventories. While monetary policy in the early 1980s can certainly claim credit for reducing the level of inflation at that time, it does not seem to deserve much of the credit for the longer-run changes that make up for the Great Moderation. Indeed, the entire notion of an abrupt change once-and-for-all change in monetary policy that permanent effects on real variables, rather than a change in monetary policy which builds transparency and credibility over time, seems somewhat implausible.

Then, unlike most research on this topic, we consider volatility behavior at the micro level for clues about the sources and consequences of aggregate volatility changes. As it turns out, the micro story is complex, with reductions in volatility along some dimensions but higher volatility in others. For example, the average volatility of firm-level employment growth fell after the early 1980s, but trended in opposite directions for publicly-traded and for privately-held firms (Davis et al., 2006). In financial data, the variance in the idiosyncratic component of firm-level equity returns more than doubled.
from 1962 to 1997 (Campbell et al., 2001), although this trend largely reflects an influx of increasingly risky new listings (Fama and French, 2004; Brown and Kapadia, 2007). At the individual level, several indicators point to a large decline in the risk of unwanted job loss since the early 1980s (Davis, 2007). However, when we consider household-level consumption changes, we find no evidence for a decline in volatility after the 1980s. Moreover, the available evidence on individual earnings uncertainty points to a longer term rise, not a decline. Thus, a puzzle arises that research on the Great Moderation has yet to confront: Why has the dramatic decline in the volatility of aggregate real activity, and the roughly coincident decline in firm-level volatility, not translated into sizable reductions in the degree of (pre-tax) earnings uncertainty and consumption volatility facing individuals and households?

With the macro and micro elements in place, we try to piece together a coherent story of the Great Moderation that is consistent with both the macroeconomic and microeconomic evidence. Our story stresses improved inventory control, particularly in terms of shorter lead times for materials orders in the durable goods sector, and a shift in production and employment activity from goods to services.

Reduced Volatility of Aggregates

The volatility of U.S. real GDP growth declined in the early 1980s, as is clearly visible in Figure 1. Early findings of a discrete break in volatility around 1983 (McConnell and Perez-Quiros, 2000) encouraged research on the Great Moderation that focused on comparisons before and after 1983. The “sudden drop” view tends to encourage explanations that emphasize changes that happened at this time – like the changes in monetary policy under Paul Volcker—and to directs attention away from factors that might cause a long term decline of volatility. For example, structural shifts in the economy, like a rising share of services in aggregate output, are unlikely to produce an abrupt drop in aggregate volatility.

In addition, the “sudden drop” view conceals the fact that many economic series did not undergo an abrupt volatility drop around 1983. Some did so much earlier, some
later. We argue, echoing Blanchard and Simon (2001) somewhat, that the suddenness of
the volatility drop is more apparent than real—that, in fact, large shocks in the 1970s and
back-to-back recessions in the early 1980s obscure longer-term developments that
contributed to a downward drift in volatility well before the 1980s. Figure 2 provides
some evidence on this issue, showing quarterly annualized growth rates for the four
sectors of the national income and product accounts that comprise GDP: nondurable
goods, durable goods, services, and structures. Each sector is scaled by its nominal share
of GDP so that the magnitudes (in terms of growth contributions) are comparable, and the
scale of the charts is the same as in Figure 1.

The panels of Figure 2 show that only in the durable goods sector did volatility
change in much the same way—both in terms of magnitude and timing—as GDP.
Nondurables output volatility dropped, but it had also been lower in the 1960s before
increasing in the 1970s, and in any case it was never anywhere nearly as volatile as
durables. Thus the decline in the volatility of nondurables output—such as it was—is
unlikely to have been a major factor in the stabilization of the early 1980s. Service
sector output was also never nearly as volatile as durable goods output, and moreover, its
volatility dropped substantially in the early 1960s, and again in the 1970s, long before the
break in GDP volatility. Structures output did experience a drop in volatility at the same
time as overall GDP, but the size of the sector and the magnitude of the contribution is
modest. In magnitude and timing, the drop in GDP volatility appears most closely related
to developments in the durable goods sector.\footnote{More formal measures of volatility confirm the patterns discussed in the text. For example, if you plot rolling five-year variances for the same four sectors and GDP, along with a covariance term reflecting the variance of GDP not accounted for by the variances of the sectors, the findings suggest that both for total GDP and especially for durables, the volatility decline in the early 1980s was an acceleration of a trend that dates back to World War II. Only the durables sector volatility exhibits a downward trend on the order of that followed by overall GDP volatility.}

Of course, observing these patterns for different sectors of GDP is fundamentally just
an exercise in accounting. It does not prove cause and effect. Perhaps the decline in GDP
volatility also caused the decline in durables sector volatility, or perhaps both had a common
cause. Still, a challenge for any explanation of the overall decline in GDP volatility is to
account for the specific patterns observed in Figure 2, as well as the more detailed facts regarding inventories and durable goods discussed below.

A question that frequently arises about the reduction in GDP volatility is the extent to which secular shifts in sector shares could account for declines in volatility. While it is true that the less volatile sectors such as services have grown over time relative to the more volatile goods sectors. It turns out, however, that at least as a far as these broad aggregates are concerned, the sectoral shift toward services plays only a modest role in the reduction of overall volatility. Specifically, if we reconstruct GDP growth fixing the sector shares at their values for a particular year, we get volatility reductions almost as large as in the raw data, and following similar patterns. For example, using the actual quarterly data, the standard deviation of the annual growth rate of GDP falls from 4.07 percent over the 1947-83 time period to 2.10 percent in the 1984-2007 time period—a decline of 1.97 percentage points. If we fix the shares of the four sectors at their 1959 levels and repeat the calculation, then the standard deviation of the annual growth rate of GDP falls from 4.28 percent over the 1947-83 time period to 2.53 percent in the 1984-2007 time period—a decline of 1.75 percentage points. Thus, about one-tenth of the decline in volatility is explained by sectoral shifts.

What about shifts within more finely disaggregated sectors? For example, within durable goods, could shifts away from automobiles and toward electronic equipment be responsible for some of the decline in durables sector volatility? It turns out that shifts within more finely disaggregated sectors do not help to explain the change in volatility. Disaggregated output data from the national income and product accounts are available only annually and only going back to 1977, which leaves only seven observations prior to the commonly used break point of 1984. Therefore, we constructed output data from the Bureau of Economic Analysis (BEA) series on constant dollar shipments and inventories, available on a consistent basis monthly from 1967 to 1997 for durable goods manufacturing in eleven two-digit subsectors: Lumber; Furniture/Fixtures; Stone, Clay and Glass; Primary Metals; Fabricated Metals; Industrial Machinery; Electronic Machinery; Motor Vehicles; Other Transportation; Instruments; and Miscellaneous. Again, we used quarterly data and measured the standard deviation of annualized growth rates, pre- and post-1983. Volatility varies greatly across our industry groups, but when
we compare the change in volatility from 1967-1983 and from 1984-1997, first using the actual data and then fixing the weights of the industries, we find that there is essentially no difference.

Still another way to cut the data is by decomposing the production function. Stiroh (2005) decomposes output growth into growth in hours of work and labor productivity, and finds that the volatility of both components, as well as their covariance, have declined. Gali and Gambetti (2007) argue that the change in the covariance between hours of work and productivity points toward “structural change” (as opposed to merely reduced shock volatilities) in the form of more aggressively anti-inflationary monetary policy, and reduced labor adjustment costs. Arias et al. (2007) argue that a decline in the volatility of productivity as measured by the Solow residual points toward the reduction of “productivity-like” shocks in the context of a real business cycle model of fluctuations.

Finally, an important question, and one we will return to in our later discussion, is the extent to which the volatility reduction is attributable to different “frequencies”—fluctuations of different durations. Economic activity fluctuates greatly at high frequencies—daily, weekly, seasonally—volatility which is generally thought to have little adverse impact on economic welfare. By contrast, fluctuations of several years duration—business cycles or longer—are generally thought to have adverse welfare consequences.

Table 3 separates out a “high” frequency cycles of less than 12 quarters component of GDP volatility (and its decline) pre- and post-1984. The numbers suggest that roughly 70 percent of the variance of GDP growth represents high frequency variation, and 80 percent of the variance of durables sector output growth. The table also suggests that a similar percentage of the of the volatility reductions came from the high frequency component. Similarly, Ahmed et al. (2004) argue that the decline in volatility was essentially uniform across all frequencies. These findings point to one reason why the welfare consequences of the Great Moderation may be modest – because much volatility is of relatively short duration, and therefore may be of limited importance in welfare terms. Another piece of evidence pointing in this direction is the finding (Groshen and Potter, 2003) that temporary layoffs play a much smaller role in
fluctuations since the mid-1980s. Such layoffs are naturally associated with changes in economic activity of short duration, such as inventory corrections. Of course, these findings are also completely consistent with substantial reductions in longer-term fluctuations—like the fact that recessions have been relatively short and mild since the 1990s. However, these facts about recessions may be a manifestation of a more general move to reduced real economic volatility.

**Inventory Behavior**

Another potentially important fact about the Great Moderation is that output volatility fell by substantially more than (and earlier than) final sales volatility, particularly in the durable goods sector (McConnell and Perez-Quiros, 2000; Kahn et al., 2002). Since the difference between output and final sales is the change in inventories, this fact implies a change in inventory behavior: specifically, either the volatility of inventory investment had declined substantially; or the covariance between inventory investment and sales has declined. Note that by convention in the national income and product accounts, the service and structures sector do not carry inventories, so the source of any change in inventory behavior must by definition lie in the goods sector.\(^2\) Figure 4 shows the behavior of output and sales volatility over time in the durable goods sector. In contrast to the behavior of output volatility, sales volatility shows only a modest decline.\(^3\)

A similar relationship exists between output, inventories and sales in terms of how they relate to changes in the volatility of real growth. Specifically, the variance of the output of durable goods can be divided up into the variance of sales, plus the variance of inventories, plus twice the covariance of sales and inventories.\(^4\) It turns out that the

\(^2\) In structures, final output includes construction in progress. However, there is evidence of a change in inventory behavior in construction, even though it is not treated as such in the national income and product accounts (Kahn, 2000).

\(^3\) McConnell and Perez-Quiros (2000) find evidence of a statistically significant break in the mid-1980s in durables output but not in final sales.
variance of sales in the durable goods sector doesn’t show much trend over time (as can be seen in Figure 4). However, the first panel of Figure 5 shows that the variance of inventory investment in the durable goods sector shows a modest downward trend, a trend which really takes hold in the 1990s. The other panel of Figure 5 shows that the covariance between sales and inventory investment in the durable goods sector declines dramatically, actually shifting from positive to negative. In both cases, there is a sharp decline in volatility around 1984, but also a downward trend in volatility from the 1950s onward as well.

Inflation Moderation and the Role of Monetary Policy

Monetary policy has advanced considerably in the last 25 years, since the beginning of the Volcker-Greenspan era of low and stable inflation. A large literature, led by Clarida et al (2000), has debated the extent to which there was a change in monetary policy regime specifically in the early 1980s, a change that had the effect of reducing both inflation and output volatility. We will argue that the contention that a discrete and substantial break in monetary policy circa 1983 can explain a discrete drop in volatility beginning at about the same time is dubious at best. It is questionable whether monetary policy had a sudden break with its past. In addition, it is difficult to reconcile an explanation for reduced volatility based on a shift in monetary policy in the

4 Although inventory investment, because it can be negative, does not have a conventionally defined growth contribution, we can define it indirectly as the difference between the growth rate of output and the growth contribution of final sales (Kahn et al., 2002). Following Whelan (2000), we can approximate the latter in terms of the real growth rate of sales and the nominal share of sales in output. Letting $\gamma_{sy}$ denote the growth contribution of $x$ to output $y$, where $x = s$ for sales and $x = i$ for inventories, we define the growth contribution of inventory investment as

$$\gamma_{iy} \equiv \gamma_{sy} - \gamma_{sy}$$

where $\gamma_{sy} = \gamma_{sy} \theta_{sy}$, $\theta_{sy}$ is the nominal share of $s$ in $y$ (measured as the average of current and lagged shares). The growth contribution of a variable to itself is just its real growth rate. With these definitions in hand, we can track the contributions of sales and inventory investment to the variance of output growth over time:

$$\sigma_y^2 = \sigma_s^2 + \sigma_i^2 + 2\sigma_{si}$$

where the variances and covariance on the right-hand side refer to the growth contributions discussed in the text.
early 1980s with the observed changes in real economic volatility both over time and by sector of the economy.

First, consider the question of how much monetary policy shifted to an entirely new regime in the early 1980s. Remember that low and stable inflation is not a post-1983 phenomenon. Inflation volatility in the period from 1955 to 1969 was almost as low as it was after 1983. Indeed, Romer and Romer (2002a, 2002b), in fact, argue that monetary policy in the 1950s was similar to policy in the 1990s. Yet overall output volatility was relatively high in the 1950s and 1960s.

We believe that the monetary policy regime shifted in the 1970s, contributing to high inflation, and that altered monetary policies under Paul Volcker brought down the level of inflation in the early 1980s. However, our central issue here is not the effect of monetary policy on inflation, but rather on volatility of real output, and the evidence of how regime shifts in monetary policy affect real volatility is ambiguous. For example, Sims and Zha (2006) argue that changes in monetary policy regimes were relatively inconsequential.

In addition, modern research on monetary policy suggests that the concept of a sudden regime shift in monetary regime broadly understood is questionable. After all, variety of factors that make up a monetary regime, including the credibility of the policymaker, transparency, and the commitment to rules. While with the benefit of hindsight, the Volcker-Greenspan era represents a change from the 1970s, it is asking a lot to believe that enhanced credibility was achieved overnight. Increased transparency at the Federal Reserve has been an evolutionary process. The Federal Open Market Committee began making public its interest rate target decisions in 1994. Only in 1998 did the committee begin releasing statements explaining its policy decisions, and the informational content of these statements has continued to evolve. At present, the statements released with the announcement of Federal Open Market Committee decisions are increasingly substantive and informative, the minutes of committee meetings are now released sooner after the meeting than in the past, and public statements by committee

\footnote{Some have argued that there was no important change in monetary policy in the early 1980s. For example, Athanasios (2002) argues that the policy regime of the 1970s was not fundamentally different, but was hit with large structural changes--a higher “natural” unemployment rate, lower trend productivity growth--for which it had limited and imperfect information in real time.}
members have undoubtedly reduced the opaqueness of policy. But at least so far, the Federal Reserve has yet to adopt an explicit inflation target, make its economic forecasts public, or move toward any semblance of an explicit policy rule. Rogoff (2006) offers evidence of reduced volatility of nominal returns on fixed income securities, consistent with reduced inflation uncertainty.

Moreover, if one considers the more detailed breakdown of volatility declines discussed thus far, it becomes even more difficult to tell a story that gives a great deal of weight to monetary policy in the early 1980s as the primary cause. After all, the break in volatility in the early 1980s may be somewhat illusory. That evidence suggests that aggregate volatility has both a trend and cyclical component, and that the trend has been downward—though interrupted by the turbulent 1970s—throughout the post-World War II era. As argued in Kahn et al (2002), any story that links monetary policy changes circa 1983 to reduced volatility would have to explain why improved monetary policy would affect durable goods differently than other sectors, and output volatility differently from sales volatility. No doubt it is possible to construct models that have these implications (such models would probably start with the greater sensitivity of demand for durable goods to interest rates), but a quantitative case for the ability of a monetary model to explain the sectoral facts about volatility has yet to be made.

In short, monetary policy mistakes during the 1970s decade may have contributed to increased volatility in that decade, and to an interruption in the longer-term trend toward reduced volatility. The cessation of those mistakes—whether from a regime change or from the dissipation of the shocks of the early 1970s—and a return to policies more resembling those of the 1950s and early 1960s, may have reduced the rate of inflation and then allowed volatility simply to return to its previous trend line. This procession of events gave the appearance of a large drop in volatility in the early 1980s, but only because the downward march of volatility had been temporarily suspended. Whatever factors were in motion over the post-World War II period to reduce volatility over time were continuing, and in time, after the disruptions of the 1970s, reasserted their dominance.
Changes in Micro Volatility

There is a disconnect between common views of volatility at the macroeconomic and microeconomic level. At the macroeconomic level, it seems clear that volatility decreased in the mid-1980s, and further that it has been decreasing in certain ways since the 1950s. However, at the microeconomic level, there is evidence that volatility in firm-level volatility has increased in sales, employment growth, and equity returns. There is widespread fear that the risk of job loss has increased, and further than uncertainty of consumption and earnings growth has increased. How can less macroeconomic volatility be reconciled with greater microeconomic volatility?

In this section, we will argue that some of the apparent increases in microeconomic volatility do not hold up on closer examination. The apparent increase in firm-level volatility actually limited to publicly traded firms, and when all tax-paying firms are included—public and private—firm-level volatility seems to be declining. The rising fears of job loss do not seem borne out in the data. However, there does appear to be rising volatility in consumption and income.

Firm-Level Volatility in Sales and Employment Growth Rates

Several recent studies find a secular rise in volatility among publicly-traded firms, which refers to firms with equity securities traded on a stock exchange or in over-the-counter markets. For example, Comin and Philippon (2005) and Comin and Mulani (2006) look at firm-level volatility in employment and sales using Compustat data, which has reasonably comprehensive coverage of publicly traded firms since the addition of Nasdaq listings in 1973. If one looks at a moving ten-year window on the standard deviation of firm growth rates, average firm-level volatility in sales and employment growth rates roughly doubled from the early 1960s to the late 1990s. This type of evidence persuaded many observers that business-level volatility rose sharply in recent decades, in glaring contrast to the big drop in aggregate volatility.

It turns out, however, that the volatility trend among all firms, not just publicly-traded firms, displays a dramatically different pattern. To develop evidence on this issue, Davis et al. (2006) exploit the Longitudinal Business Database, which covers all tax-
paying businesses in the nonfarm private sector of the U.S. economy.\textsuperscript{6} Using employment data from this database, they first confirm a strong rise in average volatility among publicly traded firms, broadly in line with results from earlier studies (although there is also a small downturn in the volatility of these firms after 1999). They then repeat the same volatility calculations for all firms, publicly traded and privately held alike, and find a 40 percent decrease in firm volatility from 1982 to 1996. Figure 9 reproduces a key figure in Davis et al. (2006), showing the average volatility of employment growth rates for publicly traded, privately held, and all firms.\textsuperscript{7} Volatility is high and declining for privately held firms, low and rising for publicly traded firms. In other words, there is a strong move toward “volatility convergence” between publicly traded and privately held firms. The same pattern holds for the volatility of establishment growth rates, although the movements over time are smaller. These authors also show that the volatility convergence phenomenon also occurs within all major industry groups; in other words, the volatility convergence pattern in Figure 9 does not arise from different industry distributions for publicly traded and privately held firms.

Why does the volatility trend among publicly traded firms depart so much from the overall trend? At one level, the answer is simple: publicly traded firms account for less than one-third of private-sector employment, so there is much room for the trend among publicly traded firms to depart from the overall trend. Digging deeper reveals another, more interesting, answer: There was a pronounced shift in the economic selection process governing entry into the set of publicly traded firms.

The starting point for understanding the shift that has occurred is to recognize the large influx of newly listed firms in the 1980s and 1990s. Fama and French (2004) report that the number of new listings (mostly initial public offerings) on major U.S. stock markets jumped from 156 per year in 1973-1979 to 549 per year in 1980-2001. Remarkably, about 10 percent of listed firms are new each year from 1980 to 2001.

\footnote{The Longitudinal Business Data is available to non-Census personnel for approved projects through the Center for Economic Studies at Census Bureau facilities in Suitland, Maryland and through one of several Census Research Data Centers operating at various locations. See \texttt{http://www.ces.census.gov} for more information.}

\footnote{Figure 9 shows results for a modified volatility measure that captures entry, exit and short-lived firms, and that does not require the deletion of observations near sample end points. In the previous studies mentioned, which were based on firm-level observations for which a ten-year window is available in the Compustat data, entry, exit and short-lived firms are excluded.}
Davis et al. (2006) report that firms newly listed in the 1980s and 1990s account for about 40 percent of employment among all publicly traded firms by the late 1990s. So the influx of new lists in the 1980s and 1990s is large in number and eventually accounts for a large share of activity.

Fama and French (2004), among others, also provide evidence that new listings are riskier than seasoned public firms by a variety of measures, and that they become increasingly risky relative to seasoned firms after 1979. Likewise, Davis et al. (2006, Figure 11) find higher volatility of employment growth rates for publicly traded firms that first list in the 1980s and 1990s. Taken together, these results point to the influx of successively riskier and more volatile cohorts which are helping to cause the the upward volatility trend in employment and sales of among publicly traded firms.

To quantify the contribution of these cohort effects to the volatility trend for publicly traded firms, Davis et al. (2006) use a regression approach with the Compustat data that includes only publicly traded firms. They first fit a weighted least squares regression with firm-level volatility as the dependent variable and year dummies as the explanatory variables, with weights proportional to firm size. The fitted year effects trace out the time path of firm-level volatility, and the difference between year effects gives the change in volatility between two points in time. They then expand the regression to include one-year cohort dummies—that is, a dummy variable for all firms being listed in their first year. They then calculated how much the difference-between-year effects change with controls for the entering cohort of new firms. According to this calculation, simple cohort effects alone account for 67 percent of the volatility rise among publicly traded firms from 1978 to 2001. In contrast, analogous calculations for size, age and industry effects – separately or in combination – account for little of the volatility rise among publicly traded firms.

**Firm-Level Variability in Equity Returns**

Campbell et al. (2001) documents a large upward trend in the volatility of firm-level equity returns for U.S. common stocks. Specifically, they find that the variance of firm-level returns in daily data more than doubles from 1962 to 1997. They also show that the trend increase in firm-level return volatility reflects a rise in the volatility of the
idiosyncratic, firm-specific component. These findings stimulated several investigations into the reasons for the rise in the volatility of firm-level equity returns and its implications. Brandt, Brav and Graham (2005) find that the volatility in firm-level equity returns turned down after 2001.

As we discussed above, Fama and French (2004) document a large influx of newly listed firms, increasingly risky public firms in the 1980s and 1990s. They conclude that this upsurge of new listings explains much of the trend increase in idiosyncratic stock return volatility. Fama and French also suggest that there was a decline in the cost of equity that allowed weaker firms and those with more distant payoffs to issue public equity. A more recent study by Brown and Kapadia (2007) reaches even stronger conclusion. Using a regression methodology similar to the one described above, they find that “there is generally no significant trend in idiosyncratic risk after accounting for the year a firm lists.” They also provide other evidence that firm-specific risks in the economy as a whole did not increase, even though the volatility of firm-level equity returns rose because of an influx of successively riskier cohorts.

**The Risk of Job Loss**

A wide variety of labor market indicators point to a secular decline in the risk of job loss, as discussed at length in Davis (2007). These indicators include: unemployment inflows by experienced workers in the Current Population Survey (CPS), the three-year job-loss rate in the Displaced Worker Survey; several measures for the gross rate of job destruction; the number of workers involved in mass layoff events; and the number of new claims for unemployment insurance benefits. All of these indicators point to a secular decline in the risk of job loss, although the extent and timing of the decline differs among the indicators.

For example, weekly new claims for unemployment benefits averaged about 0.45 percent of employment from 1967 to 1983, falling to about 0.3 percent of employment in good years and rising as high as 0.7 percent in recession years. Since 1983, weekly new claims for unemployment benefits have averages about 0.3 percent of employment, rising only to 0.45 and 0.4 percent in the worse of the recessions of 1990-91 and 2001, and falling to about 0.2 percent in the late 1990s and again in 2007. Data from the Current
Population Survey also show a dramatic decline since the early 1980s in unemployment inflows as a percentage of employment. Both indicators point to a large decline in the incidence of unwanted job loss. Davis et al. (2007) provide evidence that about half of the long term decline in unemployment inflow rates is explained by the reduction in the gross job destruction rates and in the volatility of firm-level rates of employment growth. Hence, their study provides evidence of a direct link between the secular declines in firm-level volatility in Figure 9 and the secular declines in the incidence of job loss.

Consumption and Earnings Uncertainty

Based on the evidence of large secular declines in firm-level volatility and the risk of unwanted job loss, one might expect to also see a decline in the volatility of individual earnings and household-level consumption changes. After all, many laid-off workers experience large and persistent earnings losses, apparently as a direct consequence of job loss (for example, Jacobson, Lalonde and Sullivan, 1993). However, volatility in consumption and earnings seems to be rising rather than falling.

One approach to quantifying changes in individual and household uncertainty exploits data on consumption expenditures. Gorbachev (2007) uses data from the Panel Study of Income Dynamics on food expenditures to estimate the volatility of household consumption after controlling for predictable variation associated with movements in real interest rates and changes in family structure. She finds that the volatility of household consumption expenditures increased over the period from 1970 to 2002. In preliminary work on consumption volatility using data from the interview segment of the Consumer Expenditure Survey, which contains up to four consecutive observations on quarterly household-level consumption expenditures, we have also found an modest increase in consumption volatility between 1980-91 and 1992-2004.

A rise in earnings volatility is consistent with the large body of work that has established a large rise in earnings inequality since the late 1970s or 1980s, as recently reviewed by Lemieux (2007). It seems likely that greater earnings uncertainty accounts for a nontrivial portion of the large rise in earnings inequality. Cunha and Heckman (2007) estimate the contribution of earnings uncertainty to the rise in earnings inequality. Their method uses data on schooling choices in combination with data on earnings
outcomes to decompose the realized variance of earnings into predictable and unpredictable components. They estimate that roughly a quarter of the rise in the present value of earnings uncertainty between ages 22 and 36 is due to components that are not forecastable.

Summary of Micro Volatility Implications

The volatility of firm-level employment growth rates fell after the early to mid 1980s. The decline in average firm-level volatility is similar in magnitude to the decline in aggregate volatility, but the timing differs. Although we did not discuss it here, the volatility of state-level employment growth rates also fell after the 1980s (Carlino et al., 2007). Declines in firm-level volatility and gross job destruction rates are closely linked to declines in the risk of unwanted job loss, as reflected in sharply lower unemployment inflows after the early 1980s. In this respect, data on aggregate volatility, average firm-level volatility, job destruction rates and the incidence of unemployment all point to a much more quiescent economic environment since the early 1980s. However, data on labor earnings and household consumption do not conform to a story of greater tranquility and lower uncertainty at the individual level. Although there is much room for further research, the available evidence suggests a modest to large increase in individual and household uncertainty. Assuming this assessment of volatility in consumption growth and earnings uncertainty holds up under further scrutiny, it

Improved Inventory Control

A Closer Look at Durable Goods and Inventories

Since the early 1980s, the behavior of inventories in aggregate data has shown a number of changes. Here we focus on the durable goods sector, where, as we have seen, the most dramatic declines in output volatility have occurred, and where we have already discussed evidence of a change in inventory behavior. Kahn et al. (2002) provides a discussion of inventory behavior in the nondurable goods sector. McCarthy and
Zakrajsek (2007) examine the behavior of manufacturing sector inventories pre- and post-1983.\textsuperscript{8}

Figure 12 shows the inventory-sales ratio in the durable goods sector. Whether one looks at the ratio of real (in year 2000 dollars) inventories to real sales, or nominal to nominal, the ratio began a sharp declined in the early 1980s, at the same time that volatility in the sector declined. This change is not by itself a proof of improved methods of dealing with inventories; for example, it could just represent a shift along a fixed technological tradeoff in response to changing costs of inventories, or a compositional change within sectors. But the timing of the break in trend is striking.

The inventory-sales ratio has clearly become less volatile relative to its varying trend, suggesting that businesses either make smaller mistakes or are able to correct their inventories more quickly. Again this conclusion is not definitive, as a similar result could arise because economic shocks are smaller or because industry composition has shifted. Kahn et al. (2002) also describes results from a vector autogression with sales and inventories that indicates a change in the variance decomposition pre- and post-1983. Before 1983, sales accounted for much more of the variance of inventories than inventories did of sales (37.8 versus 5.4 percent); after 1983 they were almost even (18.2 versus 14.9 percent), which is consistent with the idea that firms were better able to anticipate sales and adjust inventories in advance. Moreover, the residual variance of sales dropped precipitously, meaning that less of the variation in sales was unpredicted given prior sales and inventories. McCarthy and Zakrajsek (2007), using a structural vector autoregression, also find evidence of structural change in the handling of inventories around 1983.

\textsuperscript{8} While the inventory literature has traditionally focused on more disaggregated data, and in particular on the two-digit (SIC) level manufacturing data, for the questions examined in this paper, aggregate data has some distinct advantages. Disaggregated data can be misleading because it is impossible to tell whether changes in inventory behavior are genuine or just the result of economically (relatively) meaningless relocation. For example, if manufacturers decide to shift final goods inventories downstream to wholesalers and retailers, or shift materials inventories upstream to their suppliers, manufacturing inventories would decline relative to their shipments. Yet that decline would be largely offset by an increase in inventories elsewhere in the economy, and mere re-labeling could be misinterpreted as evidence of a structural change.
A Theory of Improved Inventory Control

Kahn et al. (2002) offers one approach to modeling the effects of improved inventory control. In this model, firms carry inventories of finished goods to avoid running out of stock in the face of uncertain demand; thus, firms trade off the cost of foregone profits from running out of stock against the cost of carrying inventories. If demand is serially correlated, mistakes in carrying inventories will get magnified in production volatility, because production will slow down when inventories are unexpectedly high and speed up when inventories run out. As a result, production will exceed the volatility of sales. If technology enables firms to have better information about demand disturbances, then they will make smaller errors in their production decisions. As a result, the additional volatility created by correcting those errors is and firms may be able to hold fewer inventories.

This type of mechanism can account for how improved management of inventories can lead to reduced production volatility (relative to the volatility of sales), but has several drawbacks. First, sales volatility may increase in this model, because the improved information essentially allows firms to accommodate demand shocks as opposed to damping them by running out of stock. This pattern of higher sales volatility is not what is observed in the firm-level data. Second, the data presented earlier shows that the covariance of sales and inventory investment becomes more negative, but in this model, this pattern only arises if the firm gets the information in time to adjust production sufficiently in advance (that inventory movements anticipate the demand shock. Then when the shock occurs, inventory investment moves in the opposite direction, as anticipated by the firm. But again, this tends to exacerbate sales volatility. Third, most inventories, particularly in durable goods, are of materials or works in process, not final goods. as pointed out by Humphries et al. (2001) and many others, which does not fit the set-up of the model. Finally, while there is much anecdotal evidence of technology that might provide better information about future sales, there is no direct evidence to assist in specifying a model. As this discussion suggests, the details might matter.

Kahn (2007) offers a variation on this approach that seeks to address these problems. In this model, firms must purchase materials from suppliers in advance, which firms hold as inventories until they are needed for production. Production is immediately
sold, but if a firm does not have enough materials in inventory, then the sales orders are held over to the future. Again, orders for final goods are serially correlated. In this model, if the firm is better able to forecast orders, the result can be reduced volatility of both production and sales. As in the earlier model, better forecasts of orders reduce production volatility because the firm will have less need to ramp up production after stock runs out to meet the quantity demand earlier. Better forecasts of orders will have two somewhat offsetting effects on sales volatility. In this model production is equal to sales, and so less volatility in production also means less volatility in sales. The effect mentioned earlier -- that sales volatility can rise because the firm no longer reduced volatility by running out of stock—continues to exist in this model. The magnitudes of these various effects will depend on underlying specifics such as inventory holding costs, price-cost markups, and the ratios of inputs to gross output at each stage of production. But for reasonable parameters, these two effects can lead to an overall decline in sales volatility. This model captures the notion that inventories may be held as works-in-progress rather than as final goods. It is also consistent with the argument of Irvine and Schuh (2005) who attribute reduced volatility to a reduced co-movement between the manufacturing and trade sectors.

The remaining issue is evidence that firm are better able to forecast orders. Here we rely on evidence from the Institute of Supply Management on average lead times for orders of production materials. This evidence is not confined to the durable goods sector, but it is striking nonetheless. Figure 13 shows that while the average lead time series does not exhibit the underlying downward trend of the volatility series, it does feature a clear drop in level post-1983 relative to earlier. It also shows some elevation in the 1970s.

What is the connection between shorter lead times and better information? In the theoretical model of inventories, the firm bases its forecast of future final goods orders on the history of past orders. The shorter the lead times, and the longer a firm can delay materials orders, the better handle it has on how much to order. Consequently the mistakes are smaller, and the firm can carry lower average inventories. This sounds like part of the rationale for the so-called “just-in-time” inventory approach, with its ability to reduce the need to carry large inventories, this is reasonable, but it may only be part of
the story. For example, some of the increased lead times in the 1970s could have been the result of the Nixon-era price controls, which created shortages and frictions in materials and could easily have led firms to order farther in advance. Similarly, the high inflation of the 1970s, could have disrupted market signals and caused some of the increased lead times, and hence the increased volatility, but this hypothesis awaits further research.

There is little doubt that vast resources have been devoted to improving what is generally referred to as “supply chain management.” Mentzer et al. (2001) define supply chain management as “the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole.” But work remains to be done on how broad general definitions like this one translates into observable behavior and data.

Conclusions

Macroeconomic volatility has generally trended downward in the postwar United States (and in many other countries as well), interrupted only by possibly monetary policy-induced turbulence in the 1970s and early 1980s. That broad decline in volatility is mirrored by declines in various measures of firm-level employment volatility. However, declining volatility is not evident in microeconomic data on consumption and earnings.

From this configuration of findings, we tentatively conclude that the welfare implications of the Great Moderation are subtler than one might think. It is likely that reduced volatility at the firm level reduces production costs by allowing greater smoothing of production, which is a social benefit. In addition, one part of the Great Moderation at the business cycle frequency is a reduction in the depth and length of recessions, which is a social benefit as well. But it also appears that the Great Moderation has not evidently translated into reduced consumption, earnings, or asset return volatility. In other words, certain kinds of economically meaningful uncertainty that have
an important effect on welfare do not seem to have a simple and direct connection to the overall volatility of output.

Of course, more research and better data may eventually uncover reduced volatility in consumption, earnings and asset returns. But another explanation for the dichotomy is that many of the reductions in volatility that have at high frequency—that is, of fluctuations of durations less than two or three years—and these changes may not be of great relevance for high-frequency consumption volatility.
Acknowledgements

Doug Elmendorf, Nick Bloom, and other participants at the San Francisco Fed’s CSIP conference made helpful comments. Parts of the paper also owe a debt to discussions with Meg McConnell. Responsibility for any flaws in the final product remains with the authors. The views expressed in this article are those of the authors and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.
References


Fink, Jason, Kristin Fink, Gustavo Grullon and James Peter Weston, 2005, “IPO Vintage and the Rise of Idiosyncratic Risk,” manuscript.


### Table 1: Impact of Sectoral Shifts on Volatility Declines

<table>
<thead>
<tr>
<th>Sectoral Shifts</th>
<th>GDP Growth (1959 sector shares)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1947Q1-1983Q4</td>
<td>4.07</td>
</tr>
<tr>
<td>1984Q1-2007Q2</td>
<td>2.10</td>
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</tbody>
</table>

*Standard deviations of annualized growth rates

### Table 2: Durable Goods Manufacturing Volatility

<table>
<thead>
<tr>
<th>Industry (SIC code)</th>
<th>Standard deviation of Output growth</th>
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<tbody>
<tr>
<td></td>
<td>1967-83</td>
</tr>
<tr>
<td></td>
<td>1984-97</td>
</tr>
<tr>
<td>Lumber (24)</td>
<td>23.15</td>
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<tr>
<td>Furniture/Fixtures (25)</td>
<td>15.38</td>
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<tr>
<td>Stone, Clay, Glass (32)</td>
<td>14.60</td>
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<tr>
<td>Primary Metals (33)</td>
<td>27.88</td>
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<tr>
<td>Fabricated Metals (34)</td>
<td>16.35</td>
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<tr>
<td>Industrial Machinery (35)</td>
<td>14.63</td>
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<tr>
<td>Electronic Machinery (36)</td>
<td>14.94</td>
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<tr>
<td>Motor Vehicles (371)</td>
<td>46.04</td>
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<tr>
<td>Other Transportation (37x)</td>
<td>23.37</td>
</tr>
<tr>
<td>Instruments (38)</td>
<td>11.42</td>
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<tr>
<td>Miscellaneous (39)</td>
<td>20.79</td>
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<tr>
<td><strong>Durable Goods (aggregate)</strong></td>
<td>14.66</td>
</tr>
<tr>
<td><strong>Durable Goods (fixed weight)</strong></td>
<td>15.41</td>
</tr>
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</table>

### Table 3: Volatility Reductions by Frequency

<table>
<thead>
<tr>
<th>Quarterly Growth</th>
<th>Variance</th>
<th>% of total</th>
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<tr>
<td></td>
<td></td>
<td>total</td>
</tr>
<tr>
<td>GDP</td>
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<td>20.48</td>
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<tr>
<td>1954-1983</td>
<td></td>
<td>4.31</td>
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<tr>
<td>1984-2007</td>
<td></td>
<td>16.16</td>
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<tr>
<td>GDP change</td>
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<td>344.02</td>
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<tr>
<td>1954-1983</td>
<td></td>
<td>64.02</td>
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<tr>
<td>1984-2007</td>
<td></td>
<td>280.00</td>
</tr>
</tbody>
</table>

Note: “High frequency” is defined as cycles of less than 12 quarters
Table 4. Firm Volatility Trends by Major Industry Group and Ownership Status

<table>
<thead>
<tr>
<th>Industry</th>
<th>All Firms</th>
<th>Publicly Traded Firms</th>
<th>Privately Held Firms</th>
<th>Volatility Ratio: Privately Held to Publicly Traded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minerals</td>
<td>0.54</td>
<td>0.41</td>
<td>-24.2</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>1983-2007</td>
<td>7.81</td>
<td>-34.5</td>
<td>0.33</td>
</tr>
<tr>
<td>Construction</td>
<td>0.78</td>
<td>0.51</td>
<td>-12.9</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>1983-2007</td>
<td>3.73</td>
<td>-33.5</td>
<td>0.53</td>
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<tr>
<td>Manufacturing</td>
<td>0.34</td>
<td>0.30</td>
<td>-1.2</td>
<td>0.16</td>
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<tr>
<td></td>
<td>1983-2007</td>
<td>1.22</td>
<td>-32.8</td>
<td>0.67</td>
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<tr>
<td>TPU</td>
<td>0.37</td>
<td>0.34</td>
<td>-6.7</td>
<td>0.11</td>
</tr>
<tr>
<td>Wholesale</td>
<td>0.53</td>
<td>0.33</td>
<td>-36.5</td>
<td>0.16</td>
</tr>
<tr>
<td>Retail</td>
<td>0.56</td>
<td>0.36</td>
<td>-36.1</td>
<td>0.17</td>
</tr>
<tr>
<td>FIRE</td>
<td>0.44</td>
<td>0.39</td>
<td>-13.1</td>
<td>0.17</td>
</tr>
<tr>
<td>Services</td>
<td>0.59</td>
<td>0.41</td>
<td>-30.7</td>
<td>0.27</td>
</tr>
<tr>
<td>All</td>
<td>0.49</td>
<td>0.38</td>
<td>-22.9</td>
<td>0.17</td>
</tr>
</tbody>
</table>

Notes: Firm-level volatility calculated per equation (6) in Davis et al. (2006). Average volatility across firms computed on an employment-weighted basis.

Source: Calculations on the Longitudinal Business Database by Davis et al. (2006).

Table 5: Simulation Results

<table>
<thead>
<tr>
<th></th>
<th>Standard deviations of</th>
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<tbody>
<tr>
<td></td>
<td>Data</td>
</tr>
<tr>
<td></td>
<td>Output growth</td>
</tr>
<tr>
<td>1954-1983</td>
<td>18.32</td>
</tr>
<tr>
<td>1983-2007</td>
<td>7.81</td>
</tr>
</tbody>
</table>
GDP Growth, 1947-2007

Quarterly, Annual Rate. Source: National Income and Product Accounts

Figure 1
Comparison of Share-Weighted Sectoral Growth Rates

Note: The calculations behind these figures are described in the text. The volatility contributions depicted in the charts are also affected by trends in sector shares over time, but the effect is very slight. The pictures would look virtually identical if sector shares were held constant.
Volatility by Sector over Time

Volatility by Expenditure Category over Time

Figure 3
Durable Goods Sector Volatility
(5-Year Centered Rolling Standard Deviations)

Figure 4
Inflation Volatility

5-year rolling standard deviations, quarterly pct change in GDP deflator

Figure 6
Durable Goods Inventory-Sales Ratio*

*The series is discontinuous (and overlapping for one year) due to the change from SIC to NAICS industry definitions

Figure 7
Figure 8: Firm-Level Volatility among Publicly Traded Firms, COMPUSTAT Data

Notes: Firm-level volatility computed as a moving ten-year window on the standard deviation of firm-level growth rates. Average volatility across firms computed on an unweighted or weight basis, as indicated.

Source: Calculations on COMPUSTAT data by Davis et al. (2006).
Figure 9: Volatility in Firm-Level Employment Growth Rates, Overall and by Ownership Status, 1978 to 2001

Notes: Firm-level volatility calculated as a ten-year weighted moving average of growth rates, inclusive of entry and exit and with a degrees-of-freedom correction. See equation (6) in Davis et al. (2006). Average volatility across firms computed on an employment-weighted basis.

Source: Calculations on the Longitudinal Business Database by Davis et al. (2006).
Figure 10. Weekly New Claims for Unemployment Insurance as a Percent of Employment, Monthly Averages, 1967-2007

Source: Calculations by Davis (2007) using seasonally adjusted data on unemployment insurance weekly claims and total nonfarm employment data in the Current Employment Survey.
Figure 11: Household Consumption Volatility by Decile of Predicted Consumption, Mean Absolute Log 6-Month Change in Consumption Per Adult Equivalent.
Production to Order

Materials orders → Z → D → $Y_M$ → M → X → $Y_F$

Works-in-process

Deliveries

U

Final Output

Figure 12
**Production Materials: Avg. Lead Time for Orders**

- Pre-84 average = 65.8
- Post-83 average = 48.0

**Output Volatility (Durables)**

*Source: ISM survey*

**5-year centered rolling variance**

Figure 13