# Declines in the Volatility Of the U.S. Economy: A Detailed Look

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Bruce Grimm
Brian Sliker



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## I. Introduction

A number of analysts have described a decline in the volatility of the U.S. economy that began in about 1984. One of the first papers placed the decline, often described as a "smoothing," in 1984 (McConnell, Mosser, and Perez-Quiros, 1999). This paper attributed much of the smoothing to the behavior of inventories and consumer spending. Fixler and Grimm (2005) also found that the volatility of revisions to the estimates of GDP declined after 1984, but not as much as the declines in the volatility of GDP itself. A paper by Kevin Stiroh (2005) provided brief descriptions of a number of the papers on smoothing, and obtained results that were not fully consistent with many of the hypotheses advanced in them. He examined the decline in overall volatility by disaggregating it into individual industries, and found that a substantial majority of the decline results from decreased covariances between industries rather than from declines in the variances of the individual industries.

This analysis takes a new look at the industry-level details of the smoothing, and disaggregates by states and economic regions, as well as by industry and industry group. It, too, finds that declines in covariances are responsible for most of the declines in the volatility of both the overall economy and of the volatility of most industries, industry groups, states, and economic regions. The declines, however, are far from uniform, and the results from the disaggregations do not fit completely with previously-advanced explanations of the causes of smoothing. The results indicate considerable differences when disaggregating by geographical area, as well as by industry. These differences suggest that general explanations of the smoothing will only work for some industries or geographic areas.

This analysis is largely based on BEA's published estimates of real gross domestic product by state (GDP_S) disaggregated by industry. It finds that the smoothing is widespread, but far from universal. The principal findings are as follows:

- When disaggregations are for economic regions or for industry groups, less than one-eighth of the decline in variance of total GDP_S is due to the effects of declines in the variances of the regions or the industry groups. The rest of the declines are largely due to the effects of declines in covariances of the regions or the industry groups.
- When disaggregations are for states or for industries, less than one-fiftieth of the declines are due to the effects of declines in their variances. The rest of the declines are also largely due to the effects of declines in covariances.

A number of BEA staff members have contributed to this analysis. They include Andrew Bernat, Robert Brown, George Downey, Dennis Fixler, Carrie Litkowski, Robert Yuskavage, and James Zavrel.

- Not all disaggregated GDP_S components became less volatile after 1984; there are increases in the GDP_S variances of nearly one-fourth of economic regions and industry groups, and one-fourth to one-half of states and industries. These increases are consistent with none of the general explanations that have been advanced for smoothing of the economy.
- Several factors that appear to be associated with the overall smoothing are the decline in inflation that was largely complete by 1983, the increasing importance of imports in the economy, and improved information technology—including increased computerization.
- It seems likely that most, or even all, of the explanations that have been advanced are correct for at least some GDP_S components, but that changing institutional conditions also have had considerable influence on individual components, promoting either lower or higher volatility.

The principal finding of this analysis is that the far-from-universal declines in volatility occurred primarily because different states and regions—as well as industries and industry groups—moved less like one another after 1984 than they did previously. The geographical and industrial diversities described here help to confirm Stiroh's finding that the general explanations previously advanced do not fit well for many industries when the economy is disaggregated. As in Stiroh's work, the "good luck" hypothesis of reduced economic shocks, advanced by Stock and Watson (2002), is consistent with many of the findings in this analysis. The explanations that have been proposed by other analysts appear to work for, at most, subsets of industries. There may also be "bad luck" institutional explanations that resulted in the patterns of increased variances for some states and industries.

## II. Data Set

### Source Data

BEA publishes estimates of GDP_Ss for 51states (including the District of Columbia as if it were a state) as well as the states grouped into the 8 economic regions distinguished by BEA in its regional accounts (New England, Mideast, Southeast, Great Lakes, Plains, Southwest, Rocky Mountains, and Far West—including Hawaii and Alaska.) For each of the states and regions, data are disaggregated into 63 industries, which may also be assembled into industry groups. For this study, durable goods manufacturing and nondurable goods manufacturing are treated as separate industry groups. Also, transportation, communications, and electric, gas, and sanitary services are separated from their common aggregate, transportation and public utilities. Three industry groups contain only one industry each: Construction, retail trade, and wholesale trade. A total of 13 industry groups are identified in this study, including government.

Real GDP_S estimates with industry detail are available on BEA's web site <www.bea.gov> (or may be constructed from the published data) from 1977 to 1997 on an SIC basis, and 1997 to 2006 on a NAICS basis.[1] BEA strongly cautions against linking the SIC and NAICS estimates.[2] The SIC-basis estimates underlying this analysis are based on annual percent changes, so the available sample period is 1978 to 1997. The change in volatility in or near 1984 has been identified by several researchers, and is used in this analysis as the last year of higher volatility. Using the 1984 break point, 7 observations are available for the higher-volatility period, and 13 for the lower-volatility period. These small sample sizes argue against doing elaborate statistical analyses, so significance tests of the declines in variances are not computed.

A problem arises when the GDP_S for an industry in a state is not present in substantial amounts in at least some years. In this analysis, when the industry-level GDP_S values are not at least 10 million real dollars in at least one year, the state industry GDP_S is added to those for the same industry in a physically-adjacent state.[3] Where the values are never as much as 10 million real dollars, the industry values are all set to zero for that state. This by and large preserves the national total real GDP_Ss for the industries. In the most prominent case, the GDP_Ss for pipelines (other than natural gas) are not separately identified (or set to zero) in 14 states. This lumping-together and culling produces very small impacts on the estimates of results presented below for states, and is not needed for regions.[4]

Weights

For simplicity, fixed weights are used rather than time varying weights. Because the estimates of movements in GDP_S components are based on percent changes, it is necessary to weight together the finer-level component variances to calculate their effects on variances of higher-level aggregates. As discussed below, the methodology used in this analysis requires that the weights for the individual states or industries, or regions or industry groups, sum to one. However, the published real (chained-dollar) measures are not additive. Also, the sums of the components of higher-level real aggregates may not equal the chained-together totals. A discussion of the advantages and costs of chained indexes may be found in Landefeld, et al. (2003).[5] Because real-dollar-based weights are



[1] BEA does not at present consider available price estimates to be adequate to support the construction of accurate state-level real industry GDP_S estimates prior to 1977.

[2] There is a discontinuity in the GDP-by-state time series at 1997. This discontinuity results from many sources, including differences in source data and different estimation methodologies. In addition, the NAICS-based GDP_S estimates are consistent with U.S. GDP, while the SIC-based GDP_S estimates are consistent with U.S. gross domestic income (GDI). This data discontinuity may affect both the levels and the growth rates of the GDP-by-state estimates. Users of the GDP-by-state estimates are strongly cautioned against linking the two data series in an attempt to construct a single time series of GDP-by-state estimates.

[3] As an example of this, the motor vehicle industry GDP_Ss of Maryland and the District of Columbia are lumped together, as are the motor vehicle industry GDP_Ss of Maine, Vermont, and New Hampshire. Some thinly populated western states, with small motor vehicle industry GDP_Ss, are also lumped together.

[4] Some sort of lumping together is necessary because it is impossible to calculate variances for published state industry GDP_Ss if one or more observations are less than \$0.5 million, or zero.

[5] BEA switched to chain indexes in 1996. The previous, fixed-weight methodology produced additive real estimates, but did not preserve real growth rate patterns with changes in base periods. The current estimates are based on Fisher chains, in which Laspeyres and Paasche quantity indexes are geometrically

used in this analysis, alternative estimates of higher level aggregates are created by summing the lower-level components and using these sums to calculate weights. These often are slightly different than the published higher-level aggregates. For example, the 1978-97 average national total real GDP_S for petroleum and coal products manufacturing is $25.877 billion, but the corresponding average summed-total GDP_S estimate is $25.827 billion, slightly less than 0.2 percent smaller. Also, a small portion of the differences for years prior to 1990 may occur because the real dollar estimates are calculated by using quantity index estimates to extrapolate backward from values in real dollars in 1990. Because the quantity indexes are on a year 2000 equals 100 basis and because the quantity indexes are published to three decimal places, differences arising from this extrapolation procedure are believed to be small in comparison to the effects of chaining.

Because the bulk of this analysis is of the sources of volatility of real GDP_S and its components, weights based on the ratios of components to more aggregate GDP_S measures are chosen for the empirical work. For example, the ratios of states' fabricated metal products industry real GDP_Ss to the sum total of all states' fabricated metal products industry real GDP_Ss are used to weight together the variances of the individual states. The weights are calculated for each year, 1978-1997, and the 20 sets of weights are averaged to obtain average weights for the full sample period. This average weighting is a plausible one, but is hardly unique. For example, early experimentation with the finance, insurance, and real estate (FIRE) industry group found that the year chosen for the weight calculations did indeed have substantial, though not overwhelming, effects on the quantitative results. The 20-year average is chosen as a robust compromise, and is used in all estimates reported here. An example of the results of alternative weighting schemes for FIRE is described in appendix 1**.**

## III. Decomposition of the Effects of Variances and Covariances

As noted previously, higher-level real GDP_S aggregates are the chained-together results of less aggregate measures. For any given industry or industry group, the national GDP_S estimates is the chained sum of the states' GDP_Ss for that industry or industry group. This also holds for total national real GDP_S. For example, total national GDP_S of all industries is equal to the chained-together estimates of states' real GDP_Ss, and a chain-effect residual is introduced.[6] The lack of additivity is the inevitable result of changing relative prices for components. In level terms, aggregate real GDP_S, $Y_t$, is equal to the sum of the individual states' GDP_Ss, $y_{it}$, plus a chain-effect residual, $u_{it}$,

$$Y_t = \sum_{i=1}^{51} y_{it} + u_{it}$$

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averaged to compute the chains. Using chain methodology, the weights are different for each year in the sample. See Landefeld, et. al., p. 10 for a more complete discussion.

[6] There is no residual if all the state-level price indexes used to obtain real estimates from current-dollar estimates are the same.

The growth rate of national-level real GDP_S, $X_t$, may be stated as a weighted sum of the growth rates of the individual state GDP_Ss, $x_{it}$, and an error term, $e_t$,

$$X_t = \sum_{i=1}^{51} w_i x_{it} + e_t$$

The effects of the residuals and the error terms introduced by the weighting scheme appear to be modest. Using weights that are equal to the average weights (constrained to sum to 1.000) over the 20-year period 1978-97, the average growth rate of real GDP_S is 1.6 percent per annum, and the difference between the sums of the levels with and without the residuals is 0.073 percent per annum, or a bit less than 1/20 of the average growth from year to year.

The variance of the growth rates of total GDP_S may be decomposed into variance effects for individual states—or regions—and "covariance effects" including a residual.

$$Var(X) = \sum_{i=1}^{51} w_i^2 \operatorname{var}(x_i) + 2\sum_{i=1}^{50} \sum_{j=i+1}^{51} w_i w_j \operatorname{cov}(x_i, x_j) + f(u,e)$$

There can be more than 1200 covariances when a state-by-state disaggregation is used, so it is convenient to deal with the weighted sum of the variance effects as grouped together in one piece, and the covariance (and chain-effect residual and weighting error) terms in a second piece that is derived by subtraction. The last term, f(u,e), is the unknown net effects of the chain-effect residuals and any weight-term errors. Limited experimentation suggests that these effects are small, but as a result of the f(u,e) term, the variance effects term is only approximate, and the sum of the other terms is only approximately the covariance effects. Even though it includes more than just the covariances, this piece is labeled covariance effects in this analysis. The approximations, however, mean that the quantitative results should only be viewed in qualitative terms. Despite this, the results are sufficiently strong that evaluations of them are made.

## IV. Declines in Volatility and Higher-Level Aggregates of Product Measures

As indicated in the discussion in section II, through 1997 real GDP_S is more closely aligned with real GDI rather than with real GDP (charts 1 and 2). Although movements in GDP and GDI are moderately different, they are equally valid measures of aggregate economic activity; see Fixler and Nalewaik (2006). All three measures of U.S. economic activity have higher volatility in 1978-84 than they do in 1985-97. In 1978-84, real GDP has the highest volatility of the three aggregates, and in 1985-97 it has the lowest volatility, and therefore it has the largest decline in volatility.

Variance of Annual Real Economic Activity
[percentage points]

| Period | GDP | GDI | GDP_S |
|---|---|---|---|
| 1978-84 | 8.8 | 8.2 | 7.7 |
| 1985-97 | 1.4 | 2.0 | 2.3 |
| Change | -7.4 | -6.3 | -5.4 |

This analysis focuses on GDP_S, which has the smallest decline in volatility. Nevertheless, the sizes of volatility for the three methods and the declines after 1984 are sufficiently similar that qualitative results based on any of the measures should hold for the other two as well. The adjustments made to GDI to get GDP_S combine with the price methodology used to calculate real GDP_S to produce the differences from real GDI.

The first disaggregation divides overall economic activity—GDP_S in this analysis—into 13 industry groups or 8 economic regions.

Whether the disaggregation is by region or by industry group, the quantitative results are very similar (table 1). The first line shows the national-level variances and change in variance in aggregate GDP_S from 1978-84 to 1985-97. They are the same as those shown for GDP_S in the above table. The next line shows, for industry groups, the weighted sums of the industry groups' variances and the change between periods. Slightly more than one-eighth of the decline in national variance is due to a decline in the weighted sum of the industry groups' variances. As shown in the third line, the remainder is the rest of the overall decline, and is predominantly due to declines in the covariances among the industry groups.[7,8]

The final pair of lines in the table show the same information, but decomposed by economic region. The results are quantitatively similar to those of the decomposition by industry groups. One-sixth of the national decline in variance is due to a decline in the weighted sum of variances of the regions. The residual, five-sixths of the total, is primarily due to declines in covariances between the regions.

Thus, the overall decline in the variance in annual national-level real economic activity is primarily due to the declines in the covariances of industry groups' or regions' economic activities. A rough, rule-of-thumb summary of the foregoing is that, if there are n non-overlapping components, only about $1/n^{th}$ of the change in the variance of the growth rate of real GDP is attributable to the weighted sum of changes of the components 'variances; the remainder is due to changes in cross-component covariances and to

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[8] This finding reinforces that of Stiroh (op. cit.), who found that 80 to 85 percent of the overall smoothing in GDP is due to declines in covariances between industries.

[8] All fixed-weighting schemes miss changes in aggregate variance due to shifts among components with different variances. In order to evaluate the effects of shifts, the second and third lines of table 1 were re-estimated using 1978-84 weights for the early period variance effects and 1985-97 weights for those of the later period. The change in the weighted sum of industry groups variances declined 0.1 percentage point less than shown in table 1. This suggests that, at the industry group level of disaggregation, the effects of changing weights are rather small.

residual effects. That is, the overall decline results mostly from different industry groups or regions behaving less alike one another in the post-1984 period. The variances decline for 10 of 13 industry groups and 6 of 8 regions. For roughly one-fourth of both industry groups and regions, volatility actually increased in the 1985-97 period.

## V. Declines in Volatility and Finer-Level Product Measures

The finer level of disaggregation of GDP_S components is for individual industries or individual states. The disaggregations are evaluated using the same methodology as is used in the preceding section, but using the finer-level breakdowns. As shown in chart 3, the states with increased variances clustered in three areas; the northeast, the south-central states, and Alaska and Hawaii.

The results of a more detailed disaggregation of the variances of national GDP_S are shown in table 2. The first row duplicates the first row of table 1, showing the variance of national GDP_S for the two periods and the decline in variance from years prior to 1985 and years following 1984. The next row shows the effects of the weighted sums of the 63 individual industries' GDP_Ss; they are even smaller—relative to the national variance—than those for industry groups. Their decline only explains a 0.1 percentage point decline in the national GDP_S decline of 5.4 percentage points. The residual effects—again predominantly covariance-related effects—are more than 50 times the size of the variance effects.

The final two lines of the table show the same information for the individual states. The quantitative results are same as those for the 63 industries. The covariance-related effects are again more than 50 times the size of the variance effects.[9]

Thus, regardless whether the disaggregation is by industries or by states, the variance effects are very small relative to the covariance effects, and account for very little of the smoothing of national GDP_S. The decline in national GDP_S volatility is overwhelmingly due to the industries, or states, moving less like one another in 1985-97 than they did in 1978-84.

## VI. Changes in Variances in Industries Using a State-by-State Disaggregation

This section examines smoothing in both industries and industry groups, with a disaggregation to state-level GDP_Ss. Table 3 shows the changes in industry groups' variances, as disaggregated by states. The variances of state GDP_Ss decline for 10 of 13 industry groups. In 7 of the 10, the covariance effects contribute more than nine-tenths of the declines in the industry groups' variances, and in 2 industry groups, declines in the covariance effects more than offset increases in the variance effects. Only for construction did a decline in variance effects more than offset a modest increase in

[9] The difference in magnitude of the decline in national GDP_S using added-together state GDP_S estimates rather than the published chained estimates may be roughly gauged by the fact that the decline in volatility using the additive numbers is 0.06 percentage point larger than that using the published, chained-together numbers.

covariance effects. For the 3 industry groups that had increases in variances, both the variance effects and the covariance effects contribute to the increases, with the covariance effects contributing most of the increases in 2 of the 3 industry groups. Thus, as is true for regions, the covariance effects contribute the large majority of the overall patterns. The industry groups that experience increased volatility account for roughly one-sixth of total national GDP_S, so industry groups with declines in volatility represent the large bulk of the economy.[10]

Table 4 shows the changes of individual industries' variances as disaggregated by states.[11] Column 1 shows the variances across states for the 63 industries in 1978-84, and column 2 shows the changes in variances from 1978-84 to 1985-97.[12] The changes are far from uniform; in 27 industries, accounting for 37 percent of current-dollar GDP_S, there are increases in variances.[13,14] These increases are widespread, and occur in all of the 8 industry groups that contain more than one industry. There is a statistically significant relationship between the size of industries' variances in the earlier period and the size of the decline—the larger the earlier-period variance, the larger the decline—but that there is little cross-industry relationship between the earlier-period variances and the later-period variances (see appendix 2).

In addition to the 27 industries with increased variances, 8 other industries have weighted sums of states' variances that are positive (column 3). Only 15 industries have both declines in variance and negative weighted sums of the effects of states variances. These industries account for just 49 percent of current-dollar national GDP_S. Thus, the decline in variance in national GDP_S occurs as declines in some industries more than offset increases in others and, within industries, increases in the variances of some states' industry GDP_Ss are more than offset by declines in others.

The residuals, which are primarily the covariance effects for the individual industries, are shown in column 4. These are the dominant components of overall changes in variance for industries. Without regard to sign, the covariance effects are

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[10] All ratios are calculated using 20-year averages for the period 1978-97, and are in current dollars. Changing relative prices, especially for computers and telecommunications equipment, make real dollar ratios meaningless in this context.

[11] Changes in variances of states' GDP_Ss with an industry disaggregation are not evaluated because for just over half of the industries (32), some states had to be combined due to very low or no GDP_S from the industry. This limitation makes it impossible for the results to be fully comparable with those reported for a state disaggregation in this analysis.

[12] One industry-state combination is removed from the analysis: Alaska is removed from the pipeline transportation industry. The opening of the Trans Alaska Pipeline during 1977 led to a more than 1850 percent increase in 1978 for pipeline GDP_S for Alaska. This was a one-time event that had nothing to do with volatility in general, but was large enough in its effects to distort the measures for all pipelines. Its removal, however, does not affect the qualitative results for pipelines.

[13] However, using 1978-97 average weights, the declines in variances of just 4 industries accounted for 150 percent of the decline in total GDP_S variance. The industries are farm, construction, motor vehicles, and petroleum and coal products manufacturing.

[14] This is roughly comparable to Stiroh's (op. cit.) findings that, in terms of value-added volatility, 9 of 35 and 11 of 41 industries experienced increased variances.

larger than the variance effects in 60 of 63 industries.[15] Also without regard to sign, the average share of the change accounted for by covariance effects is 95 percent; on a weighted basis—using 1978-97 average weights—the share of the negative covariance effects is 84 percent. This figure is similar to Stiroh's (op. cit., p. 3) finding that about 80 percent of the decline in output variance can be traced to smaller covariances between industries, but this analysis is for covariances between states, and within industries. As with the variance effects, the covariance effects are far from uniform; they increased in 29 of the 63 industries.

In sum, at the level of detail obtained by disaggregating the individual industries by states, it is hard to discern the source of the decline in variance of national-level GDP_S. For individual industries, the covariance effects greatly outweigh the variance effects, and are larger in absolute size in all but 3 industries. The variance and covariance effects generally reinforce each other; they have opposite signs in just 15 industries. The diversity at this level of disaggregation suggests that the summary explanations advanced by other researchers—possibly except for the "good luck" hypothesis—do not fit well with the estimates of volatility for all industries or industry groups, or for all states or regions.

## VII. Possible Causes of the Decline in Volatility in National Economic Activity

As described by Ramey and Vine (2004), Stock and Watson (op. cit.), and Stiroh (op. cit.), several explanations for the decline in overall variance have been suggested by various analysts. As discussed previously, Stiroh obtained industry-level results that did not generally fit well with most of the explanations. The results described here are similar. In particular, the finding of lack of uniformity of the directions of changes in volatility across industries or industry groups, or states or regions, is difficult to reconcile with the general explanations, such as improved inventory management or better economic and fiscal policies. Also, the use here of 20-year average weights in calculating variance effects pretty much eliminates declines in variance effects due to a shift toward smoother sectors of the economy, such as services industries. (Further, the shift toward relatively less volatile services industries' GDP_Ss—cited by some analysts—is only about 0.016 of the overall economy, and is offset by a 0.023 shift away from government GDP_S, which is even less volatile.)

The various explanations that have been suggested do work well for some individual industries or industry groups. For example, a review of farm GDP_S found that very high volatility in the 1978-84 period reflects a few years with widespread very poor farming weather, combined with very volatile prices for some farm products. The pattern is not repeated in the 1985-97 period. In contrast, the agricultural services, forestry, and fishing industry—which seems likely to be closely related to farm product in the medium to long term—is less volatile, but its volatility increases in the later period. Thus, the hypothesis of good luck in the form of smaller exogenous shocks in the 1985-97 period seems to fit well with the farm industry's experience.

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[15] The sizes of the two effects appear to be tied for real estate, but if more decimal places are examined, the covariance effects are larger.

Other industries seem poorly suited to any of the proposed explanations. For example, of the three government industries—which have relatively low volatility throughout the 20-year sample period—two have small declines in volatility in the 1985-97 period, and the third has a small increase. There is little reason to expect that governments would be much affected by the various explanations. As another example, depository institutions have had major structural changes, evolving from an era typified by local—or at most, state-level institutions—to an industry that tends to be dominated by regional, or often national-level companies. Reflecting this transformation, the industry's volatility—which is relatively low in 1978-84—increases sharply in the 1985-97 period. This increase appears to be the result of changes in the structure of the industry, and probably does not fit well with the proposed explanations.

The overarching feature of the decline in variance of national GDP_S is that the various parts of the economy move less like one another than they did before 1985. As described above, this phenomenon is found for most industry groups and economic regions. It is also true for the 37 industries that experienced declines in variances; in 35 of these industries, the covariance effects are larger than the variance effects, and typically are much larger.

As suggested above, no one cause seems likely to be able to explain the declines in variances in the industries that experienced declines. For example, the improved inventory management explanation suggested by McConnell and Perez-Quiros (2000) seems better suited for the manufacturing industries than for some others, such as the services industries. The increases in variances of some industries in each multi-industry group are not fully consistent with some explanations, such as the "better policy " explanation, that have been advanced by some analysts. Stiroh's (op. cit.) finding that improved labor market dynamics underlies much of the overall decline in volatility suggests a channel through which better planning was implemented.

It remains to consider other possible explanations for the increased diversity of the various industries and geographic areas. The large numbers of industries—and to a lesser extent states—that have experienced increased volatility strongly suggest that no one explanation will fit all the patterns of volatility.

A first possible explanation is improved technology that leads toimproved planning. The improved inventory management explanation fits into this category, but there are no data at the detailed levels employed in this review to evaluate this. A similar explanation is that increasing adoption of new information technology allowed better, more efficient management of businesses and control of employment, production, and inventories. The increases in information technology investment are quite striking; real investment in information processing and equipment and software rose from $9.5 billion in 1972 to $218.9 billion in 1997.

A second possible explanation is the increased importance of foreign imports in the economy. The average ratio of real U.S. imports to real GDP is 0.062 in the 1978-84 period, and 0.084 in the 1985-97 period. Increased imports can lower volatility in at least two ways. First, changes in imports can be used to help absorb demand shocks to domestic industries. Second, imports can reduce the covariances between states. As an example, an auto assembly plant in state A initially uses parts and subassemblies manufactured in state B. If the assembly plant switches to parts and subassemblies imported from abroad, then the motor vehicle manufacturing industries in states A and B become less alike because imports are affected by fluctuations in state A, but the motor vehicle production in state B no longer retains the links to state A's production.

A third possible explanation is provided by the end of high rates of inflation by 1983.[16] High rates of inflation previously made business planning more difficult and, more importantly, resulted in high volatility in prices and relative prices that further exacerbated the difficulties of planning.[17] The effects of volatility of relative prices may well be even more important than the effects of higher volatility in overall prices. Robert Gordon (2005) has emphasized the importance of more volatile prices in transmitting supply shocks in the era of higher volatility. Lower price volatility makes it easier to do efficient business planning and, therefore, may lead to lower volatility in the outputs of industries. The decline in inflation volatility explanation appears to encompass the better economic policy explanation suggested by some analysts; more effective anti-inflation monetary policies, in particular, can lead to lower and less volatile inflation.

It is possible to evaluate quantitatively whether these explanations are consistent with the observed overall pattern of volatility. The disaggregated data are not able to support detailed evaluations, so the variance of the growth rate of real GDP is chosen as the measure to be examined. A sample period of 1972 to 1997 is chosen to give an equal number of observations before 1985 and after 1984. The measure explained is the moving six-year variance of real GDP; that is, the observation for 1972 is the variance in real GDP from 1967 through 1972, the observation for 1973 is the variance of rates of change of real GDP from 1968 through 1973, and so on.

Three measures are chosen as rough proxies for the three explanations. The improved technology explanation is proxied for by a six-year moving average lag of the ratio of real information processing equipment and software investment to real GDP (that is, the 1972 value for the measure is the average ratio from 1967 through 1972, and so on). Due to the chaining methodology used to construct real NIPA aggregates, the ratio cannot be expressed in meaningful units, but it gives an approximate indication of the real importance of this technology investment in the overall economy. Because the measure is only a simple approximation of the relationship between technology and volatility, no attempt is made to consider alternative specifications or functional forms, or alternative measures of technology.



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[16] Neff (1949) found that the economies of 6 large cities moved less alike in 1921-29 than they did in the rest of the 1919-45 period. He attributed this to the effects of relative price stability because "…it is through shifting prices that much of the linkage between areas takes place." (p. 117)

[17] See, for example Debelle and Lamont (1997).

The increased import penetration explanation is proxied for by a six-year moving average lag of the ratio of real imports to real GDP. Again, the use of the chain methodology to calculate real GDP means that the ratio cannot be expressed in meaningful units, but the ratio gives an indication of the relative importance of imports to domestic production. Again, no attempt is made to consider alternative specifications or functional forms.

The effects of decreased inflation volatility are proxied for by a moving six-year variance of the annual percent changes in the GDP price index. It is constructed the same way that the six-year variance measure of real GDP is. As a proxy, its value is limited because it only captures aggregate changes, and does not fully reflect the disparities in movements of the relative prices that are believed to be an important component of the uncertainty resulting from price changes.

The three explanations are examined by estimating ordinary least squares regression equations explaining the volatility of real GDP using the three explanatory measures. The results are shown in table 5. The absolute values of t-test statistics are shown in parentheses. The first 3 equations show the results of regressing the variances in GDP against each of the three explanatory measures. All three measures have estimated coefficients that are significant at the $p \leq .001$ level, but the variance in GDP prices measure has the highest R-bar-square and F-test statistic.[18] The equation with the ratio of imports to GDP has somewhat better summary statistics than the equation with the ratio of information processing equipment and software investment to GDP. All three coefficients have the expected signs. The statistical significance of the coefficients of the measures indicates that they are all consistent with the explanations, but does not demonstrate causality.

Equation 4 has both the investment and imports ratios as explanatory variables. Although it has a higher R-bar-square than do the equations with either measure alone, the sign of the investment ratio coefficient is reversed. This appears to be the result of substantial multicollinearity between the two ratios; the correlation of the two ratios is 0.99.[19]

Equation 5 has both the imports ratio and the GDP price variance measure as explanatory variables. This equation yields an R-bar-square of 0.834, and both estimated coefficients have the expected signs and are statistically significant, with p-values of less than 0.01. Equation 6 replaces the imports ratio with the investment ratio, and produces similar results, with a modestly lower R-bar-square.



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[18] Because both the dependent variable and the inflation volatility measure are 6-year variances time series, there is a risk that some of the estimated relationship is due to this functional specification. An alternative specification, that looks at the rate of inflation instead of its volatility was also estimated using a 6-year moving average of the percent changes in the GDP price index. It indicated a highly significant relationship between inflation and volatility, with a $p \leq .001$ for the alternative inflation measure, an R-bar-square of .578, and an F-test statistic of 35.2.

[19] The deliberately simple measures used as explanatory variables, combined with a rather small number of observations precluded using collinearity-reducing tactics such as first-differencing.

Finally, equation 7 includes all three measures. Only the price measure is individually statistically significant. Again, the coefficient of the investment ratio has the wrong sign.

An implication of the results of equations 1, 2, 4, and 7 is that it is not possible to distinguish between the imports and investment stories, but that the imports story appears to be somewhat more compelling. It is possible that both of the explanations are correct, but that the relatively simple measures used here are not adequate to distinguish their separate effects.

The equations provide a good depiction of the movements of the volatility of real GDP. Chart 4 shows the time series of the variance of real GDP, and the estimated pattern from equation 5. Although the year-to-year fluctuations are not fully captured, the general pattern of rising and falling variance is matched by the fitted pattern. In particular, the estimated values do a good job of replicating the decline in variance in the mid-to-late 1980s and the subsequent relatively low variances, which remain at or below 2 percent. (Although not shown, GDP variance remains near or below 2 percent through 2005.)

Some observers have suggested that, instead of there being a decline in about 1984, the higher variances in the 1970s and early 1980s are the exceptions to a longer-run declining trend. Blanchard and Simon (2001) argued that there has been a "…large underlying decline in output volatility…a steady decline over several decades …(that) was interrupted in the 1970s and early 1980s, and returned to trend in the late 1980s and the 1990s." Appendix 3 looks at longer-run patterns of volatility of real GDP.

It seems that more detailed analyses are needed to tell the full story, and that the full story is made up of industry-level (or state-level) details that are beyond the scope of this analysis. An example of this is provided by the motor vehicle industry, which has a decline in volatility of about 75 percent in the later period. The largest component of this industry is automobile manufacturing. Anecdotal evidence suggests that the clustering of suppliers near final assembly plants led to improved efficiency and, presumably, smoothness. Import penetration was increasingly important during the sample period. Also, foreign manufacturers began assembling many models domestically, and built new plants for this. This was accompanied by a large-scale shift in motor vehicle manufacturing from the Great Lakes states to the Southeastern states. Presumably, more detailed analyses, using additional sources of information, would yield additional insights into the decline in volatility in the motor vehicle manufacturing industry.[20]

## VIII. What Else?

[20] Ramey and Vine (op. cit.) emphasize the importance of declines in volatility of durables manufacturing industries, particularly motor vehicles manufacturing, to the overall decline in volatility. The small portion of the economy accounted for by motor vehicles, however, means that this is not a sufficient explanation for the overall decline in volatility.

This analysis has attempted to examine changes in the variance of aggregate economic activity using detailed industrial and geographic disaggregations. It raises a new question: What about the 27 industries and 15 states that have increases in variance? All of the industries have increases due to covariance effects, and all but 4 also had increases due to variance effects. For these industries, the increases range from 0.4 percentage point for stone, clay, and glass products manufacturing to 454 percentage points for nondepository institutions. In 25 industries, the covariance effects are larger than the variance effects. Thus, for these industries the reverse of the patterns of the industries with declines in variance appears to be true; the primary effects within the industries are those of movements by the states becoming more like one another.

A possibility is that most or all of the explanations advanced by various analysts are correct, but that institutional conditions in the various industries resulted in deviations from the overall trends. Even the industries with increases in variance may be affected by the general explanations, but institutional conditions or other causes more than offset these.

It seems likely that reasons for the changes in variances of individual industries will be revealed only by detailed studies of the individual industries. If such studies are undertaken, they ought to include the industries with both increases and declines in variance. Only such analyses could clearly distinguish institutional reasons from the good luck explanation. Such detailed examinations, however, are beyond the scope of this analysis.

## IX. Conclusions

The decline in volatility in real economic activity that occurred about 1984 is widespread, but far from universal. The detailed results obtained in this analysis do not fully support the explanations suggested by some analysts, such as better economic policies. Others, such as better inventory management, improved labor markets, and better technologies, seem best suited for some specific industries or industry groups. The explanations suggested in this analysis likewise do not seem to work for all industries, although they work reasonably well in the aggregate. However, the good luck hypothesis seems likely to hold in many cases. The states with increased volatility are clustered geographically, which suggests additional factors are at work that have not yet been suggested. In the longer run, institutional factors seem to have been very important. It may well be that declines in volatility may be best analyzed at a very detailed level, paying special attention to industry-specific (or state-specific) detailed causes.

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Chart 1.--Real GSP and Real GDP; percent change

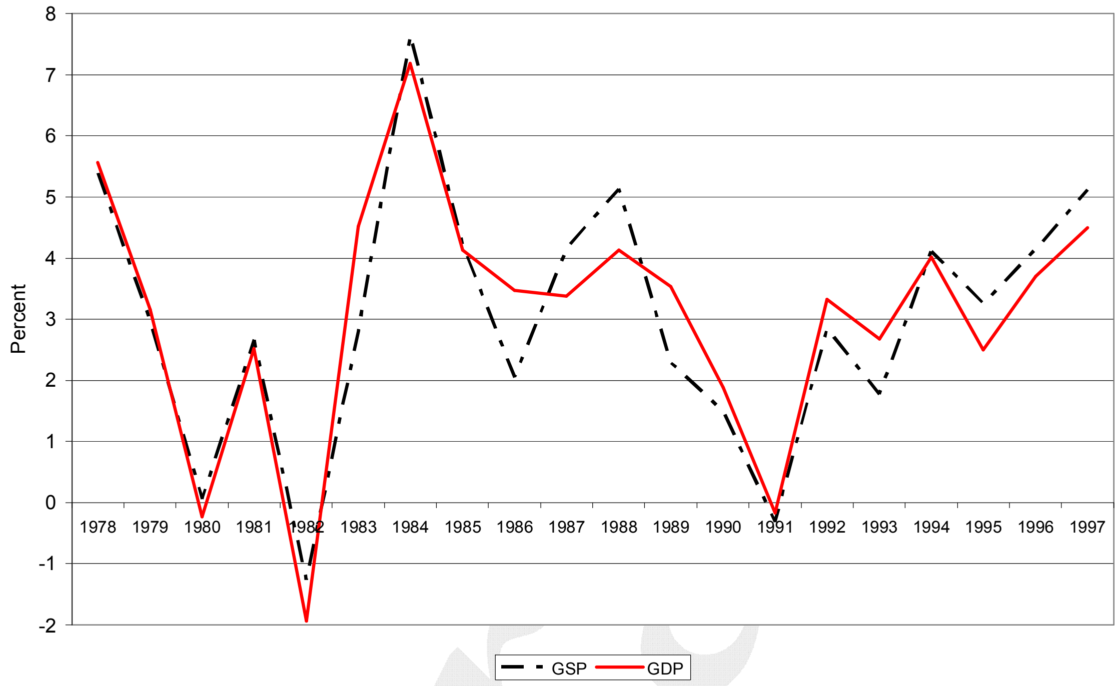

Chart 2.--Real GSP and Real GDI; percent change

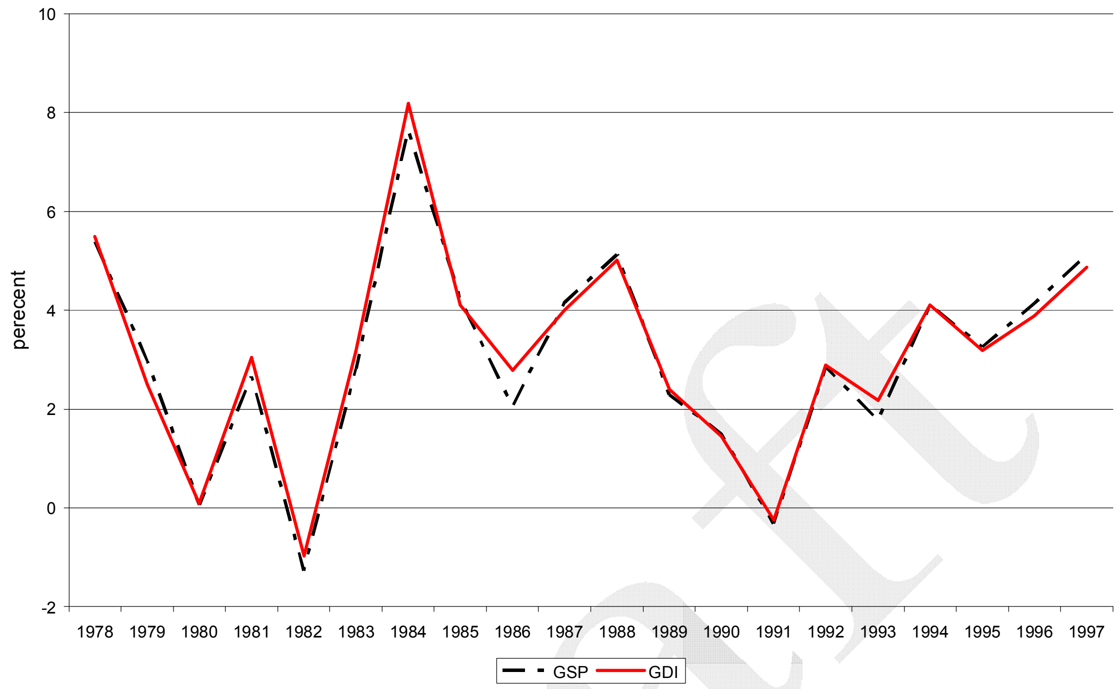


Chart 3

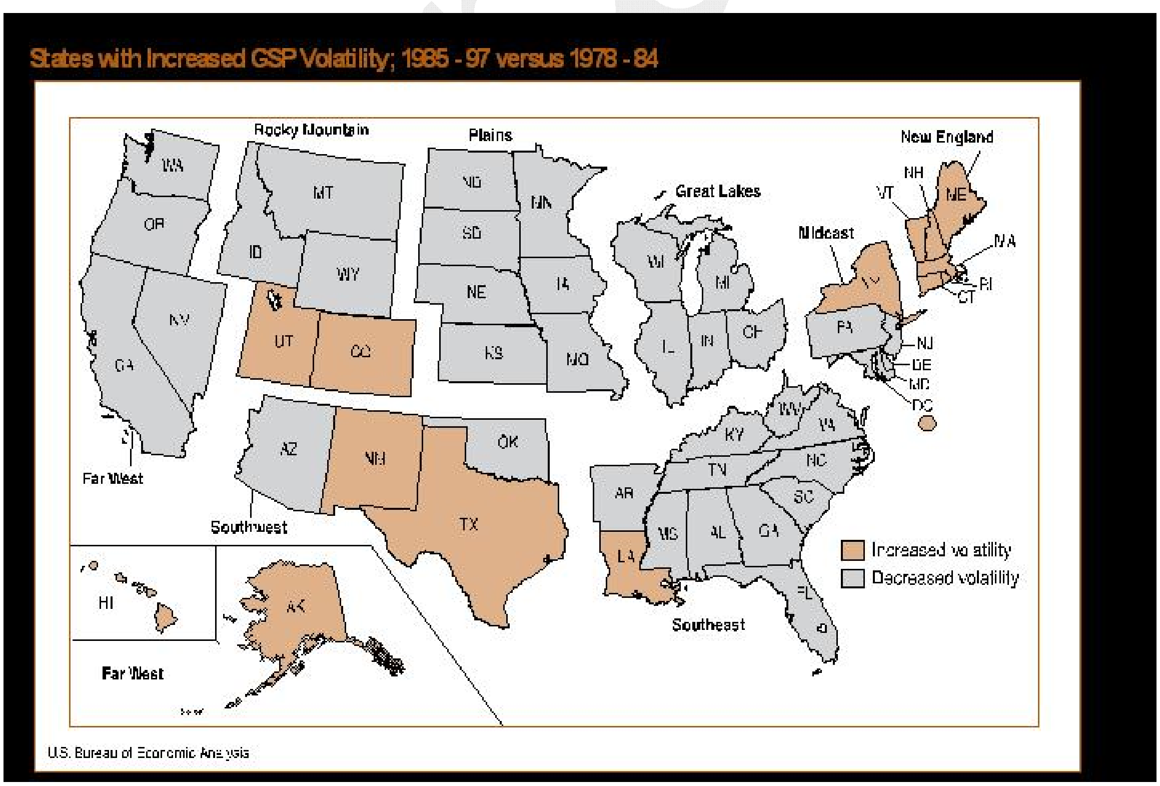

Chart 4.--6-Year Variance of Real GDP

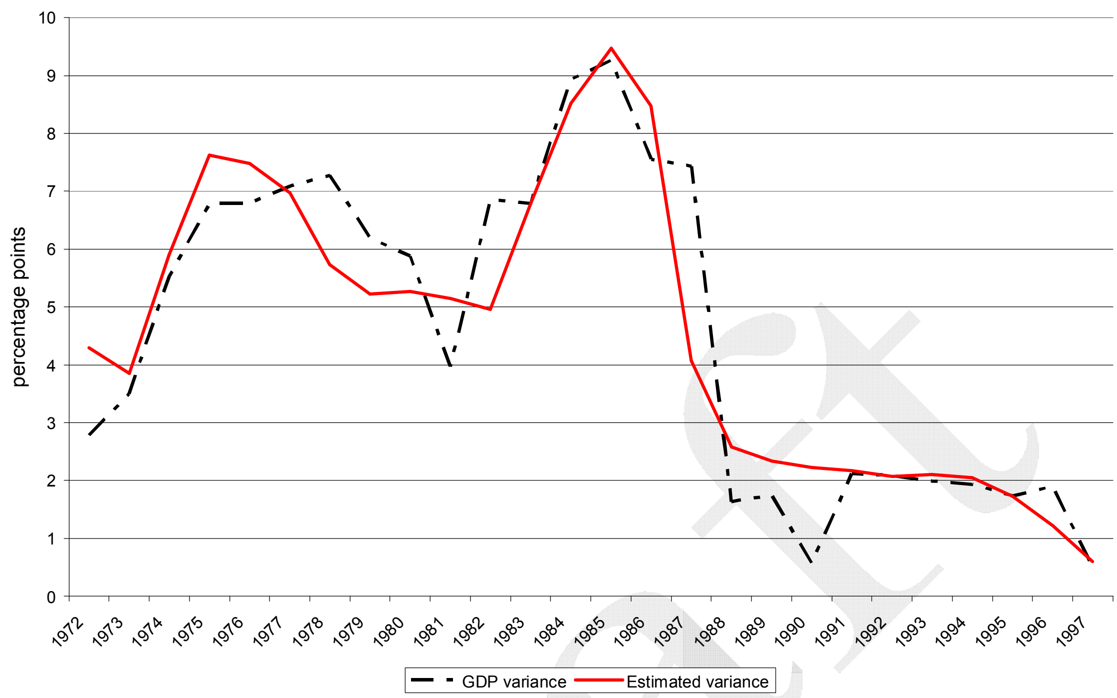

Table 1.— Industry Groups' and Regions' Effects on the Variance of Real National GDP_S
[Percentage points]

| | Variance | | |
|---|---|---|---|
| | 1978-84 | 1985-1997 | Change |
| National GDP_S variance | 7.7 | 2.3 | -5.4 |
| Effects of 13 industry groups' variances and covariances | | | |
| Weighted sums of groups' variances | 1.3 | 0.6 | -0.7 |
| Residual, including covariances | 6.5 | 1.8 | -4.7 |
| Effects of 8 regions' variances and covariances | | | |
| Weighted sums of regions' variances | 1.4 | 0.6 | -0.8 |
| Residual, including covariances | 6.3 | 1.8 | -4.5 |

Table 2.— Industries' and States' Effects on the Variance of Real National GDP_S
[Percentage points]

| | Variance | | |
|---|---|---|---|
| | 1978-84 | 1985-1997 | Change |
| National GDP_S variance | 7.7 | 2.3 | -5.4 |
| Effects of 63 industries' variances and covariances | | | |
| Weighted sums of industries' variances | 1.0 | 0.9 | -0.1 |
| Residual, including covariances | 6.7 | 1.5 | -5.2 |
| Effects of 51 states' variances and covariances | | | |
| Weighted sums of states' variances | 0.4 | 0.3 | -0.1 |
| Residual, including covariances | 7.3 | 2.1 | -5.2 |

Table 3.—Changes in Variance of Industry Groups' GDP_Ss Disaggregated by States; 1978-84 to 1985-97
[Percentage points]

| Industry Group | 1978-84 variance | Change in variance | Weighted sum of variance effects | Covariance effects, other |
|---|---|---|---|---|
| Agriculture, forestry, and fishing | 364.1 | -274.5 | -12.9 | -261.6 |
| Mining | 67.9 | -45.3 | -2.9 | -42.4 |
| Construction | 84.9 | -68.5 | -69.0 | 0.5 |
| Durable manufacturing | 58.0 | -36.2 | -2.6 | -33.6 |
| Nondurable manufacturing | 17.9 | -9.4 | -0.3 | -9.2 |
| Transportation | 31.3 | -14.2 | -0.4 | -13.7 |
| Communications | 21.1 | 41.3 | 1.6 | 39.7 |
| Electric, gas, and sanitary services | 14.7 | 20.3 | 0.5 | 19.8 |
| Wholesale trade | 14.4 | -4.0 | -0.2 | -3.8 |
| Retail trade | 19.7 | -8.1 | -0.2 | -7.8 |
| Finance, insurance, and real estate | 2.7 | -1.0 | 0.2 | -1.2 |
| Services | 4.9 | -1.9 | 0.0 | -1.9 |
| Government | 0.7 | 0.1 | 0.1 | 0.0 |
| Addenda: | | | | |
| Manufacturing | 30.6 | -17.0 | -0.9 | -16.1 |
| Transportation and public utilities | 4.8 | 46.1 | 1.7 | 44.4 |

Table 4.—Changes in Variance of Industries' GDP_Ss; 1978-84 to 1985-97
[Percentage points]

| Industry | 1978-84 Variance | Change in variance | Weighted. sum of variance effects | Covariance effects, other |
|---|---|---|---|---|
| Farms | 542.6 | -376.7 | -15.2 | -361.4 |
| Ag. services, forestry, and fishing | 14.2 | 21.1 | 2.5 | 18.6 |
| Metal mining | 202.5 | -167.6 | 3.3 | -170.9 |
| Coal mining | 80.8 | -51.9 | -6.2 | -45,7 |
| Oil and gas extraction | 97.7 | 7.0 | 0.4 | 6.6 |
| Nonmetalic minerals, except fuels | 232.4 | -190.6 | -7.7 | -182.9 |
| Construction[a] | 84.9 | -68.5 | -69.0 | 0.5 |
| Lumber and wood products | 77.6 | -35.1 | -3.1 | -32.0 |
| Furniture and fixtures | 64.8 | -42.0 | -0.8 | -41.2 |
| Stone, clay, and gas products | 124.7 | 0.4 | 0.1 | 0.3 |
| Primary metal industries | 200.9 | -176.3 | -7.5 | -168.8 |
| Fabricated metal products | 48.5 | -19.2 | -2.6 | -16.6 |
| Industrial machinery and equipment | 69.0 | 4.2 | 2.3 | 1.9 |
| Electronic and other … equipment | 56.6 | 18.8 | 9.5 | 9.3 |
| Motor vehicles and equipment | 471.4 | -346.2 | -459.3 | 113.1 |
| Other transportation equipment | 131.0 | -81.2 | 0.7 | -81.8 |
| Instruments and related products | 21.2 | 197.2 | 54.7 | 142.5 |
| Miscellaneous manufacturing | 169.2 | -142.6 | -8.3 | -134.3 |
| Food and kindred products | 23.2 | 25.7 | 1.6 | 24.0 |
| Tobacco products | 131.7 | 135.5 | -9.7 | 145.2 |
| Textile mill products | 24.8 | -9.0 | -1.4 | -7.5 |
| Apparel and other textile products | 33.6 | -28.2 | -1.1 | -27.1 |
| Paper and allied products | 22.3 | 5.5 | 2.1 | 3.4 |
| Printing and publishing | 12.4 | -2.5 | 0.3 | -2.8 |
| Chemicals and allied products | 39.6 | -16.3 | 3.7 | -20.0 |
| Petroleum and coal products | 1558.3 | -1147.6 | -76.0 | -1071.6 |
| Rubber and misc. plastics products | 43.3 | -28.3 | -1.3 | -27.0 |
| Leather and Leather products | 24.9 | 30.3 | 15.0 | 15.3 |
| Railroad transportation | 76.6 | -39.7 | 0.2 | -39.2 |
| Local and interurban passenger trans. | 31.3 | 7.3 | 0.9 | 6.4 |
| Trucking and warehousing | 52.0 | -44.9 | -1.8 | -43.1 |
| Water transportation | 20.3 | 8.6 | -0.7 | 9.3 |
| Transportation by air | 55.6 | -15.2 | -0.1 | -15.2 |
| Pipelines, except natural gas | 216.5 | -143.4 | -53310.8 | 53167.5 |
| Excluding Alaska | 317.2 | -196.7 | -4.6 | -192.1 |
| Transportation services | 15.2 | -1.2 | 0.0 | -1.2 |
| Communications[a] | 21.1 | 41.3 | 1.6 | 39.7 |
| Electric, gas, and sanitary services[a] | 14.7 | 20.3 | 0.5 | 19.8 |
| Wholesale trade[a] | 14.4 | -4.0 | -0.2 | -3.8 |
| Retail trade[a] | 19.7 | -8.1 | -0.2 | -7.8 |
| Depository institutions | 3.7 | 30.8 | 7.8 | 23.0 |
| Nondepository institutions | 14.8 | 454.0 | -1413.9 | 1867.9 |
| Security and commodity brokers | 23.7 | 237.0 | 64.3 | 172.7 |
| Insurance carriers | 87.8 | -40.8 | 3.0 | -43.8 |
| Insurance agents, brokers & services | 28.9 | 27.7 | 1.5 | 26.1 |
| Real estate | 3.1 | -0.4 | -0.2 | -0.2 |

Table 4 continued.—Changes in Variance of Industries' GDP_Ss; 1978-84 to 1985-97
[Percentage points]

| Industry | 1978-84 Variance | Change in variance | Weighted. sum of variance effects | Covariance effects, other |
|---|---|---|---|---|
| Holding and other investment offices | 10.7 | 327.4 | -228.0 | 555.3 |
| Hotels and other lodging places | 18.2 | -9.6 | -1.4 | -8.2 |
| Personal services | 13.8 | 1.4 | 0.2 | 1.3 |
| Business services | 17.1 | 18.3 | 1.4 | 16.9 |
| Auto repair, services, and parking | 28.4 | -7.3 | -0.5 | -6.9 |
| Miscellaneous repair services | 82.8 | -42.2 | -3.9 | -38.2 |
| Motion pictures | 105.6 | -42.0 | -17.3 | -24.7 |
| Amusement and recreation services | 2.1 | 20.3 | 3.0 | 17.3 |
| Health services | 2.5 | 2.1 | 0.2 | 1.9 |
| Legal services | 14.8 | 1.5 | 0.5 | 1.0 |
| Educational services | 5.7 | -2.2 | -0.2 | -2.0 |
| Social services | 24.6 | -21.1 | -1.7 | -19.4 |
| Membership organizations | 1.1 | 2.5 | 0.0 | 2.5 |
| Other services | 19.0 | 78.9 | 4.1 | 74.8 |
| Private households | 65.5 | -49.8 | -3.8 | -46.0 |
| Federal civilian (government) | 5.2 | -1.3 | 0.1 | -1.3 |
| Federal military (government) | 2.5 | 1.1 | 0.5 | 0.6 |
| State and local (government) | 0.9 | -0.3 | 0.1 | -0.3 |

a. Also designated to be a (one industry) industry group in this study.

Table 5.—Equations Explaining the Variance in Real GDP
Period 1972-97

| Equation number | Constant | Real Imports/ Real GDP | Real Investment in IP Equipment and Software /Real GDP | Variance in GDP Price Index | R-bar-square | F-test Statistic |
|---|---|---|---|---|---|---|
| 1 | 14.489<br>***(7.117) | -138.052<br>***(4.963) | | | .486 | ***24.637 |
| 2 | 5.873<br>***(9.941) | | -134.742<br>***(4.493) | | .375 | ***20.188 |
| 3 | 2.119<br>***(5.438) | | | 1.273<br>***(8.751) | .751 | ***76.586 |
| 4 | 46.482<br>***(7.941) | -771.523<br>***(4.959 | 1517.223<br>***(4.111) | | .691 | ***28.930 |
| 5 | 7.453<br>***(4.910) | -67.065<br>***(3.594) | | 1.005<br>***(7.161) | .834 | ***63.764 |
| 6 | 3.789<br>***(6.304) | | -143.154<br>**(3.313) | 1.068<br>***(7.985) | .824 | ***59.710 |
| 7 | 18.545<br>*(2.260) | -276.102<br>(1.803) | 473.915<br>(1.374) | 0.848<br>***(4.740) | .840 | ***44.783 |

* $p \leq .05$, ** $p \leq .01$
*** $p \leq .001$

## Appendix 1.—The Effects of Some Weighting Schemes on Estimates of Variance and Covariance Effects

There is no clear-cut "right" way to calculate weights over a two-decade time span that does not have an impact on the relative importance of the variance and covariance effects, and possibly even on the signs of these effects. Stiroh (op. cit.) used two-period averages of the observed weights. This has the disadvantage that changes in the weights over time can affect the size of the variance effects, and correspondingly, the residual covariance effects. Fixed weights eliminate this disadvantage, but at the cost of imposing weights that are not optimal for all, or even most, periods.

The choice of weights can make a considerable difference in the estimates. An example is provided by the finance, insurance, and real estate industry group (FIRE), which underwent considerable transformation as many depository institutions were transformed from local or state firms to national or super-regional firms. Table A1 shows the effects of different weighting methods for FIRE, including the 1978-97 average used in the reported calculations (three decimal places are shown to aid the discussion).

Table A1.—Changes in Variance, Variance Effects, and Covariance Effects for FIRE Using Different Weighting Methods

| Weighting scheme | Δ U.S. variance | Variance effects | Covariance effects |
|---|---|---|---|
| 1978 weights | -1.029 | 0.191 | -1.220 |
| 1985 weights | -1.029 | 0.222 | -1.251 |
| 1997 weights | -1.029 | 0.233 | -1.262 |
| 1978-84 average weights | -1.029 | 0.205 | -1.234 |
| 1985-97 average weights | -1.029 | 0.212 | -1.241 |
| 1978-97 average weights | -1.029 | 0.209 | -1.238 |

The change in U. S. variance is the same in all cases. The estimated variance effects vary by up to one-fifth, but all have a positive sign, indicating a tendency for increased aggregate variance. The 1978-84 weights indicate somewhat lower variance effects than do the 1985-97 weights—an effect not captured by any of the fixed weighting schemes. The residual covariance effects are all negative, with the covariance effects increasingly large as time passes.

## Appendix 2.—Equations Examining the Relationships Between Earlier-Period Variances, Declines in Variances, and Later-Period Variances

Table A2 shows the results of ordinary least squares cross-section regressions. (The numbers in parentheses below the coefficient terms are absolute values of t-test statistics for the coefficients.) The first regressions explain the declines in variances by the sizes of the earlier-period variances. Equation 1a includes all 63 industries, and the variances are calculated for the periods 1978-84 and 1985-97. Equation 1b excludes the 10 industries with the largest changes in variances; it is shown to evaluate the possibility that outliers are distorting the estimated relationships.

Table A2.—Equations Explaining Variances and Changes in Variances

| Dependent variable | Explanatory variable | Constant term | Explanatory variable coefficient | R-bar-square |
|---|---|---|---|---|
| 1a. Delta variance | 1978-84 variance | 45.675<br>***(3.91) | -0.782<br>***(15.35) | 0.791 |
| 1b. Delta variance | 1978-84 variance | 21.211<br>***(4.10) | -0.734<br>***(9.70) | 0.641 |
| 2. 1985-97 variance | 1978-84 variance | 49.555<br>***(3.77) | 0.154<br>(1.39) | 0.015 |

*** $p \leq .001$

Both equation 1a and equation 1b yield similar results, suggesting that the outliers do not distort the results. There is a strongly statistically significant negative relationship between the size of the earlier-period industry variance and the size of their changes (the F-test statistics are 235.8 and 94.1 for the two regressions). The values of the coefficients of the variance in both equations are not significantly different from one another (with t-test statistics against one another of less than 1.0). Both constant terms are similar in size, not statistically significantly different from one another, and positive.

Equation 2 indicates that there is very little relationship between the industries' variances in the two periods, and the 1978-84 variances are not statistically significant in explaining the 1985-97 variances. Although the constant term is significant, the F-test statistic is just 1.9, which is not statistically significant.

Appendix 3.—Longer-Run Trends in the Volatility of Economic Activity

Blanchard and Simon (op. cit.) looked at the volatility of U.S. economic activity using a moving twenty-quarter window of variance of real GDP. They found a pattern beginning in the 1970s similar to the pattern reported in this analysis. Because their sample began in the early 1950s, however, they found what they interpreted as a trend decline from the mid 1950s to the late 1990s that was interrupted by increased variance in the 1970s and early 1980s.

The 6-year-long real GDP variances used in their analysis may be extended further back in time than the 1970s starting points used in the main text. Chart A1 shows 6-year variances beginning with 1955. (This starting point means 1950 is the first year used in the calculation of the first variance, and so on.) The 6-year variances have a pattern similar to that found by Blanchard and Simon; declining variances to about the end of the 1960s, increased variances in the 1970s and early 1980s, and then a sharp decline in variances thereafter that is maintained through the most recent available year, 2005.

Because quarterly estimates of real GDP are only available beginning with 1947:I, and because they used 20-quarter calculations of variance, Blanchard and Simon were not able to push their variance calculations back before 1952. Annual estimates of real GDP, however, are published by BEA beginning with 1929. This means that 6-year variances can be calculated beginning with 1935. These are shown for the period 1935-2005 in chart A2. The variances until the early 1950s are extremely high in comparison with those thereafter.

It is not surprising that there were very high variances in the years before the 1950s. The observations though about 1940 cover the period dominated by the economic dislocations associated with the Great Depression. Those in the 1940s are greatly influenced by the changes that occurred as the economy first shifted to an all-out war footing to support World War II, and then returned to a largely civilian foundation. By the mid-1950s, the economy by and large was in a "normal" mode, albeit with somewhat higher defense spending than prior to 1940, and that was associated with the cold war.

Viewed in the longer-term framework, the relatively low GDP variances in the 1960s may be viewed alternatively as a temporary departure from a long period of higher variance, that occurred in a decade that had just one recession near its beginning. Indeed just one measure—the variance of prices—featured in this analysis as a proxy for the pattern of price volatility, was low and would help explain the period of lower variances in the 1960s. The other two proxy measures suggest high variance. Import penetration was low until a pick-up that began in the late 1960s. Similarly, information technology had little influence; the share in GDP of information processing equipment and software was 0.2 percent or less until it began to increase sharply in the mid 1970s.

Thus, institutional circumstances appear to dominate the observed pattern of real GDP variance until the mid-1950s. Thereafter, the decline in GDP variance observed in the 1960s could just as well be the anomaly, rather then the return of modestly higher variances in the 1970s and early 1980s.

**Chart A1.--6-Year Variance of Real GDP**

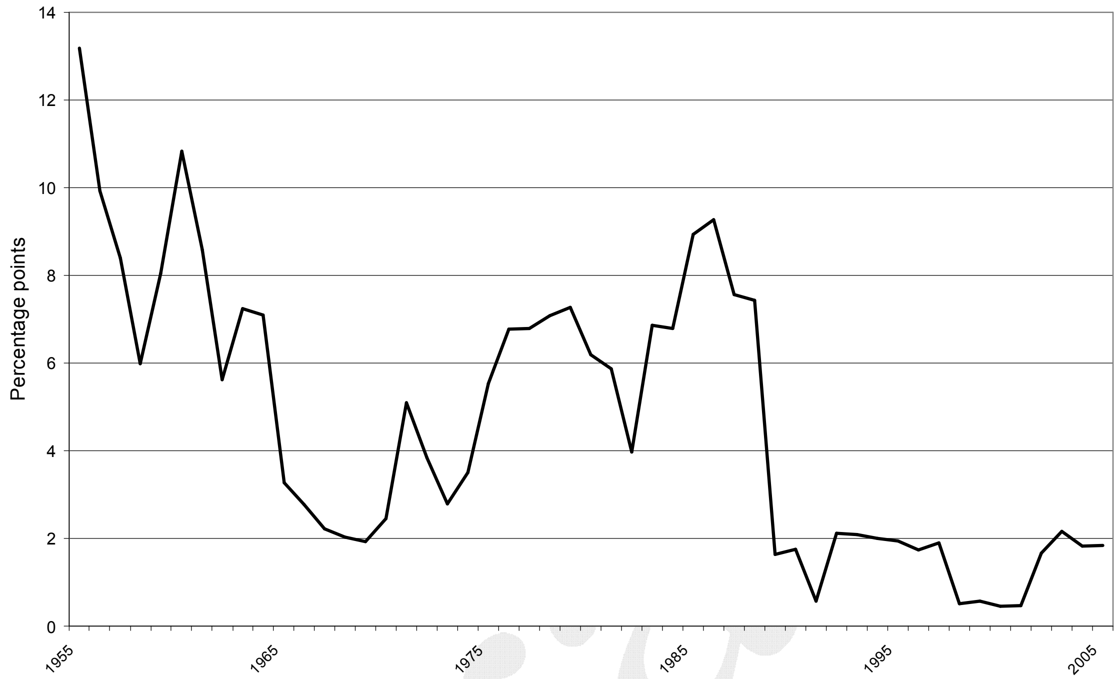


**Chart A2.--6-Year Variance of Real GDP**