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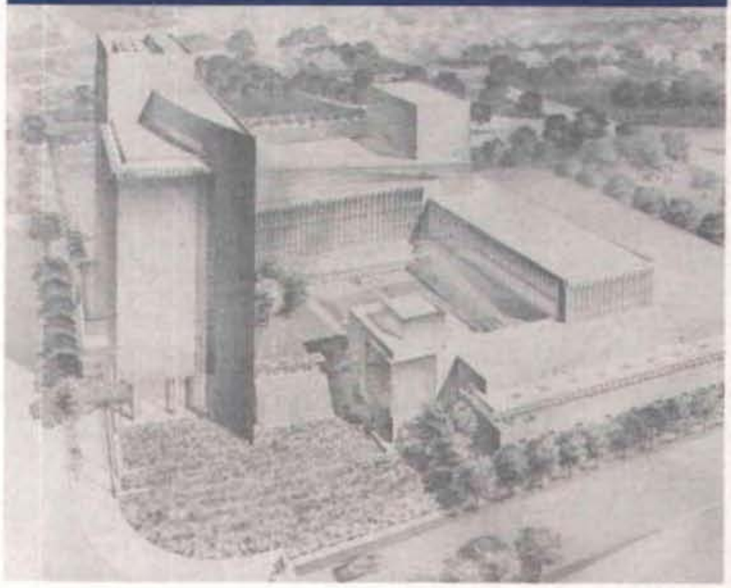

The Federal Funds Rate as an Indicator of Monetary Policy: Evidence from the 1980s

Nathan S. Balke and Kenneth M. Emery

Demographics and the Long-Term Outlook for Housing Investment

John K. Hill and D'Ann M. Petersen

A Primer on the Nature of Business Cycles

Gregory W. Huffman

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Federal Reserve Bank of Dallas

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On the cover: an architectural rendering of the new Federal Reserve Bank of Dallas headquarters.

Contents

Recently, several economists have argued that movements in the federal funds rate are a good proxy for changes in monetary policy. In this article, Nathan Balke and Kenneth Emery critically examine this view and the evidence supporting it. Using simple vector autoregressions, they find that before 1980 the correlations between the federal funds rate and other important macroeconomic variables are consistent with a traditional monetary policy interpretation of the federal funds rate. However, they show that after 1982 the relationships between the federal funds rate and other macroeconomic variables change significantly. Most important, the correlations between the federal funds rate and other macroeconomic variables observed during the 1980s are not as consistent with a traditional monetary policy view of the federal funds rate as they were before 1980.

Balke and Emery's work highlights how relationships between important macroeconomic variables can change when institutions or policy regimes change. While the federal funds rate may still be a good indicator of monetary policy, its relationship with other important macroeconomic variables is now clearly different from what it was before 1980.

John Hill and D'Ann Petersen measure the importance of projected shifts in the size and age distribution of the U.S. population for domestic housing investment. Their analysis runs through the year 2010 and provides separate estimates for single-family and multifamily investment.

Hill and Petersen find that the contractionary effects of the population slowdown are already being felt in the housing industry and probably have been since the latter part of the 1980s. In Hill and Petersen's simulations, demographic shifts lower net housing investment by 17 percent from the late 1980s through the first half of the 1990s. Population factors then reduce net investment an additional 22 percent through the year 2005 before turning favorable.

(Continued on the next page)

Contents

(Continued from the previous page)

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The Federal Funds Rate as an Indicator of Monetary Policy: Evidence from the 1980s

How monetary policy affects economic activity is a perennial question in macroeconomics. One of the main impediments to answering this question is the absence of agreement on what is an accurate gauge of monetary policy. Historically, many economists have used changes in the quantity of money as an indicator of changes in monetary policy. One problem with this approach, however, is that changes in money can result from factors other than changes in monetary policy. For instance, economic conditions can significantly influence money growth over the course of the business cycle.

Several economists have argued that movements in short-term interest rates, particularly movements in the federal funds rate, may be a better indicator of changes in monetary policy than are changes in the quantity of money (McCallum 1983, Laurent 1988, Bernanke and Blinder 1992, and Goodfriend 1992). This view is based on the observation that, with the exception of the 1979–82 period, the Federal Reserve appears to have implemented its monetary policy by targeting the federal funds rate.

In support of the federal funds rate as a gauge of monetary policy, Bernanke and Blinder (1992) present evidence that the federal funds rate is a better predictor of future economic activity than are other interest rates or other monetary aggregates. Additionally, using data before 1979, they show, using a simple vector autoregression (VAR), that changes in the federal funds rate are systematically related to changes in inflation and unemployment. (See the box entitled "Vector Autoregressions.") Specifically, the federal funds rate rises in response to unexpected increases in inflation and falls in response to unexpected increases in unemployment. Thus, their results are consistent with a monetary policy that "leans against the wind," or reacts countercyclically to the business cycle.

In this article, we use simple vector autoregressions to examine whether the relationships found by Bernanke and Blinder for the pre-1979 period persist after 1982, when the Federal Reserve returned to a policy of explicitly targeting the federal funds rate. The results provide more recent evidence on whether sensible monetary policy reaction functions can be derived using the federal funds rate as an indicator of the stance of monetary policy, and whether the funds rate has information about future inflation and unemployment. Also, because the vector autoregression methodology uncovers correlations among macroeconomic variables, the results of this examination may reveal changes in the correlations of macroeconomic variables after 1982 that shed light on several monetary policy issues.[1] For instance, if monetary policy is now less countercyclical, does the federal funds rate now respond less to innovations in unemployment or inflation? Do changes in

The authors thank John Duca, Joseph Haslag, and Evan Koenig for helpful comments and suggestions. We also thank Adrienne Slack for her capable research assistance. Any remaining errors are the authors' responsibility.

[1] *According to the Lucas Critique, changes in policy regimes or economic institutions will likely change the relationships among macroeconomic variables.*

the federal funds rate now have less information content for economic activity? If so, does this imply that monetary policy became less effective during the 1980s? While answering these types of questions using the vector autoregression methodology is difficult, VARs do provide correlations with which economic models must contend.

In this article, we first review the recent literature on measuring monetary policy. We then present the empirical results, and finally, we outline some interpretations of these findings.

Vector autoregressions and monetary policy

Traditional monetarists (for example, Friedman and Schwartz 1963) view the growth of the money stock as a good indicator of monetary policy. While traditional monetarists argue that the money supply has important effects on the real economy in the short run, they typically stress that policymakers should avoid the temptation to temporarily stimulate real economic activity by rapidly expanding the money supply. Traditional monetarists fear such actions would increase inflation in the long run and exacerbate the business cycle. With the advent of rational expectations in macroeconomics, however, most economists view only unexpected policy actions as having real effects on the economy. Thus, rational expectations monetarists (for example, Sargent and Wallace 1975) take the view that only unexpected changes in the money supply will have temporary real effects, while expected changes in the money supply will be immediately reflected in the price level.

Sims (1980) questions the importance of unexpected changes in money for future changes in economic activity. Using a four-variable VAR, he shows that once the information content of interest rates is taken into account, only a small portion of the unexpected variation in output can be attributed to unexpected changes in the money supply. While some researchers have questioned the robustness of Sims' results, the conclusion that interest rates have substantial information content about future economic activity has held up. For a time, these results were considered damaging to the view that monetary policy is an important factor in explaining business cycles.

However, later research (McCallum 1983 and Laurent 1988) maintains that Sims' results do not imply that monetary policy is unimportant in determining economic activity. These economists argue that because the Federal Reserve conducts policy by targeting the federal funds rate and because changes in the money supply can be caused by factors other than changes in monetary policy, unexpected changes in the federal funds rate may be a better measure of monetary policy than unexpected movements in the money supply.

If the federal funds rate is a good indicator of monetary policy and monetary policy has real effects on the economy, then the federal funds rate should be a good predictor of economic variables. Bernanke and Blinder (1992) show that the federal funds rate is a good predictor of major macroeconomic variables before 1979 and that the federal funds rate better predicts macroeconomic variables than other interest rates or monetary aggregates.[2] Bernanke and Blinder also discover, using a simple VAR, that the federal funds rate responds to variables the Federal Reserve has been traditionally concerned with—unemployment and inflation. In other words, "reaction functions" can be estimated in which monetary policy (changes in the federal funds rate) reacts countercyclically in response to unexpected movements in unemployment and inflation.

In the next section of this article, we examine whether the relationships found by Bernanke and Blinder for the pre-1980 period held up during the 1980s.

Empirical results

Pre-1980 results. Bernanke and Blinder (1992) specify a series of three-variable VARs consisting of a measure of monetary policy, the prime-age (25–54) male unemployment rate, and the inflation rate as measured by the consumer price index. Each variable is regressed on six lags of itself and six lags of the other two remaining variables. The data are monthly, starting with July 1959 and ending in September 1979, when interest rate

[2] *When post-1979 data are added to their sample, the statistical significance of the federal funds rate in prediction equations generally declines. Their results are consistent with those of Bernanke and Blinder (1990).*

Vector Autoregressions

Vector autoregressions (VARs) are time series models that use only past values of the variables of interest to make forecasts. For instance, a three-variable VAR system of interest rates, unemployment, and inflation can be expressed as

$$R_t = \beta_1 + \Sigma R_{t-i} + \Sigma U_{t-i} + \Sigma \pi_{t-i} + \epsilon_{Rt}$$
$$U_t = \beta_2 + \Sigma R_{t-i} + \Sigma U_{t-i} + \Sigma \pi_{t-i} + \epsilon_{Ut}$$
$$\pi_t = \beta_3 + \Sigma R_{t-i} + \Sigma U_{t-i} + \Sigma \pi_{t-i} + \epsilon_{\pi t},$$

where R, U, and π are the interest rate, unemployment rate, and inflation rate, respectively. β is an intercept term, t is a time subscript, and ϵ is an error term. Thus, each of the three variables is expressed as a linear function of past values of itself and past values of other variables in the system.

In practice, the estimated error terms from each equation are correlated so that it is not correct to assume that, for instance, ϵ_{Ut} represents an independent surprise movement in the unemployment rate. To better interpret the dynamic relationships present in the data, the residuals from the VAR are broken up into linear combinations of independent (orthogonal) shocks. A common orthogonalization is to assume that the VAR system is *recursive* so that there is a chain of causality among surprises in the variables during any given period. For example, a possible recursive system of the VAR above is one in which the interest rate responds to an exogenous shock, and unemployment responds to the contemporaneous interest rate and an exogenous unemployment shock, while the inflation rate responds to the contemporaneous interest rate, contemporaneous unemployment rate, and an exogenous inflation shock. In effect, new surprises, or a shock term for each variable, are created that are now uncorrelated with each other. The transformation of the original shocks into recursive, orthogonal shocks is called the *Choleski decomposition*.

The Choleski decomposition is controversial because if the VAR is used to draw economic inferences, then the recursive restriction imposed on the system should be supported by economic theory. If the identifying assumption of recursivity is not justified, then the estimated parameters will be a mixture of both structural and reduced-form parameters. However, for forecasting purposes, the use of Choleski decompositions in VARs does not pose a problem because no economic inferences are being drawn from the estimated parameters.[1]

[1] For more on VARs, see Todd (1990), Runkle (1987), Sims (1986), Cooley and LeRoy (1985), and Hakkio and Morris (1984).

targeting was de-emphasized. Bernanke and Blinder impose recursivity on the system using the Choleski decomposition, with the ordering from the policy variable to the unemployment rate to the inflation rate.

Bernanke and Blinder use both the federal funds rate and the spread between the federal funds rate and the ten-year U.S. Treasury bond rate, henceforth the *spread*, as indicators of monetary policy. The spread is an alternative indicator of monetary policy because it controls for the general level of market interest rates and therefore provides further information about whether a particular level of the federal funds rate represents a restrictive or loose monetary policy. Figure 1 plots both the federal funds rate and the spread.[3] Note that the spread is nearly a mirror image of the federal

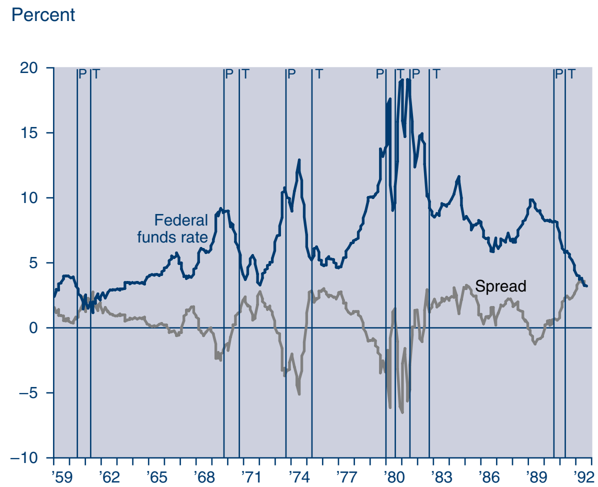
[3] *A similar figure appears in Bernanke and Blinder (1992).*

funds rate. In general, as Bernanke and Blinder point out, run-ups in the federal funds rate have preceded the onset of all recessions since 1959.

Because the estimation results for the individual equations within a VAR system are of little interest, they are not reported here. Table 1, however, reports the marginal significance level of exclusion tests for lags of the right-hand side variables. As in Bernanke and Blinder, the hypothesis that lags of inflation or unemployment can be excluded from the federal funds rate equation is easily rejected. This result indicates that the recent state of the economy, as measured by lagged inflation and unemployment, contains information about future movements in the federal funds rate. In addition, lags of the federal funds rates are significant in both the inflation and unemployment equations, suggesting, at a minimum, that knowledge of the federal funds rate helps predict these variables. The results for the spread between the ten-year Treasury bond rate and the federal funds rate are qualitatively similar to those of the federal fund rate; for this reason, we do not present them here.

When M2 growth is added to the three-variable system, the federal funds rate still retains its importance (as measured by the significance levels) in explaining the behavior of inflation; the rate is somewhat less important for unemployment. Furthermore, we can reject the hypothesis that the federal funds rate can be dropped from the four-variable system consisting of federal funds rate, M2 growth, unemployment, and inflation.

Figure 1
Federal Funds Rate and Spread



SOURCE: Board of Governors, Federal Reserve System.

Table 2 presents the forecast error variance decompositions for the VAR, including the federal funds rate and M2.[4] A variance decomposition divides the total forecast error variance, at different forecast horizons, into portions attributable to shocks in each of the variables in the system.[5] From Table 2, we find a substantial proportion of the forecast error variance in the federal funds rate is caused by uncertainty about the future values of unemployment and inflation. In other words, knowledge about future states of the economy tells us something about future movements in the federal funds rate. The decompositions for inflation and unemployment indicate that uncertainty about future values of the federal funds rate contributes only modestly to uncertainty about their future values. The contribution of federal funds shocks to the forecast variance of unemployment tends to be greater at longer horizons than that of M2. On the other hand, M2 tends to contribute more to the forecast variance of inflation than does the federal funds rate. Still, the majority of the forecast error variance for inflation and unemployment arises from uncertainty about shocks to those variables themselves.[6]

Overall, the federal funds rate had important predictive content for unemployment and inflation during the period July 1959–September 1979. This

[4] *We employ a Choleski decomposition with the ordering of federal funds rate, M2, unemployment, and inflation. The qualitative results are unchanged if M2 and the federal funds rate or unemployment and inflation are switched in the ordering.*

[5] *The 90-percent confidence bands for the variance decompositions and impulse response functions (reported below) are generated using a Monte Carlo procedure and are available from the authors on request.*

[6] *Using the spread variable, the forecast error variance decompositions are similar. However, shocks to the spread contribute less to the total inflation forecast error variance, and shocks to inflation contribute less to the total spread forecast error variance.*

Table 1
Marginal Significance Levels for Exclusion of Lags, 1959–79

Three-variable system (federal funds rate, unemployment, inflation)

	Marginal Significance Levels		
		Lags of	
	Federal funds	Unemployment	Inflation
Equation			
Federal funds	.0000	.0000	.0002
Unemployment	.0092	.0000	.2300
Inflation	.0000	.0698	.1304

Four-variable system (federal funds rate, M2, unemployment, inflation)

	Marginal Significance Levels			
			Lags of	
	Federal funds	M2	Unemployment	Inflation
Equation				
Federal funds	.0000	.0357	.0003	.0035
M2	.0000	.0000	.0897	.4875
Unemployment	.1140	.1032	.0000	.1032
Inflation	.0000	.0063	.2523	.2376

Tests for dropping variable from four-variable system

M2	$\chi^2(18) = 40.88$	(.0016)
Federal funds	$\chi^2(18) = 85.50$	(.0000)

is the case even after allowing for the effect of money aggregates, as measured by M2. This finding provides indirect evidence that the federal funds rate may be a good indicator of monetary policy.

An additional source of evidence provided by Bernanke and Blinder is that the response of the federal funds rate to shocks in unemployment and inflation is consistent with a "lean against the wind" policy; that is, the federal funds rate rises in response to a positive inflation shock and falls in response to a positive unemployment shock.

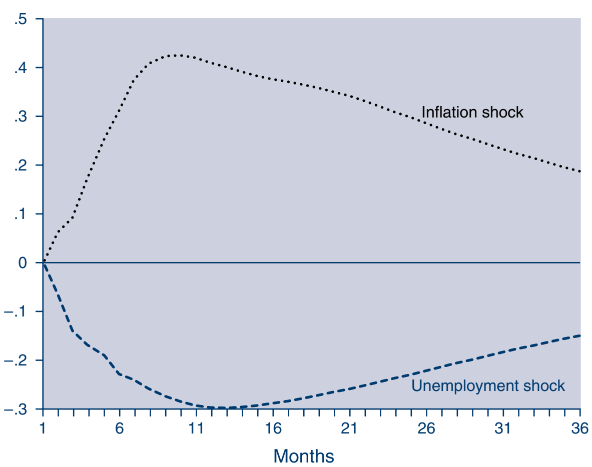
Figures 2 and 3 plot impulse response functions for the three-variable VAR that includes the federal funds rate, unemployment, and inflation and is estimated over the sample period up to September 1979.[7] Figure 2 displays the response of the federal funds rate over time to unexpected movements in inflation and unemployment.[8] As underscored by Bernanke and Blinder, the plots look very much like "lean against the wind" monetary policy reaction functions. The federal funds rate rises in response to an unexpected increase in inflation and falls in response to an unexpected increase in unemployment.

Figure 3 displays the responses of unemployment and inflation to an innovation in the federal funds rate. The qualitative pattern of the impulse response function for unemployment is

[7] *The qualitative behavior of the impulse responses using the spread variable as the monetary policy variable is very similar.*

[8] *The ordering of the unemployment rate and the inflation rate in the VAR does not affect the results that follow. Also, the inclusion of money growth, as measured by M2, in the VAR system does not qualitatively affect the impulse responses of the other three variables.*

Figure 2
Responses of Federal Funds Rate to Inflation and Unemployment Shocks

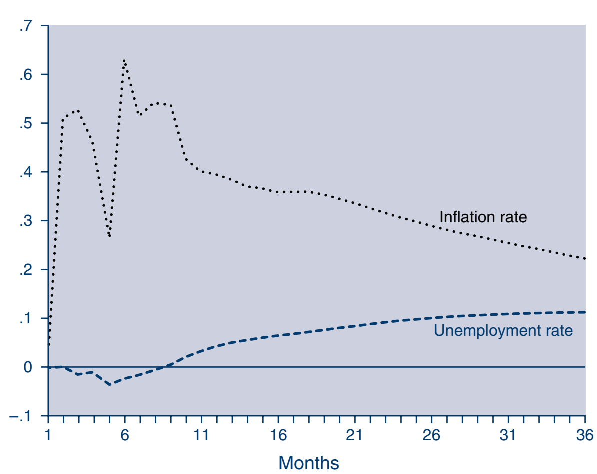


broadly consistent with the view that unexpected changes in the federal funds rate represent changes in monetary policy. Figure 3 shows that after a temporary and short-lived fall, the unemployment rate rises in response to an unexpected increase in the federal funds rate. On the other hand, the inflation rate response moves the wrong way if one interprets a surprise increase in the federal funds rate as a tightening of monetary policy. This "price level" effect, noted by Eichenbaum (1992) in his comment on Sims (1992), raises doubts about interpreting federal funds rate innovations as unexpected monetary policy changes.[9] This price level effect, does not, however, necessarily provide evidence against the effectiveness of a "lean against the wind" policy. The reason is that such a countercyclical policy, to the extent that it is predictable, would be embodied in the coefficients of the VAR and not necessarily be reflected in unexpected movements of the federal funds rate.[10]

Post-1982 results

In this section, we examine whether the relationships found by Bernanke and Blinder persist during the 1980s. There are several reasons they may not. First, financial innovation and deregulation during the 1980s may have changed the effectiveness and the transmission mechanism of monetary policy (Bosworth 1989 and Kahn 1989). Second, the high-inflation decade of the 1970s may have changed the way the public reacts to inflation. In particular, the Phillips curve may have steepened, lessening even the short-term trade-off between inflation and unemployment. Furthermore, financial markets may have become more sensitive to inflation fears, and these concerns are more readily reflected in increases in long-term interest rates. Finally, the Federal Reserve may have focused more of its policy on control-

Figure 3
Responses to Federal Funds Rate Shocks



[9] Similarly, Gordon and Leeper (1993) cite this effect in arguing that innovations in the federal funds rate are an inappropriate indicator of monetary policy. As an alternative, they construct a structural model of the money market to identify monetary policy surprises.

[10] Another explanation for this price level effect would be to distinguish between nominal and real federal funds rate innovations. Many analysts would argue that a monetary policy tightening occurs only when the real federal funds rate rises. The price level effect found here may only signal that increases in the nominal federal funds rate are not as large as the contemporaneous increases in inflation and, therefore, do not constitute a tightening of monetary policy. An examination of the viability of the real federal funds rate as an indicator of monetary policy is left for future research.

Table 2

Forecast Error Variance Decompositions, 1959–79

Federal funds rate

Forecast horizon	Percentage of forecast error variance explained by: Federal funds	M2	Unemployment	Inflation
6	77.7	2.9	8.9	10.5
12	51.7	9.3	18.7	20.3
24	30.5	31.9	22.2	15.5
36	23.9	41.6	21.8	12.7

M2

Forecast horizon	Percentage of forecast error variance explained by: Federal funds	M2	Unemployment	Inflation
6	22.5	70.3	3.3	4.0
12	21.1	64.0	8.1	6.8
24	23.1	60.0	9.8	7.1
36	24.3	58.0	9.4	8.3

Unemployment rate

Forecast horizon	Percentage of forecast error variance explained by: Federal funds	M2	Unemployment	Inflation
6	1.1	2.8	96.2	.3
12	1.7	6.0	90.4	.6
24	13.2	10.2	68.1	3.6
36	23.8	8.7	57.5	8.0

Inflation rate

Forecast horizon	Percentage of forecast error variance explained by: Federal funds	M2	Unemployment	Inflation
6	12.9	7.7	2.9	76.5
12	17.2	11.8	4.7	66.2
24	15.5	24.5	6.7	52.3
36	14.2	33.6	8.0	44.2

ling inflation before inflation accelerates. This shift may be the result of a heightened aversion to inflation by the public or increased awareness by the Federal Reserve of the limitations of monetary policy in affecting the real economy.

Is the VAR evidence still consistent with the view that the federal funds rate is a good indicator of monetary policy? The first step in answering this question is to test whether there is any evidence of structural instability in the VAR system after 1982.[11] VARs are estimated over the November 1982–September 1992 period and are compared with VARs estimated over the July 1959–September 1979 period. Using standard likelihood-ratio tests,

[11] *We exclude the October 1979–September 1982 period, when the Federal Reserve de-emphasized the targeting of interest rates in setting monetary policy.*

Table 3
Test for Structural Change Between the 1959–79 and 1982–92 Samples

Three-variable system (federal funds rate, unemployment, inflation)

Entire system	$\chi^2(57) = 137.0$	(.0000)

Significance levels for structural change equation by equation

Federal funds	.0352
Unemployment	.0081
Inflation	.0000

Four-variable system (federal funds, M2, unemployment, inflation)

Entire system	$\chi^2(100) = 219.5$	(.0000)

Significance levels for structural change equation by equation

Federal funds	.0043
M2	.0000
Unemployment	.0442
Inflation	.0000

the hypothesis of stability is easily rejected for the VAR systems using both the federal funds rate and the spread and including and excluding M2 (*Table 3*).[12] Taken equation by equation, there is also evidence that the correlation structure from the 1959–79 period differs from that of the 1982–92 period.

Does the federal funds rate retain its predictive ability in the post-1982 period? Table 4 displays the marginal significance level of exclusion tests for the post-1982 period. The federal funds rate still has predictive content for inflation and unemployment, with significance levels close to or less than 10 percent; therefore, we can strongly reject the hypothesis that the federal funds rate can be dropped from the system. M2, however, loses much of its predictive power in the later sample; therefore, we cannot reject the hypothesis that M2 can be dropped from the system. Furthermore, the significance levels of lags of unemployment and inflation in the federal funds equation indicate that these variables do not explain much of the movement in the federal funds rate in the later period.

Examining the forecast error variance decompositions for the VAR from the pre-1980 and post-1982 periods (*Table 5*), the federal funds rate still explains a modest percentage of the forecast variance of unemployment and inflation. The contribution of M2, on the other hand, falls substantially in the post-1982 period. Thus, it appears that the federal funds rate has become more important relative to M2 in explaining the behavior of inflation and unemployment in the post-1982 period.

Perhaps the most striking difference in the variance decompositions is the small percentage of the forecast error variance for the federal funds rate that can be attributed to uncertainty about future inflation. In other words, inflation shocks

[12] Evidence of a unit root in the level of the federal funds rate and the unemployment rate made us cautious about using the data in levels form to make inferences using likelihood-ratio tests. However, instability was also found when the VAR system was estimated in first differences. There was also evidence of instability when the system was estimated in error-correction form using a cointegrating vector found by the methodology developed by Johansen and Juselius (1990).

Table 4
Marginal Significance Levels for Exclusion of Lags, 1982–92

Three-variable system (federal funds rate, unemployment, inflation)

	Marginal Significance Levels		
		Lags of	
Equation	Federal funds	Unemployment	Inflation
Federal funds	.0000	.1700	.8184
Unemployment	.0923	.0000	.6415
Inflation	.0133	.5909	.0003

Four-variable system (federal funds rate, M2, unemployment, inflation)

	Marginal Significance Levels			
			Lags of	
Equation	Federal funds	M2	Unemployment	Inflation
Federal funds	.0000	.1060	.3003	.3911
M2	.0000	.0033	.7979	.0322
Unemployment	.1163	.6812	.0000	.6765
Inflation	.0362	.8822	.6827	.0006

Tests for dropping variable from four-variable system

M2	$\chi^2(18) = 18.66$	(.4129)
Federal funds	$\chi^2(18) = 65.04$	(.0000)

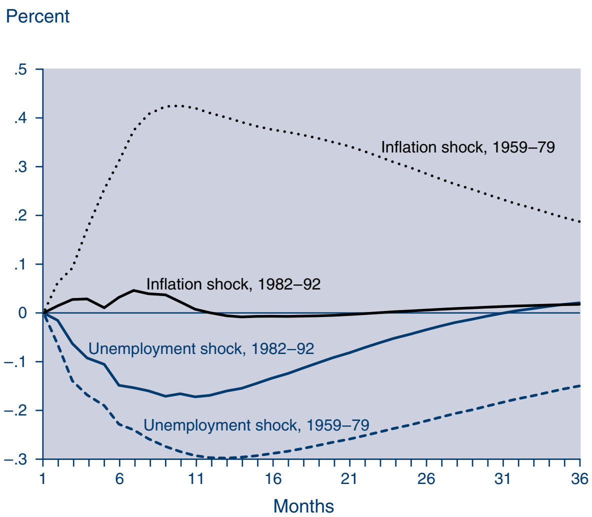
account for little of the variability in the federal funds rate in the later period. This finding raises questions about the traditional monetary policy interpretation of the federal funds rate, since that interest rate does not appear to respond to inflation shocks in the post-1982 period.[13] Additionally, the variance decompositions indicate that a larger percentage of the forecast variance in the federal funds rate can be attributed to uncertainty about innovations to the federal funds rate itself. It seems the federal funds rate has become more independent of the other variables in the VAR during the 1980s.

Figures 4 and 5 present impulse responses for the post-1982 period for the three-variable VAR.[14] Figure 4 displays the reaction of the federal funds rate to unexpected increases in inflation and unemployment. The response of the federal funds rate to an unexpected increase in the unemployment rate in the post-1982 period is less than that in the previous period, although it does indicate a loosening of monetary policy in response to a surprise increase in unemployment. Additionally, the 90-percent confidence bands of the two responses overlap and, hence, are not statistically different from each other. On the other hand, the response of the federal funds rate to an unexpected increase

[13] *Again, the variance decompositions using the spread are similar except that uncertainty about future inflation contributes little to the forecast error variance of the spread (and vice versa) in both the earlier and later periods.*

[14] *The differences in the impulse responses between the two periods result mainly from differences in the estimated coefficients of the VAR equations and not from differences in the sizes of the standard deviation shocks. The size of the shocks for each variable are very close across the two periods.*

Figure 4
Responses of Federal Funds Rate to Inflation and Unemployment Shocks



in inflation does not correspond to a “lean against the wind” reaction function. The federal funds rate for the most part fails to respond at all to an inflation shock, and the confidence bands of the two responses do not overlap over a horizon of three to twenty months.[15] A “lean against the wind” policy would suggest an increase in the federal funds rate in response to a positive inflation shock. Therefore, whereas in the earlier sample a monetary policy reaction interpretation could be applied, in the 1982–92 period the response of the policy variables do not look like typical reaction functions.[16]

Finally, the response of unemployment and inflation to shocks in the federal funds rate casts further doubt on the interpretation of federal funds rate innovations as monetary policy changes in the post-1982 period (*Figure 5*). The response of unemployment to unexpected increases in the federal funds rate is negative in the post-1982 period rather than positive as in the 1959–79 period (the 90-percent confidence bands of two responses do not overlap after thirteen months). The response of inflation in the post-1982 period to a federal funds rate shock, as in the pre-1980 period, moves in the wrong direction but is much less persistent in the post-1982 period than in the earlier period.

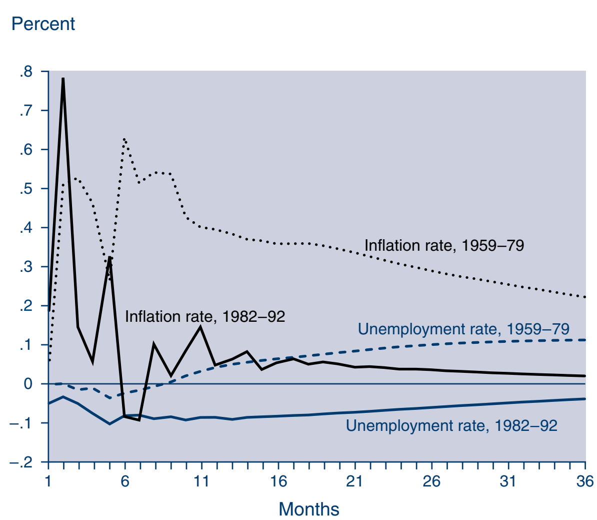
Thus, while the federal funds rate has become more important relative to M2 in explaining inflation and unemployment, it appears that the Federal Reserve no longer “leans against the wind” with respect to inflation shocks in the post-1982 period.

As a final note, the above results are robust to using the core-CPI inflation rate rather than just the CPI inflation rate and to trying to control for the effect of the decline in 1986 oil prices by introducing a dummy variable for this period into the VAR.

Possible interpretations of the results

As noted in the box on vector autoregressions, making economic inferences from estimated VARs is controversial. The fundamental difficulty is that the estimated relationships are derived from reduced-form equations. Thus, VARs provide evidence on correlations in the data, but these correlations may be consistent with a number of

Figure 5
Responses to Federal Funds Rate Shocks



[15] *The spread between the ten-year Treasury bond yield and the federal funds rate actually increases in response to a positive inflation shock.*

[16] *Supporting this point, lagged inflation is no longer statistically significant in the federal funds rate equation.*

Table 5

Forecast Error Variance Decompositions, November 1982–September 1992

Federal funds rate

Forecast horizon	Percentage of forecast error variance explained by			
	Federal funds	M2	Unemployment	Inflation
6	89.4	5.7	4.4	.6
12	75.7	10.6	12.4	1.2
24	72.5	11.6	14.3	1.5
36	73.3	12.7	12.7	1.3

M2

Forecast horizon	Percentage of forecast error variance explained by			
	Federal funds	M2	Unemployment	Inflation
6	18.6	63.1	.3	18.0
12	24.4	56.7	1.4	17.5
24	28.7	52.8	2.2	16.3
36	32.2	50.2	2.5	15.1

Unemployment rate

Forecast horizon	Percentage of forecast error variance explained by			
	Federal funds	M2	Unemployment	Inflation
6	22.6	.6	76.5	0.3
12	21.3	1.3	75.3	2.1
24	23.4	1.8	70.3	4.5
36	26.6	2.6	66.2	4.5

Inflation rate

Forecast horizon	Percentage of forecast error variance explained by			
	Federal funds	M2	Unemployment	Inflation
6	11.0	3.6	1.7	83.7
12	11.5	4.2	3.2	81.0
24	12.3	4.3	3.7	79.8
36	12.6	4.3	3.7	79.3

economic theories.[17] In this section, we discuss several plausible interpretations of the changed relationships found from the VARs above. These interpretations rely on developments in monetary policy issues that arose during the 1980s.

That the Federal Reserve no longer "leans against the wind" with respect to inflation in the post-1982 period is somewhat surprising given the supposedly higher premium the Federal Reserve put on price stability during this period. Economic models of monetary policy indicate that a monetary authority's increased desire to fight inflation results in policy's being tightened more severely in the case of an unexpected increase in the inflation rate (Ball 1990 and Alogoskoufis and Smith

17 In other words, the economic theories have "observationally equivalent" reduced forms.

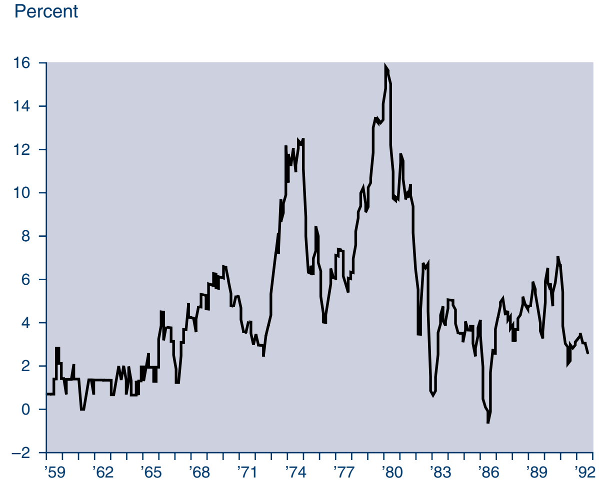
1991). If the federal funds rate is a good indicator of monetary policy, these results indicate just the opposite: the policy response to an increase in the inflation rate became muted during the 1980s.

One plausible explanation of the results that reconciles the muted response of the federal funds rate with an increase in the Federal Reserve's resolve to fight inflation is evidence that the behavior of inflation changed during the 1980s. Inflation since the early 1980s exhibits substantially less persistence than in the previous period, so that increases in inflation one month are temporary and, in fact, tend to be followed by a decrease in the next month (Emery, forthcoming). This change in the persistence of inflation is reflected in the difference between the response of inflation to federal funds shocks in the two periods noted in Figure 5. The behavior of inflation during the 1980s implies that lagged values of inflation provide little information about inflation in the future. As a result, unexpected movements in inflation, as measured by the VAR, no longer require a monetary policy response.

An additional explanation is that the Federal Reserve has abandoned a "lean against the wind" policy and instead conducts monetary policy in a more forward-looking manner. That is, the Federal Reserve increases the federal funds rate in anticipation of inflation so as to not get behind the curve with respect to fighting inflation. Since low-dimension VARs, such as the ones examined in this article, probably do not reflect all the information available to the monetary authorities at the time policy decisions are made, the estimated impulse response function for the federal funds rate may not adequately capture the forward-looking nature of monetary policy.

Sims (1992) uses a similar argument in explaining the perverse inflation response to a federal funds rate innovation. Because the VAR does not reflect all the information available to the monetary authority when it conducts policy, the federal funds innovations in these VARs still reflect systematic policy responses. Therefore, the positive response of inflation to a positive federal funds innovation is really capturing the increase in the federal funds rate in anticipation (correctly) of inflation. The resultant tightening is not sufficient to completely eliminate the subsequent inflationary pressures. If, indeed, this price puzzle does

Figure 6
U.S. Inflation
(Six-month moving average)



SOURCE OF PRIMARY DATA: Bureau of Labor Statistics.

reflect a forward-looking Federal Reserve, then because this price puzzle is present in both periods (even more so in the earlier period, as indicated in Figure 5), it appears that the Federal Reserve is not substantially more forward-looking in the 1982–92 period than in the 1959–79 period.

Of course, it is very possible that the two explanations offered here are related. A more forward-looking Federal Reserve could conceivably be better able to diminish the persistence of inflation by effectively offsetting fluctuations in the underlying trend inflation rate, so that the price level effect is diminished. Many analysts have maintained that the Federal Reserve stabilized the inflation rate around 4 percent during most of the 1980s (Goodfriend 1992) and that as a result of this policy, deviations of inflation away from 4 percent were temporary. By contrast, movements in inflation before 1980 tended to be more indicative of rising or ebbing inflationary pressures because the Federal Reserve did not respond quickly enough to changing price pressures (*Figure 6*).

Conclusions

The vector autoregression evidence on the federal funds rate as an indicator of monetary policy weakens when the period since 1982 is examined. Specifically, in contrast to the pre-1980 period, the federal funds rate no long displays a "lean against the wind" response to inflation—that is, it does not increase in response to unexpected increases in inflation. However, this change does not necessarily imply that the federal funds rate is no longer an indicator of monetary policy. The vector autoregression results indicate that after 1982, the federal funds rate responds to unexpected changes in the unemployment rate in a manner similar to that before 1980 and consistent with a traditional monetary policy interpretation. Furthermore, there exist several possible explanations that are consistent with a monetary policy interpretation of the federal funds rate.[18]

Nonetheless, the main message of this article is to highlight how correlations between important macroeconomic variables can change when institutions or policy regimes change. While the federal funds rate may still be a good indicator of monetary policy, its relationship with unemployment and inflation is now clearly different from what it was before 1980.

[18] *See Goodfriend (1992) for a narrative approach that supports the use of the federal funds rate, in addition to other long-term rates, as a good indicator of monetary policy during the 1980s.*

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Demographics and the Long-Term Outlook for Housing Investment

Housing construction has been a driving force behind U.S. economic recoveries. On average, residential construction has accounted for two-thirds of the increase in final sales during cyclical upturns (Perry and Schultze 1993). In the most recent recovery, however, homebuilding activity has been modest, accounting for less than a third of the increase in final sales. With housing affordability at a twenty-year high, those in the industry are puzzled and concerned by the lackluster growth of home construction.

Why has the housing industry not boosted the economy as much during this recovery? Demographics would seem to be an important part of the answer. The average annual increase in the population aged 25 and over is projected to fall from the 2.6 million experienced during the 1980s to 1.7 million in the 1990s. As growth in the adult population slows, so will the demand for new housing.

The purpose of this article is to measure the importance of projected shifts in the size and age distribution of the U.S. population for the rate of growth in housing demand (that is, net housing investment). We wish to give the reader a sense of just how much and for how long the population slowdown is likely to restrain housing demand. The analysis runs through the first decade of the next century and provides separate estimates for single-family and multifamily housing.

Our results indicate that the contractionary effects of the population slowdown are already being felt in the housing industry and probably have been at work since the latter part of the 1980s. In our simulations, changes in the size and age distribution of the population lower net housing investment by 17 percent from the late 1980s through the first half of the 1990s. Population factors then reduce net investment an additional 22 percent from the mid-1990s through the first half of the first decade of the next century before turning favorable.

On a percentage basis, the effects of the population slowdown are greatest in multifamily building. Population shifts reduce net investment in multifamily units by 60 percent from the late 1980s through the end of this century. Single-family building is not spared, however. Population factors decrease net investment in single-family homes by one-third from the late 1980s through the middle of the first decade of the next century.

Are the demographics inexorable? Is it possible that changes in immigration policy could offset the slowdown in the native population? The numbers show that to stave off a decline in new home construction, immigration quotas would have to be doubled, from the current limit of 700,000 people per year to around 1.5 million per year.

We also investigate whether the effects of the population slowdown could be reversed by changes in cohabitation patterns. In the scenario most favorable to housing investment, we assume that high economic growth encourages substantial new household formation and that baby boomers, who in their younger years had less of a taste for marriage than did their parents, continue to live as single adults in relatively high proportions. The implied changes in household formation have a

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strong effect on the mix of new housing demand, greatly favoring multifamily investment. However, these changes can only reduce the projected decline in total net investment from 36 percent to 22 percent from the late 1980s through the early part of the twenty-first century.

Population shifts may not be the only influence on housing demand over the next few decades. Housing demand is also greatly affected by interest rates and tax laws. But given what we know about the size of the decline in births following the end of the baby boom, demographics are certain to play a major role in the future of the U.S. housing industry. Any long-term assessment of housing demand must begin with basic population arithmetic.

Framework for analysis

To calculate the effect of demographic shifts on housing demand, we use a method similar to the one developed by Jaffee and Rosen (1979). We begin with individual population projections by age group and use historical headship rates to estimate the household population by age of household head and type of household (family or nonfamily). Projections of housing demand by type of home (single-family or multifamily) then are developed by combining the estimates of household population with historical propensities to demand housing of a particular type by age and type of household.

The computational framework is given formally by

$$(1) \qquad HSF = K_s \sum_i POP_i [f_i \theta_{fi} + n_i \theta_{ni}]$$

and

$$(2) \qquad HMF = K_m \sum_i POP_i [f_i (1-\theta_{fi}) + n_i (1-\theta_{ni})],$$

where *HSF* and *HMF* are the stock demands for single-family and multifamily housing in a given year; K_s and K_m are scale factors; POP_i is the number of people in age bracket i; f_i is the likelihood of a person of age i heading up a family household (the family headship rate); n_i is the likelihood of a person of age i heading up a nonfamily household (the nonfamily headship rate); θ_{fi} is the likelihood that a family household headed by a person of age i would occupy a single-family home; and θ_{ni} is the likelihood that a nonfamily household with head of age i would occupy a single-family home.

In our basic population analysis, all of the terms in equations 1 and 2 are treated as constants, except for the population data. We simply run the population numbers through the equations to see how much of an effect on housing investment we should expect from population shifts alone.

To specify the equations, the scale factors K_s and K_m were chosen so that the two simulated series on net investment would replicate, respectively, the average value of new single-family and new multifamily homes put in place during the period 1970–89. The resulting values are $K_s = 73.2$ and $K_m = 45.0$, both in thousands of 1982 dollars. Values used for the remaining parameters are based on 1980 data and are shown in Table 1. The headship rates are Bureau of the Census estimates. Following Census convention, family households are either married couples or single-parent households with at least one child. Nonfamily households include singles and two or more unrelated individuals sharing a residence. The propensities to occupy single-family housing are from the Current Population Survey.

Especially important to the analysis are the terms in brackets in equations 1 and 2. These terms represent the number of single-family and multifamily housing units demanded per capita. Their values are shown in the last two rows of Table 1. Within the adult age categories, the most significant variation in the numbers occurs between the age groups 25–34 and 35–44. The frequency of single-family home demand rises by a third and that of multifamily demand falls by a little more than a third as households move from one age group to the next. These differences in per capita housing demand play a significant role in our analysis, because every member of the baby boom generation passes between these age groups sometime during the 1980s and 1990s.[1]

[1] *The baby boom generation refers to those born between the years 1946 and 1964.*

Table 1
Anatomy of Per Capita Housing Demand in 1980 by Age Group and Type of Structure

	Age of householder					
	<25	25–34	35–44	45–54	55–64	≥65
Headship rates, by type of household						
Family (f_i)	.04	.36	.47	.47	.43	.34
Nonfamily (n_i)	.03	.11	.07	.08	.13	.29
Percent of households occupying single-family homes, by type of household						
Family (θ_{fi})	.55	.75	.86	.88	.89	.86
Nonfamily (θ_{ni})	.31	.38	.46	.55	.63	.62
Single-family homes per capita ($f_i\theta_{fi} + n_i\,\theta_{ni}$)	.03	.32	.43	.46	.46	.46
Multifamily housing units per capita $[f_i\,(1-\theta_{fi}) + n_i\,(1-\theta_{ni})]$	.04	.16	.10	.09	.10	.17

The effect of population shifts on net housing investment

Equations 1 and 2 provide the analytical framework for measuring the effect on housing demand of shifts in the size and age distribution of the population. To carry out the analysis, we use population data for the period 1980–2010, with data through 1990 being Census estimates of actuals and data beyond 1990 being Census projections. The demographics have their most visible impact on the rate of growth in housing demand, or net housing investment. Thus, we show the calculated path of net housing investment (*Figure 1*). To help smooth the series, the results are presented as annual averages over five-year periods.

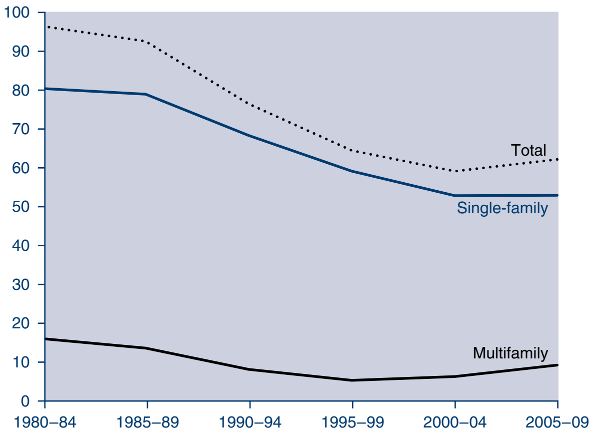
The first point to notice is that the population slowdown does not bring about an absolute decline in housing demand. Net investment remains positive throughout the forecast period. What the demographics do is reduce the rate of growth in housing demand. From the latter half of the 1980s through the period 2000–04, total net housing investment falls by 36 percent. On a percentage basis, the population slowdown is most important for multifamily building. Net investment in multifamily units declines by 60 percent from the late 1980s through the late 1990s. The demographics reduce single-family investment throughout the 1990s and into the first half of the first decade of the next century. Net investment in single-family homes falls by one-third over this period.

Table 2 details the results by age group. The most significant patterns in the numbers relate to the baby boom generation. Baby boomers enter the 35–44 age group in the early 1980s, producing a bulge in housing investment in that age bracket through the mid-1990s. We can then follow the bulge as the cohort matures. The bulge appears in the 45–54 age bracket beginning in the early 1990s, and it reappears in the 55–64 group at the turn of the century. The baby boomers also leave their mark as they vacate an age bracket. Their maturation is the reason for the absolute drop in housing demand in the 25–34 age group during the 1990s and in the 35–44 age group during the first decade of the next century.

Also noticeable, although much less signifi-

Figure 1
Net Housing Investment by Type of Structure: Simulated Series Based on Shifts in the Size and Age Distribution of the U.S. Population (Five-Year Averages of Annual Rates)

Billions of 1982 dollars



cant in size, is the effect of the baby bust generation born in the Great Depression. The relatively low number of births during the 1930s is the reason for the low net investment numbers in the 55–64 age group during the period 1985–94 and in the 65-plus age group during the period 1995–2004.

Housing and immigration policy

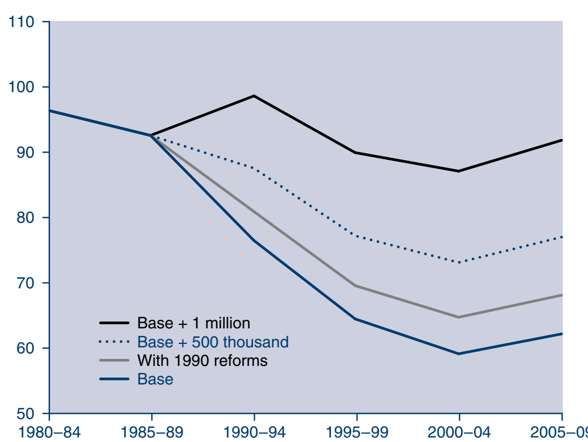
Our prediction that net housing investment will fall sharply over the next two decades is made essentially on the basis of a projected decline in the growth of the U.S. adult population. We can be confident in our assumptions about the future growth of the native population, because in a forecast that goes out no more than twenty years, the size of adult age groups can be estimated from known birth rates. The major risk in the population forecast is immigration. In this section we give the reader a sense of how much more open U.S. immigration policy would have to be if a slowdown in housing demand is to be avoided.

To quantify the impact of alternative immigration policies, we use the same algebraic framework as in the previous section but modify the population numbers to reflect an increased flow of immigrants. In our simulations, an infusion of new immigrants occurs each year beginning in 1991 and continuing throughout the forecast period. Upon arrival, these new immigrants are distributed across age groups in the same way as legal immigrants who were admitted into the United States between 1980 and 1988. Except for age, immigrants are identical to natives.[2]

The increase in immigration allowed for in the simulations is something over and above the immigration assumed by the Census Bureau in its projections. In the Census projections we used for our base case, net immigration was assumed to occur at a rate of about 500,000 people per year. These projections were made before the Immigration Act of 1990, which raised legal immigrant quotas to about 700,000 per year. We consider three alternatives to our base case. The first provides for an increase in flows of 200,000 immigrants per year. This case gives us a rough idea of how important the 1990 reforms will be to the

Figure 2
Housing and Immigration Policy (Simulated Net Investment)

Billions of 1982 dollars



[2] *There are, of course, significant differences between immigrants and natives. Most crucial for housing demand is that immigrants on average earn less income, even after a long assimilation period (see Borjas 1990). Thus, our simulations probably overstate the impact of new immigrants on housing demand.*

Table 2
Effect of Population Shifts on Net Housing Investment by Type of Structure and Age of Householder, 1980–2009
(Average Annual Rates, in Billions of 1982 Dollars)

	Age of householder						
	<25	25–34	35–44	45–54	55–64	≥65	Total
Change in demand for single-family homes							
1980–84	–1.1	21.4	38.0	–1.1	3.9	19.2	80.4
1985–89	–.1	7.8	38.4	19.4	–6.6	20.5	79.5
1990–94	.1	–13.8	28.2	39.1	–.3	15.0	68.3
1995–99	.2	–17.7	10.0	39.9	19.1	7.5	59.1
2000–04	.0	–5.3	–18.8	29.6	38.0	9.5	52.8
2005–09	–.1	7.3	–23.9	10.7	38.3	20.9	53.3
Change in demand for multifamily housing							
1980–84	–.1	6.6	5.6	–.1	.5	4.3	16.7
1985–89	–.1	2.4	5.7	2.4	–.8	4.5	14.1
1990–94	.0	–4.3	4.1	4.9	.0	3.2	8.0
1995–99	.0	–5.5	1.5	5.0	2.5	1.6	5.2
2000–04	.0	–1.6	–2.7	3.6	5.0	2.1	6.4
2005–09	.0	2.2	–3.5	1.3	5.0	4.6	9.5

housing industry. In our second case, immigrant flows are raised by 500,000 people per year. In a final scenario we assume immigration quotas are increased by 1 million per year.

The results are shown in Figure 2. As one would expect, housing investment rises uniformly with each successive increase in the quota limit. The 1990 reforms are seen to have a modest effect on housing investment. In the base case, net residential investment drops by 33 percent from the late 1980s through the end of the first decade of the twenty-first century. In the scenario with 1990 reforms, investment still falls by 26 percent. To avoid a decline in net housing investment, immigration quotas have to be raised to 1.5 million per year, more than double the amount under current policy.

Housing and headship rates

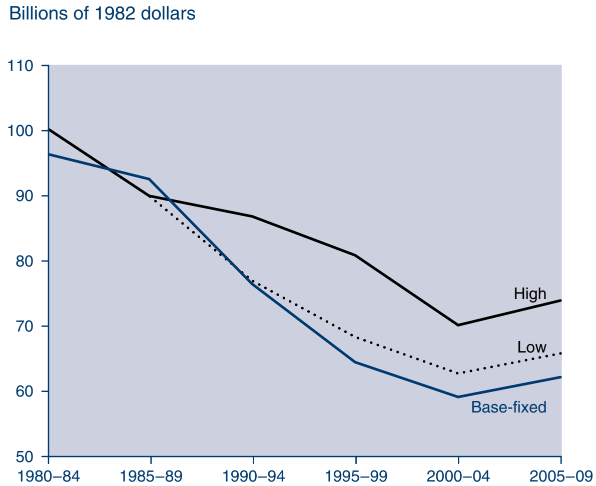
In projecting housing demand from demographic data, it is necessary to know not only how many people there are but how they group themselves into households. Over the past two decades, there has been a growing trend toward single-adult households. Rising divorce rates, delayed marriages, and greater societal acceptance of singleness have contributed to this trend. Because single adults have a higher propensity to rent apartments than do families, we would expect that the trend toward singleness has tilted the demand for housing away from single-family and toward multifamily units. With a greater number of households being formed from a given population, the overall level of housing demand may also have been raised.

The purpose of this section is to determine the importance of recent and possible future changes in cohabitation patterns for housing investment. We once again use equations 1 and 2, but now we allow headship rates to change over time. For the years 1980 through 1990 we use Census estimates of actual headship rates. For the years 1991 through 2010, we consider a range of possible values based on the work of Hendershott (1988). Hendershott's projections run from 1990 through the year 2000. We use these projections to extend the actual headship rates to 2000. For the first decade of the twenty-first century, we assume that the trends over the previous ten years continue but at only one-half the rate.

From the group of alternative scenarios suggested by Hendershott, we chose two that produce a wide range of possible outcomes for housing investment.[3] In the scenario we label "high," the projected headship rates are based on the assumption that economic growth will be high and that baby boomers will continue to have a strong preference for living as single adults, even as they grow older. In the "low" scenario, income growth is assumed to be low and there is a less rapid decline in the married-couple share of households.[4]

The results of the simulations involving changing headship rates are shown in Figures 3 through 5. For comparison, we also present the base case. Beginning with actuals, the changes in headship rates that occurred during the 1980s appear to have altered the mix of housing investment but not the total amount. Comparing the base case with the series simulated from actual headship rates, net investment in multifamily homes is raised 25 percent by the changes in headship rates. This rise is offset by a comparable absolute decline in single-family investment, however, so that total net residential investment is essentially unchanged.

Figure 3
Housing and Headship Rates: Alternative Scenarios Involving Changing Patterns of Cohabitation (Simulated Net Investment)
All Homes



Turning to the projections, the results from the "low" scenario are similar to those for the 1980s. The projected changes in headship rates have a large percentage effect on multifamily investment, but only a small effect on total investment. The total investment series with changing headship rates is, over the entire forecast period, only 5 percent higher than the base case series.

The changes in headship rates assumed in the "high" scenario have a more sizeable impact on housing investment. Once again the results are most dramatic in multifamily investment. The projected changes in headship rates almost double the average annual rate of multifamily investment. Because of substantial increases in total headship rates in this scenario, single-family investment is also raised, by an average of 11 percent over the forecast period. In total, net housing investment is 19 percent higher because of the projected changes in headship rates. These gains are not sufficient, however, to offset the contractionary effects of the population slowdown. Total net housing investment continues to fall in this scenario.

Long-run forecasts of multifamily building clearly must factor in the possibility of a continued trend toward single-adult households. Not to do so would understate investment by one-quarter or

[3] *In addition to the Hendershott scenarios, we considered an alternative forecast using projected headship rates from the Bureau of the Census. The results using these projections fell between the other two scenarios. Thus, we did not include these results in the text.*

[4] *Hendershott projects total headship rates (family plus nonfamily) on the basis of assumptions about future economic conditions. The relationships are consistent with the theory that privacy is a normal good. More households will be formed from a given population the greater the ability of the population to afford housing. The breakdown of total headship rates by type of family depends upon assumptions about future tastes for marriage.*

more. Future changes in cohabitation patterns are probably less crucial in the overall outlook for residential construction. We obtained numerically significant results for total housing investment only after making extremely aggressive assumptions about future rates of household formation. Even in this case, total residential investment is projected to fall 22 percent from the late 1980s through the period 2000–04.

Implications

Our analysis has focused on the rate of growth in housing demand, or net housing investment. We chose to present our results in this way because shifts in the size and age-mix of the population speak more directly to this variable than to any other. Those interested in the future of the housing industry, on the other hand, are probably more concerned with what the population slowdown will mean for construction jobs and home prices. We conclude with a discussion of what our results suggest will happen to these variables. In our discussion, we use results from the base-case simulations, with fixed headship rates. This represents something of a worst-case scenario. But absent a major liberalization of immigration policy or rapid economic growth, it may not be far off the mark.

Figure 4
Housing and Headship Rates (Continued)
Single-family

Billions of 1982 dollars

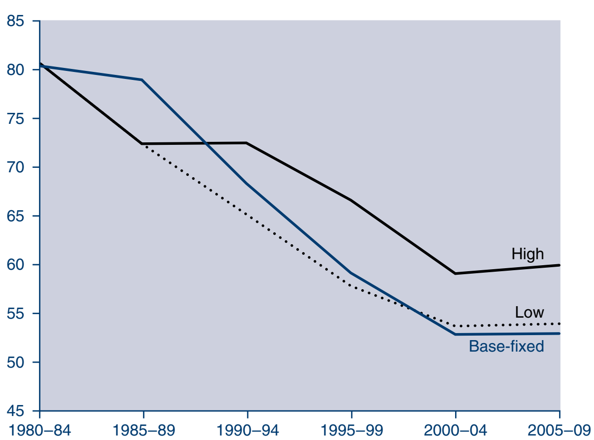
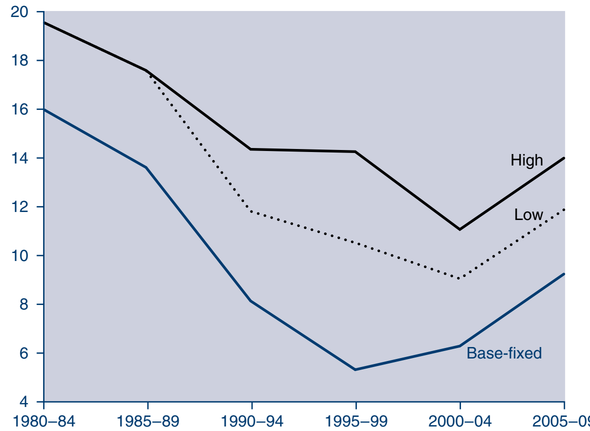


Figure 5
Housing and Headship Rates (Continued)
Multifamily

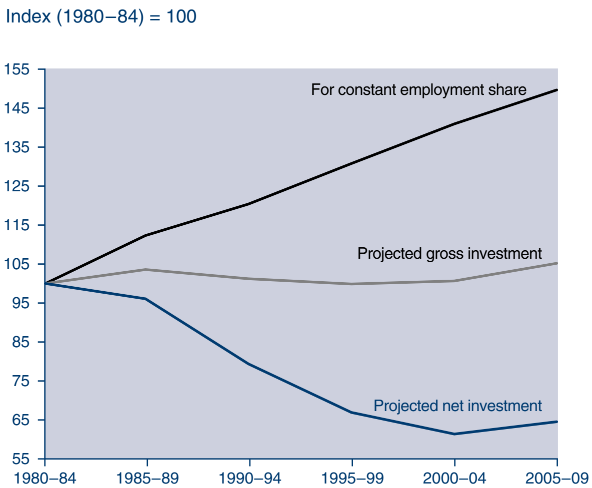
Billions of 1982 dollars



To assess the outlook for residential construction employment, we need to think in terms of *gross* investment rather than *net* investment. That is, we need to consider the construction that is needed to maintain and replace worn out buildings as well as that required to provide for a growing household population. To obtain estimates of gross housing investment, we assume that the stock of single-family homes depreciates at an annual rate of 2.25 percent and that apartments depreciate at an annual rate of 4 percent. Gross investment, then, is the sum of net investment plus what is needed to offset depreciation. In Figure 6 we show the resulting series on gross residential investment, along with the baseline series on net housing investment. To make comparisons easy, we index each series to equal 100 over the period 1980–84.

The population slowdown will bring about a sharp reduction in net housing investment but no significant change in gross investment. Thus, the homebuilding industry need not contract absolutely. There will be little if any job growth, however, and the industry is certain to play a smaller role in the economy. The top line in Figure 6 shows how much gross investment would have to rise to keep pace with historical and projected growth in the U.S. labor force. The width of the gap between this line and the line on gross housing

Figure 6
Gross Investment Needed to Maintain Housing's Share of Employment



investment indicates the degree to which demographic changes will reduce the share of residential construction in national employment. With gross investment being essentially flat and the labor force growing about 50 percent from the early 1980s through the year 2010, housing's share of employment is reduced by one-third.

Turning to home prices, it is useful to think of the price of a home as reflecting two components: the price of the land and the price of the structure. Given a certain fixity in the supply of land suitable for residential development, land prices will move with the stock demand for housing—rising as housing demand rises and falling as housing demand falls. Our analysis shows that future demographic shifts will reduce the rate of growth in housing demand but not its absolute level. Housing demand will continue to rise over the foreseeable future. There is, then, no apparent reason for residential land prices to be weakened by the population slowdown. It is always possible that real estate markets have failed to appreciate the extent of the slowdown in housing demand, having capitalized excessively any future appreciation in land values and having set themselves up for a price correction. But this would be a matter of some speculation and certainly not a necessary consequence of the demographics.

With a rising supply price for new home construction, the price of residential structures will vary directly with the rate of gross investment demand. How much prices would fall in response to a decline in investment demand depends on the size of the drop in demand and the price elasticity of supply of new structures. From the work of Muth (1983), it is widely believed that the supply of new homes is highly elastic in the long run, ensuring a limited price adjustment whatever the shift in demand. Our analysis further suggests that the shift in demand is not likely to be large in the first place. In our simulations, the demographics halt the growth of gross housing investment, but they do not reduce it.

Considering both land and structures, it is difficult to see in the population numbers a compelling reason for average home prices to fall. Thus, we strongly disagree with the conclusion of Mankiw and Weil (1989) that home prices may fall by half over the next two decades because of the demographic slowdown. There is more potential, we believe, for relative price adjustments to take place between different types of homes. The stock demand for housing will fall sharply for households in the age group 25–34 during the 1990s and for those aged 35–44 during the first decade of the next century. Prices of homes specialized to suit people in these age brackets (starter homes, homes for families with young children) may well weaken. On the other hand, the demographics will serve to strengthen the prices of homes that are popular with older adults who have graduated their children, the so-called empty nesters.

The population slowdown is an important economic and social event with the potential to substantially reduce the importance of homebuilding in the economy and to alter the prices of some single-family homes. However, these changes will be consumer driven and so should not be resisted. The changes also will take decades to play out and are relatively easy to forecast. They would not seem to pose a significant threat to macroeconomic stability. Policymakers need to be well-informed about the extent of the change in the housing industry that can be expected from the demographics to avoid overstimulating the economy and causing undue delay in the process of structural change.

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A Primer on the Nature of Business Cycles

For a considerable time, economists have devoted much effort to obtaining a greater understanding of the causes of the business cycle, or (as it used to be called) the trade cycle. Business cycles, in themselves, are thought by many to be undesirable. Therefore, a greater understanding of the nature and causes of business cycles would be useful in leading to the development of government fiscal or monetary policies that alleviate their impact. Dynamic economic models developed in the past decade have been especially useful in enhancing our understanding of observed business cycles. Although the economics profession apparently still has some way to go to understand the full nature and causes of these fluctuations, it is possible at this stage to describe which features or sectors of economies contribute the most to observed business cycles.

Economists and analysts sometimes disagree about what might be the primary source of observed business cycles. Some might say that these cycles are caused by changes in technology, while others would ascribe much of the culpability to the behavior of government or central banks. The point of this article is not to settle this issue, nor even to describe the controversies. Instead of focusing on issues on which economists may disagree, this article is intended to study the issues about which little disagreement can take place. Specifically, the intention here is to describe the behavior of observed economic aggregates over the course of the business cycle. This article, then, is to be a "user's guide" to obtain a better understanding of the business cycle in the United States in particular and in market economies in general.

The article is organized as follows. The next section will show exactly how the different components of aggregate output behave over the course of the business cycle. Additionally, the different categories of consumption and investment will be studied in more detail. The behavior of labor productivity over the course of the business cycle will then be analyzed. Lastly, the business-cycle properties of the U.S. and Canadian economies will be compared.

Defining the business cycle

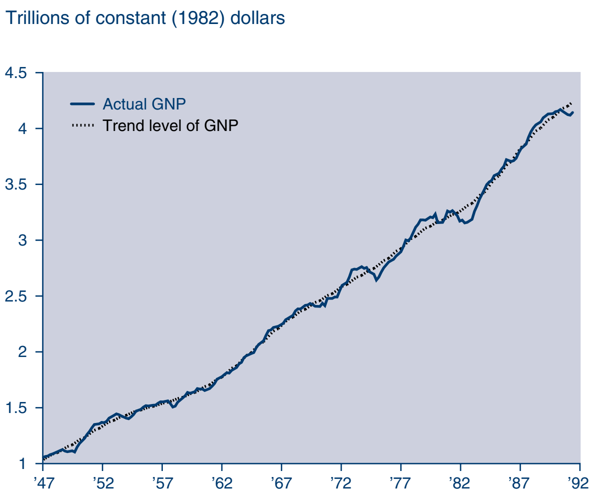
There are several different ways to define "the business cycle." Loosely speaking, the term usually refers to fluctuations of economic aggregates around their trend values. This is easily understood by looking at Figure 1. The solid line is the actual time path of the U.S. gross national product from the first quarter of 1947 through the third quarter of 1991.[1] The dotted line is what one might identify as the trend value of output over the same period.[2] The difference between these two lines will be referred to as the fluctuation of actual output around its trend value. Fluctuations of output above and below its trend are what is usually referred to as the business cycle. (See the

The comments of Stephen Brown, Kenneth Emery, and Mark Wynne are gratefully acknowledged.

[1] *The data are in 1982 dollars. This data set is the most recent for which government spending is available back to 1947.*

[2] *It should be noted that there are several ways to describe the behavior of the trend of an economic aggregate such as GNP. The method here is that employed in Hodrick and Prescott (1980). This method happens to give rise to a variable trend growth rate. An alternative description of the trend would change the definition of the cycles. However, for the most part, the magnitude and correlations of these fluctuations, described later, would be roughly the same even with an alternative definition of the trend.*

Figure 1
Actual and Trend Levels of GNP



SOURCE OF PRIMARY DATA: U.S. Department of Commerce.

box titled "Is There a Trend in Economic Time Series?" on page 40.)

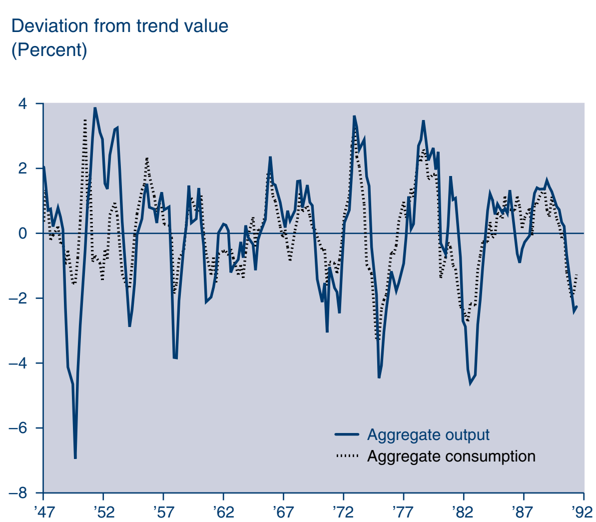
Obviously, aggregate output is not the only economic aggregate that exhibits growth and fluctuations; almost all the aggregates do. Therefore, for any such aggregate, its business-cycle fluctuations can be described as the fluctuations around its trend value.

Aggregate spending in the United States can be separated into its components of aggregate consumption spending, investment and government spending, and exports and imports. Furthermore, these aggregates can be broken down into narrower categories, as will be shown later. It is then enlightening to inquire, Which components of aggregate output contribute to its observed fluctuations?

Consumption. In Figure 2, the fluctuations of aggregate output around its trend are the solid line. The vertical axis is a measure of the percentage deviation of the variable from its trend value. The dotted line represents the fluctuations of aggregate consumption. Analysis of this diagram reveals that the fluctuations in aggregate consumption are somewhat smaller than those of aggregate output. Perhaps this is not too surprising. Consumers apparently wish to "smooth" their consumption patterns: they do not increase their spending too much when times are good and do not cut back too much when times are bad.

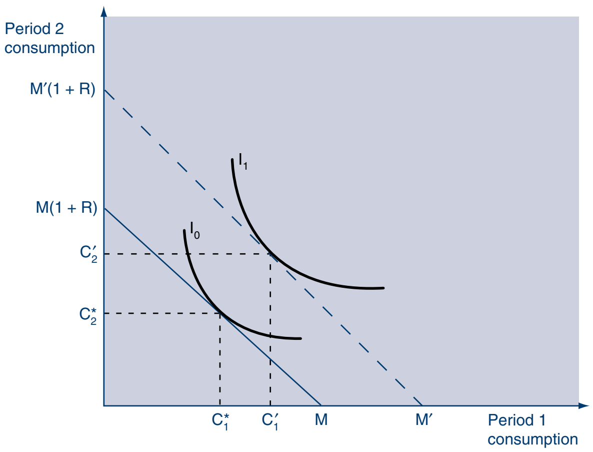
The reason for this behavior can perhaps be best illustrated by the simple microeconomic experiment depicted in Figure 3. This diagram illustrates the choices open to an agent who must make consumption choices in two time periods. The horizontal axis measures the amount of consumption in the first period, while the vertical axis measures second-period consumption. The agent can spend M units on consumption in the two periods, and R is the net real interest rate. M represents the maximum real discounted value of consumption in the two periods. Given this information, the agent will then have indifference curve I_0 tangent to the budget constraint with wealth M. The agent will choose to consume C_1^* in the first period and C_2^* in the second period. Should some event occur, such as an increase in wealth from M to M', the agent can afford to consume more. The diagram illustrates the case in which the agent chooses to consume more in each period and, so, consumes C_1' in the first period and C_2' in the second period. This is the sense in which consumers are said to want smooth consumption patterns.[3]

Figure 2
Aggregate Output and Consumption



[3] *This is nothing more than a restatement of the permanent income hypothesis, as described by Milton Friedman (1957).*

Figure 3
Consumption Choices over a Two-Period Horizon



A practical illustration of such a phenomenon is that a person who wins a lottery and has a large increase in income, or a person who temporarily loses his job and has a decrease in income, rarely changes consumption purchases by an amount equal to the change in income but, instead, spreads the change in income out by changing both present and future levels of consumption purchases.

Consequently, with this analysis in mind, it is not surprising to observe that aggregate consumption does not exhibit pronounced fluctuations relative to those of aggregate output. Although aggregate consumption obviously fluctuates, its fluctuations could hardly be said to be the driving force behind aggregate output fluctuations. For aggregate output to fluctuate as much as it does, some component of output other than consumption must fluctuate more than does consumption.

Figures 4 through 6 present a further breakdown of the behavior of aggregate consumption. Figure 4 shows that the consumption of nondurable goods fluctuates very little relative to the level of aggregate output. Figure 5 illustrates similar behavior for the consumption of services. On the other hand, Figure 6 shows that the consumption of durable goods fluctuates much more than does the level of aggregate output. This diagram indicates that consumer purchases of such items as appliances and automobiles increase (decrease) *substantially* when output is growing (falling) relative to its trend value.

The behavior of the various components of aggregate consumption is further illustrated in Table 1. The first column indicates the relative volatilities of the components of aggregate output, as measured in percentage standard deviations, for the sample period. The percentage standard deviation of aggregate output over the period is 1.92 percent, and aggregate consumption fluctuates slightly less than does aggregate output. Nondurables consumption and consumption of services fluctuate less than does total consumption, but the consumption of durable goods fluctuates more.

The second column of Table 1 shows how the various aggregates are correlated with aggregate output. The closer are these numbers to 1, the more likely the relevant variable will tend to move in the same direction as aggregate output. It is clear from the table that all categories of consumption are procyclical; that is, on average, they tend to grow when aggregate output grows and to decline when output declines. However, these variables differ in the amount of fluctuation over the course of the business cycle.

Because of the relatively small fluctuations in aggregate consumption, some researchers have indicated that the presence of business cycles should

Figure 4
Aggregate Output and Nondurables Consumption

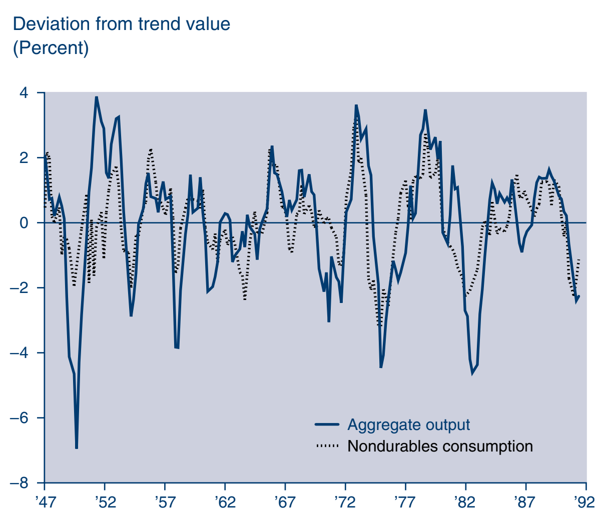


Table 1
Cyclical Behavior of Various U.S. Economic Time Series, 1947:1–1991:3

	Percentage standard deviation	Correlation with output
Aggregate output	1.92	1.000
Aggregate consumption	1.24	.681
Durable goods	5.36	.441
Nondurable goods	1.23	.635
Services	.71	.671
Aggregate investment	8.72	.777
Producer durable equipment	6.25	.793
Nonresidential structures	4.55	.476
Residential structures	10.77	.422
Aggregate government	4.38	.346
Federal defense	9.31	.411
Federal nondefense	12.11	–.164
Exports	6.92	.427
Imports	5.04	.647
Inventories	1.90	.645
Hours of work	1.85	.898
Labor productivity	.86	.302

SOURCE OF PRIMARY DATA: U.S. Department of Commerce.

not be a matter of great concern.[4] The reason is that consumers, for the most part, care about the quantity of goods they are able to consume. However, as indicated in Table 1, the quantity of aggregate consumption does not fluctuate very much over the course of the business cycle.

Table 2 shows how the components of consumption change as output changes at various lags.[5] All components of consumption are fairly highly correlated with output several quarters in the future. This means that purchases of consumption goods will begin to increase even before other components of aggregate output begin to rise and will fall before aggregate output begins to fall.

Investment. Figure 7 presents a comparison of the fluctuations in aggregate output and those of aggregate investment. It is apparent that the fluctuations in investment are *much larger* than those in output. Table 1 also illustrates the relatively large volatility of investment. Not all categories of

[4] For example, Lucas (1987) constructs a model that allows him to ask how much average lifetime consumption the typical consumer would be willing to forgo to fully insure himself against future consumption fluctuations. For a wide range of plausible parameter values, Lucas finds that such a consumer would be willing to give up less than one-tenth of 1 percent of the average consumption level to rid himself of these fluctuations. This is not to say that consumers or policymakers should be indifferent about business cycles. Instead, the implication is that the societal costs of the fluctuations are likely to be small relative to the costs imposed by, say, distortional fiscal policy or compared with the benefits to be gained by even moderate increases in the consumption growth rate.

[5] Table 2 measures the simple correlations of aggregate output and the past or future levels of various components of consumption. For example, the correlation of output with the level of purchases of consumer durables two quarters ago is 0.465. The correlation of output with the level of consumption of services three quarters in the future is 0.181.

Figure 5
Aggregate Output and Services Consumption

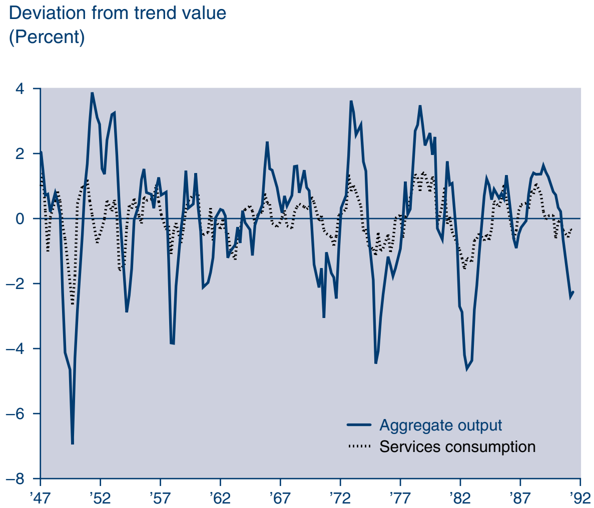
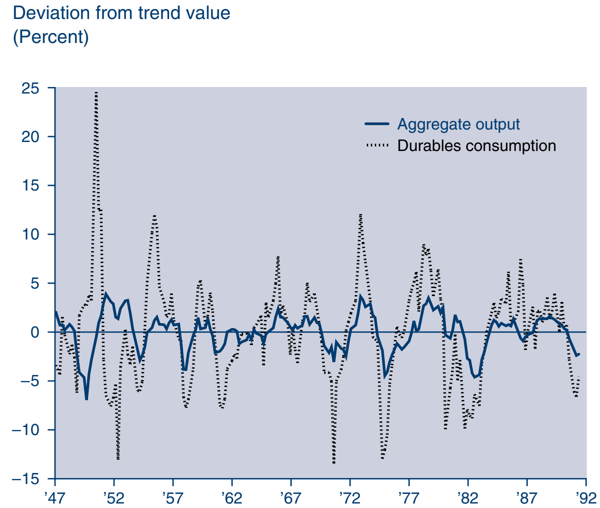


Figure 6
Aggregate Output and Durables Consumption



investment, however, behave in the same manner over the course of the business cycle. In particular, investment in producer durable equipment and investment in residential structures are especially volatile. Nevertheless, all components of aggregate investment are procyclical.

As Table 1 indicates, of all the components of aggregate output, aggregate investment and its subcomponents apparently are likely responsible for most of the observed fluctuations in output. Investigating the behavior of each subcomponent of aggregate investment reveals which fluctuates most over the course of the business cycle. As shown in Table 1, investment in residential structures (houses and apartments) exhibits extreme fluctuations, with investment in producer durable equipment and nonresidential structures being somewhat less volatile but still more volatile than aggregate output itself.

Table 3 shows how the different components of investment behave at different points in the business cycle. In the first column, the correlation between aggregate output and residential investment two quarters ago is 0.610, a relatively high value. Apparently, just before the growth rate of aggregate output begins to rise (fall), residential construction begins to rise (fall). Hence, one might think of residential construction as a leading indicator of aggregate output. The behavior of nonresidential investment is not at all similar to that of residential investment. The correlation between aggregate output and nonresidential investment two quarters ago is 0.016. However, the correlation of output and nonresidential investment two quarters in the future is 0.557. This might mean that producers or firms are reluctant to undertake this type of fixed invest-

Figure 7
Aggregate Output and Investment

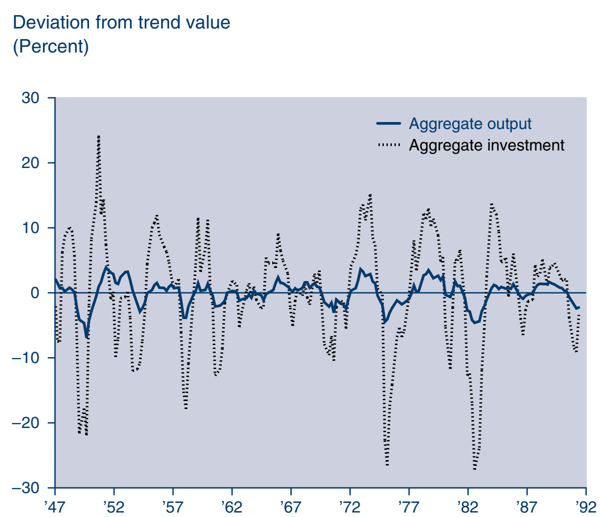


Table 2
Correlation of Various Components of Consumption with Aggregate Output for United States at Various Lags

Lag length (Quarters)	Correlation of output: With consumption of durable goods	With consumption of nondurable goods	With consumption of services
8	.065	–.211	–.243
7	.127	–.099	–.207
6	.187	–.039	–.130
5	.253	–.191	–.009
4	.348	–.335	.187
3	.411	.455	.397
2	.465	.575	.580
1	.480	.648	.692
0	.441	.635	.671
–1	.249	.520	.518
–2	.033	.339	.336
–3	–.201	.139	.181
–4	–.346	–.013	.043
–5	–.424	–.146	–.058
–6	–.387	–.223	–.115
–7	–.343	–.283	–.168
–8	–.268	–.307	–.211

ment until other components of output have already begun to increase.

Similar behavior is seen for investment in producer durable equipment. The correlation between aggregate output and investment in this equipment two quarters ago is 0.369, while the correlation for two quarters in the future is 0.674. Aggregate output is very highly correlated with investment in equipment in the same period, with a correlation coefficient of 0.793. Table 3 indicates that producers are willing to begin investment in durable equipment slightly earlier than in structures (nonresidential investment). This might be attributed to the fact that investments in equipment are typically smaller than those in structures, and producers are reluctant to make the larger investments until they are confident that sales have increased.

Table 3 also illustrates an interesting behavior for inventories. The correlation between aggregate output and inventories one to three quarters in the future is high. There is one obvious possible reason. As aggregate output rises, consumers increase their purchases of goods and thereby help deplete producer inventories, which firms, after several quarters, seek to replenish. Conversely, when aggregate output begins to fall, consumers hold off on these purchases, which helps to increase firms' inventories. Firms then move to lower the level of inventory holdings to minimize costs.

Table 1 and Figure 8 also show the behavior of aggregate inventories. This variable fluctuates to just about the same degree as does aggregate output. However, as will be shown, the *change in inventories* is also a component of aggregate investment, and it fluctuates tremendously.[6]

[6] *An increase or decrease in inventories of finished goods, semifinished goods, or raw materials is classified as an investment in inventories, and this is a component of aggregate GNP.*

As noted above, it is of interest to investigate which components of aggregate investment contribute most to the large fluctuations in the total. The prime candidate for being the primary source of these fluctuations would seem to be aggregate investment. Within this category, residential construction causes much of the fluctuations in total investment. However, another variable (excluded from Table 1) also contributes a great deal to the fluctuations in investment—namely, investment in business inventories. We can break down the variance of aggregate inventories according to this equation: $\Delta I = \Delta INVEN + \Delta OI$, where ΔI represents the *change* in total investment, $\Delta INVEN$ represents the *change* in inventory investment, and ΔOI is the *change* in all other forms of investment. This equation can then be used to show the following relationship for the respective variances:[7]

$$\text{var}(\Delta I) = \text{var}(\Delta INVEN) + \text{var}(\Delta OI) + 2\text{cov}(\Delta INVEN, \Delta OI).$$

This equation provides us with a tool to describe to what degree the changes in inventories are responsible for the behavior of changes in total investment. For the U.S. data, the values computed for the variables are as follows: $\text{var}(\Delta I) = 473.57$, $\text{var}(\Delta INVEN) = 269.64$, and $\text{var}(\Delta OI) = 125.27$. The covariance in the equation is of negligible size. In other words, changes in inventory investment apparently are responsible for a very large quantity of the change in total investment over the course of the business cycle. This is especially surprising because the average change in business inventories represents only 3.4 percent of average changes in *total* investment in the post–World War II period.

Figure 9 further illustrates this behavior. Shown here are the change in aggregate investment and the change in business inventory investment. From the diagram it is hard to see the difference between these two variables, but this is the important point. Despite the fact that business inventory investment is a very small portion of total investment, most of the changes in the latter variable from quarter to quarter are due to changes in inventory investment.

Figure 8
Aggregate Output and Business Inventories

Deviation from trend value
(Percent)

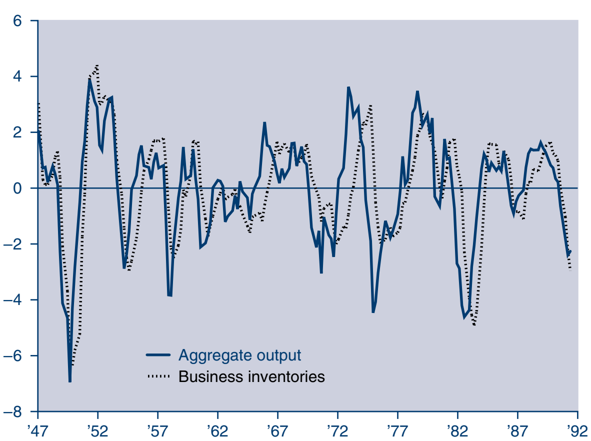
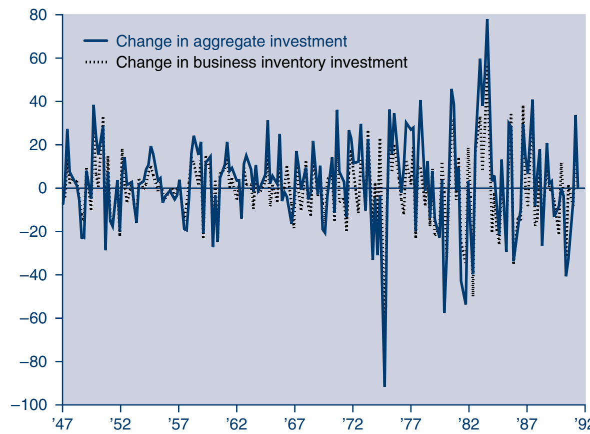


Figure 9
Changes in Aggregate and Business Inventory Investment

Billions of constant (1982) dollars



[7] *The variance of a variable is a measure of the degree of fluctuation exhibited by the variable in question. For example, if var(ΔI) equals zero, then it must be the case that the change in investment is always the same. Cov(ΔINVEN,ΔOI) is the covariance of the change in inventory investment and the change in all other forms of investment. This is a measure of the degree to which these two variables move together over the course of the business cycle.*

Table 3
Correlation of Various Components of Investment and Inventories with Aggregate Output for United States at Various Lags

Lag length (Quarters)	Correlation of output: With lagged residential investment	With lagged nonresidential investment	With lagged producer durable equipment	With lagged inventories
8	.032	–.335	–.336	–.351
7	.115	–.383	–.309	–.361
6	.213	–.413	–.259	–.368
5	.330	–.399	–.182	–.349
4	.468	–.331	–.056	–.283
3	.565	–.186	–.124	–.131
2	.610	.016	.369	.094
1	.572	.261	.614	.362
0	.422	.476	.793	.645
–1	.172	.561	.811	.805
–2	–.078	.557	.674	.844
–3	–.276	.466	.467	.766
–4	–.398	.337	.227	.596
–5	–.423	.201	.016	.392
–6	–.396	.060	–.136	.176
–7	–.350	–.043	–.248	–.022
–8	–.304	–.128	–.323	–.193

It should also be noted that by far the largest portion of business inventory investment is attributable to changes in inventories of nonfarm businesses.

Government spending, exports, and imports. Table 1 and Figure 10 indicate that total government spending is more than twice as volatile as aggregate output. Additionally, both defense spending and nondefense spending of the federal government are much more volatile than is aggregate output. Given this behavior of federal spending, government spending at the state and local levels clearly is much less volatile over the course of the business cycle.

Although total government spending is moderately procyclical, federal nondefense spending is countercyclical. This behavior might be attributed to what are sometimes referred to as "automatic stabilizers." That is, some types of government spending programs actually increase (decrease) more when aggregate output is declining (increasing), which contributes to the countercyclical spending pattern.

Table 1 and Figures 11 and 12 show that exports and imports are much more volatile than is aggregate output, but both are procyclical. Exports to other countries typically increase when income in the other countries increases and the foreign consumers demand more American-made goods. To the extent that income in other countries moves in tandem with that in the United States, one would expect U.S. exports to be procyclical. For identical (but reversed) reasons, U.S. imports also would be procyclical.

Productivity and employment hours. In analyzing the behavior of the business cycle, it is important to consider employment, or total hours of work, and labor productivity. Productivity refers to how much is produced, on average, by each hour worked. In other words, one usually gauges the productivity of the U.S. economy by calculating the quantity of goods and services produced and then dividing by the quantity of hours worked in producing those goods and services.

Figure 13 and Table 1 indicate that hours of work are about as volatile as is aggregate output over the course of the business cycle. But Figure 14 and Table 1 indicate that labor productivity is less volatile than output or hours of work. This is of interest because one might tend to believe that changes in productivity are closely linked to changes in hours of work. That is, when workers are most productive, it will be in the interest of employers to hire more workers or to have employees work longer hours. Apparently, however, relatively small changes in productivity help produce larger swings in the quantity of hours worked.

A well-known tenet is that the growth rates of some components of aggregate output increase before those of other variables. A variable whose growth rate increases just before a period of faster economic growth is referred to as a leading indicator of aggregate output.[8] It is important to investigate which variables exhibit this behavior and which variables exhibit faster growth after most other variables.

Analysis of Figure 14 shows why some people think of labor productivity as a leading indicator of aggregate output. Changes in productivity tend, on average, to be followed by changes in aggregate output, in the same direction, from three to five quarters later. Therefore, if labor productivity were to begin to rise substantially this quarter, one might reasonably expect aggregate output to increase in about a year. Note that Figure 14 shows that this sequence does not happen for every period but on average.

This relationship is illustrated in the middle column of Table 4, which lists the correlations between output and labor productivity at various lags. Changes in productivity provide practically no information about how output will behave two years into the future but are a good leading indicator of output at shorter ranges, such as one year. However, contemporaneous productivity and output exhibit a much weaker correlation. Note also that this relationship is not symmetric; output is a "negative" leading indicator of productivity.

This analysis illustrates why some economists suggest that the key to higher economic growth in the United States is to raise labor productivity. Table 1 indicates that a rise in labor productivity is likely to be accompanied by a subsequent increase in aggregate output. Furthermore, the more productivity rises, the more future output will

Figure 10
Aggregate Output and Government Spending

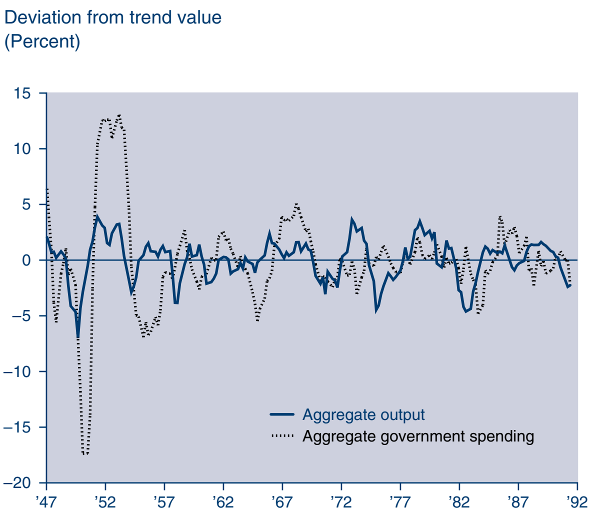
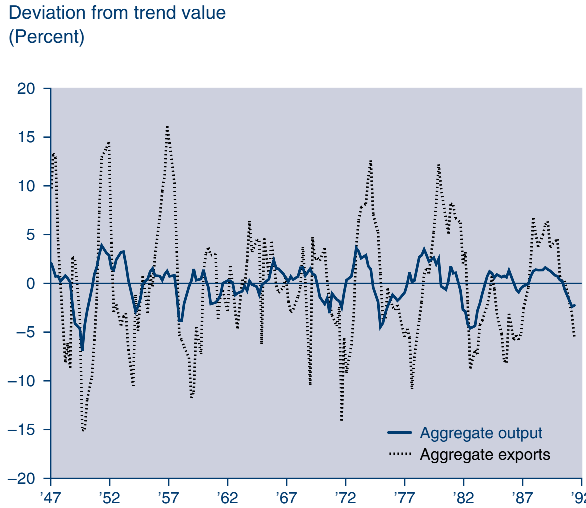
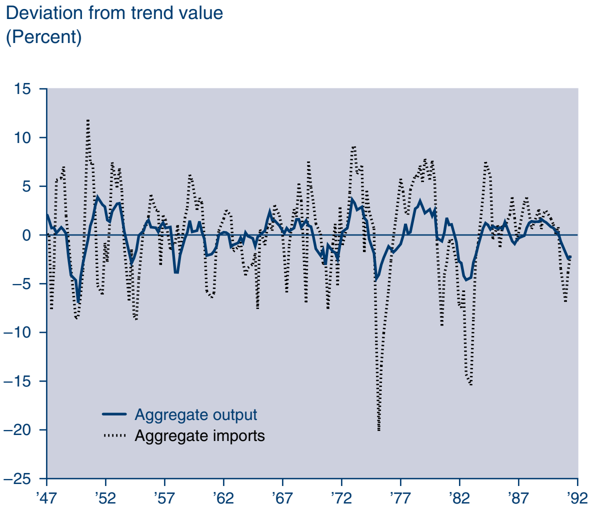


Figure 11
Aggregate Output and Exports



[8] *Productivity is only one of several measures of future economic activity. Koenig and Emery (1993) provide an analysis of the performance of the U.S. Commerce Department's composite index of leading indicators.*

Figure 12
Aggregate Output and Imports



increase. Figure 14 shows how the recent increase in productivity has apparently been accompanied by a subsequent rise in output, which has helped pull the U.S. economy out of the latest recession.

Table 1 and Figure 13 show that the level of output and total hours of work are very highly correlated. This is not surprising. If the quantity of goods and services produced is to rise, more work must be undertaken to produce the goods and services because, over short periods, increasing the use of labor is easier than increasing the quantity of capital. However, with output and employment tending to move in tandem, it is not surprising that labor productivity is a good leading indicator of future employment hours as well. The third column of Table 4 shows that a change in labor productivity tends, on average, to be followed by a change in employment hours, in the same direction, from four to six quarters later.

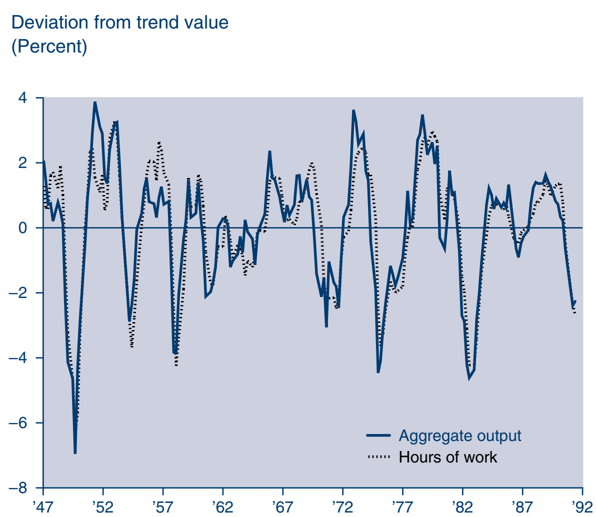
Lastly, labor productivity is not the only leading indicator or gauge of future economic activity. Table 3 indicates that, to some extent, residential investment and investment in producer durable equipment are leading indicators. They begin to increase just before aggregate output rises. In addition, Table 2 shows that consumption of nondurable goods and consumption of services are also leading indicators.

Some international comparisons

An appropriate question at this juncture is, How robust are the above-described features of the U.S. business cycle? That is, do all market economies exhibit the same sort of cyclical fluctuations as does the U.S. economy, or is each economy very special or different? If all economies exhibit very different types of business cycles, then the policy remedies used to deal with them might need to be quite distinctive. On the other hand, if economies exhibit similar business cycles, then unique and economy-specific policies do not have to be used.

Fortunately, many market economies apparently exhibit cyclical fluctuations that are very similar to those observed in this country. The Canadian economy is a good example. Table 5 presents statistics for the Canadian economy that are the counterpart of the U.S. statistics in Table 1.[9] The two economies are strikingly similar in many respects. First of all, both have aggregate invest-

Figure 13
Aggregate Output and Employment Hours



[9] *In 1991, Canada accounted for 20.4 percent of U.S. merchandise exports and 19 percent of U.S. merchandise imports. Japan, the next biggest trading partner, accounted for only 11.3 percent and 18.7 percent, respectively.*

Table 4
Correlation of Aggregate Output and Employment Hours with Labor Productivity for United States at Various Lags

Lag length (Quarters)	Correlation of output with lagged productivity	Correlation of hours with lagged productivity
8	.160	.262
7	.315	.427
6	.419	.521
5	.480	.561
4	.492	.523
3	.486	.441
2	.488	.301
1	.390	.095
0	.302	–.149
–1	.001	–.310
–2	–.183	–.400
–3	–.314	–.389
–4	–.343	–.343
–5	–.325	–.273
–6	–.294	–.219
–7	–.264	–.175
–8	–.220	–.134

ment that is much more volatile than aggregate output, which, in turn, is more volatile than aggregate consumption. For both countries, durable goods consumption is more volatile than nondurable goods consumption, which is more volatile than service consumption in both countries. In both economies, the variability of investment in residential construction is greater than that of producer durable equipment, which is greater than the variability of investment in nonresidential structures. Government spending, imports, and exports exhibit similar degrees of variability. The correlations of these economic time series with aggregate output for the respective countries are also similar.

There are other business-cycle features that are of much interest. Many models commonly used to study business cycles generally imply that movements in consumption in two different countries should be highly correlated. This implication is especially strong when the countries have a great deal of trade in goods and capital, as do Canada and the United States. The reason is simple. As illustrated earlier, there is a general presumption that consumers prefer smooth consumption patterns, rather than "feasting" today and "famine" tomorrow. If some temporary event in the United States causes consumers to cut back on consumption today, they should be able, at least to some

Figure 14
Aggregate Output and Labor Productivity

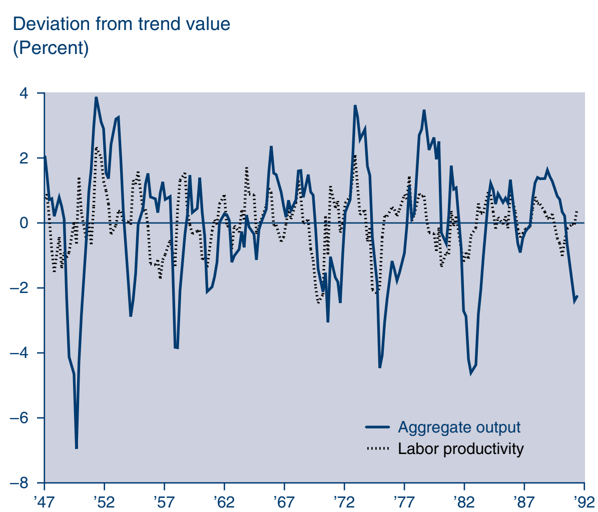


Table 5
Cyclical Behavior of Various Canadian Economic Time Series, 1947:1–1991:3

	Percentage standard deviation	Correlation with output
Aggregate output	1.84	1.000
Aggregate consumption	1.77	.753
Durable goods	6.96	.665
Nondurable goods	1.29	.478
Services	1.09	.471
Aggregate investment	5.01	.624
Producer durable equipment	7.79	.568
Nonresidential structures	6.29	.367
Residential structures	8.14	.370
Aggregate government	4.38	.184
Exports	4.04	.536
Imports	5.69	.762
Inventories	4.19	.300

SOURCE OF PRIMARY DATA: Statistics Canada.

extent, to borrow from abroad (through financial markets) to increase present consumption and pay back the loan by forgoing future consumption. Hence, even the vagaries of the business cycle should still leave consumption in different countries highly correlated, despite any other similarities or differences in aggregate behavior.

This description applies, in particular, to the presumed behavior of consumption of services and nondurable goods, because they are easily purchased. The general economic presumption, however, is that purchases of durable goods might be somewhat less correlated across countries. The reason is that consumers are somewhat inhibited in purchasing *and* selling durable goods to smooth their consumption paths of these goods. Furthermore, consumers sometimes have to acquire outside financing to purchase houses, cars, and televisions. Arranging such financing can be costly, and a consumer may be reluctant to purchase and sell numerous durable assets. Additionally, because of the relatively thin resale market in used consumer durable goods, it is costly for a consumer to trade in them to smooth consumption patterns.

Some economists would suggest that there is perhaps less reason to believe that the correlation of various categories of investment in two countries will be higher over the course of the business cycle than the correlation of, say, the components of consumption. Technological innovations in the two countries might make their investment change in a different manner. Lastly, there would seem to be little economic presumption that government spending in the two countries should be strongly correlated.

It is, then, of interest to see if these predictions are in accord with the data for Canada and the United States. Table 6 presents the correlations of the various aggregates in this country and Canada.[10] The correlation between aggregate output in these two countries is 0.637. However, except for government spending, none of the subcategories of GNP has a greater degree of correlation.

A very surprising result in Table 6 is that durable goods consumption and investment in

[10] *Backus, Kehoe, and Kydland (1992) document that for many countries, aggregate consumption is less highly correlated across countries than is aggregate production.*

Table 6
Correlation of the Components of Aggregate Output for Canada and United States

	Correlation coefficient
Aggregate output	.637
Aggregate consumption	.540
Durable goods	.578
Nondurable goods	.270
Services	.152
Aggregate investment	.194
Producer durable equipment	.387
Nonresidential structures	.260
Residential structures	.533
Aggregate government	.714
Exports	.393
Imports	.435
Inventories	.608

residential construction are two of the components of aggregate spending that are the most highly correlated in the United States and Canada. For the reasons described earlier, the components of aggregate output that are most likely to be highly correlated across countries—consumption of services and consumption of nondurable goods—have the lowest correlations. Durable goods consumption is more highly correlated than are the other components of consumption.

Inspection of Tables 1, 5, and 6 reveals that investment in residential construction in the United States and Canada is more highly correlated than it is with the output of their respective countries. Furthermore, both investment in residential structures and investment in producer durable equipment in the two countries are more highly correlated than is the consumption of services. These outcomes are especially surprising in light of the fact that the amount of trade in goods, services, and capital between the countries apparently is large and they have relatively similar economic systems.

In addition, Table 6 shows that the degree of correlation between government spending in the two countries is rather high, although there is no natural economic reason why it should be. Lastly, the degree of correlation of inventories in the countries is high as well.

Final remarks

This article has documented exactly how the various aggregates in the U.S. economy fluctuate over the course of the business cycle. Some aggregates increase just before aggregate output begins to rise, while other variables lag aggregate output. It has been shown that labor productivity is a leading indicator of aggregate output and that these two variables are highly correlated.

The article also shows that the business cycles observed in Canada and the United States since 1947 are very similar in many respects. There is a very strong parallel pattern between the aggregates in the two countries. This pattern of behavior does not mean, however, that their business cycles are coincident or identical. In fact, although economic theory might predict that various components of consumption in the two countries should be highly correlated, the data appear to indicate the opposite. For example, the correlation between the consumption of services and the consumption of nondurable goods is very low. Future research needs to be done to provide a greater understanding of this seemingly anomalous behavior.

Is There a Trend in Economic Time Series?

To some extent, analysts disagree about what is meant by "business cycle." Many would support the idea that this term should refer to the fluctuations of output around its trend value. However, there is also disagreement about what constitutes the trend value of output.

At one extreme is the view that the trend level of output grows at some *constant* rate of, say, 2.5 percent per year. People who support this view are said to maintain that output is trend stationary, with a constant trend growth rate. Fluctuations of actual output around this trend are referred to as the business cycle.

At the other extreme is the view that there is no identifiable constant "trend level of output" that would allow isolation of the business-cycle fluctuations. This view maintains that the future trend level is the level of output that the economy would produce in the future *if output grew at the current level forever*. That is, the economy is always on its trend path, and there are no deviations from trend. If the growth rate changed in the future, then the trend level would also change. This view is that the only fluctuations to be concerned with are changes in the growth rate or the trend, rather than deviations from trend. Researchers using this technique are said to view economic aggregates as growth or difference stationary. They might use the term "business-cycle fluctuations" to refer to the changes in the growth rates of the various economic time series.

The approach in the article here is somewhere between these two polar views. As Figure 1 shows, the trend (dotted) line is not a straight line. This means that the trend level of output *grows at a variable rate*. This way of decomposing the growth and fluctuation components of economic time series, suggested by Hodrick and Prescott (1980), has become popular in business-cycle research. King and Rebelo (1993) analyze this filter in detail and make some comparisons with other detrending methods. Christiano and Eichenbaum (1990) discuss whether it can even be determined if there is a trend in economic time series.

Just as analysts might disagree about what is meant by "business cycle," they might also disagree about what is meant by "recession" and "expansion." Does "recession" refer to periods when output is declining and, if so, declining for how long? Or does the term refer to when output is below trend and, if so, how much below which trend? One popular method for defining these terms is that used by the National Bureau of Economic Research. The NBER looks at a broad range of economic time series that can be said to characterize aggregate economic activity. It uses these data to identify peaks in economic activity—which help to identify the onset of recessions—and troughs—which indicate when the recessions have ceased. This approach is described in Zarnowitz (1992). The ancestor of this research is the original work of Burns and Mitchell (1946). More recently, Wynne and Balke (1993) describe similar dating schemes and use them to identify the asymmetries in the U.S. business cycle.

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