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Empirical Evidence on the Austrian Business Cycle Theory

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Abstract. The Austrian business cycle theory suggests that a monetary shock disturbs relative prices, such as the term structure of interest rates, systematically altering profit rates across economic sectors. Resource use responds to those changes, generating a cyclical pattern of real income. The divergence of the interest rate structure, from the previous and unchanged time preferences, means that the expansion is unsustainable and must end in recession. Quarterly data for eight U.S. business cycles, 1950:1 through 1991:1 are standardized by time period and used to explore business cycle facts and relations between money, interest rates, capacity utilization and income. Results are consistent with the hypotheses of the Austrian theory of a business cycle caused by a monetary shock and propagated by relative price changes.

JEL classification: E3.

The Austrian theory of the business cycle, as originally presented by Mises (1966, 1971) and Hayek (1967), implies several distinctive hypotheses about patterns of relative prices, the response of the income level and its composition, and the role of resource constraints. Business cycle theories demonstrate their power of explanation by hypothesis testing or by simulation in comparison to actual cycles. Since Burns and Mitchell (1946), "stylized facts" of cycles have become the behavior that needs to be explained. Austrian theory offers distinctive stylized facts about the cyclical behavior of real interest rates, changes in composition of capital structure, the relation of short-term to long-term interest rates, and the endogenous nature of expansion and contraction phases. Garrison (1986:449–450), Tullock (1988:74–76), and others have considered the empirical question of the explanatory power of the Austrian theory and whether the mechanism of price induced changes in the composition of the capital stock is sufficient in magnitude to account for the macroeconomic phenomenon of a business cycle. There is a clear need to consider how well the Austrian theory can explain observed cyclical behavior.

There have been few empirical analyses of the Austrian theory, due to limited ability to express Austrian concepts in operational terms and to methodological opposition to empirical testing of hypotheses. Mises (1966:56) claimed that "the impracticality of measurement is not due to the lack of technical methods for the establishment of measure. It is due to the absence of constant relations.... Statistical figures referring to economic events are historical data. They tell us what happened in a non-repeatable historical case." Within this methodology, empirical behavior could confirm or illustrate theory or characterize historical episodes, but would not be considered evidence in the evaluation of theory. The concepts of subjective economic behavior present widely recognized problems for measurement and statistical estimation, and the approach of methodological individualism places limits on the empirical analysis of macroeconomic phenomena. The Austrian business cycle theory, with its emphasis on the microeconomic structure of production over time is particularly susceptible to aggregation problems, with the implication that empirical analysis of business cycle phenomena should explore less aggregated macroeconomic data.

With awareness of these methodological issues, the statistical analysis presented here offers empirical evidence on the magnitude and reliability of Austrian explanations of the characteristics of the eight most recent U.S. business cycles. Could monetary policy shocks explain these cycles? Are there consistent relative price signals that guide the business cycle process? Are the responses large enough to explain business cycle behavior? Preliminary empirical evidence about the business cycle process supports the Austrian tenet that resource use and aggregate income respond to cyclical changes in interest rates.

Theory and Hypotheses

Hayek analyzed permanent real causes of changes in aggregate economic activity, such as changes in time preferences or the productivity of new technology, can which generate economic expansions. Since adequate saving is provided by such permanent real changes, price signals are not distorted, and there is not the inconsistency of plans and ultimate recession that monetary shocks create. To the extent that changes in post-war U.S. income were generated or affected by permanent real causes, the empirical analysis of this paper will only represent their patterns through the trends of real natural income.

Business cycle behavior has only monetary causes in the Austrian theory. Equilibrium in the credit market requires the balance of real flows of funds from saving and the demand for loans for investment, including changes in money supply and demand. The real interest rate represents several margins of productivity and preference, including the price margins between different stages of production (Rothbard 1970:315–316) and the marginal return to extending the time dimension of production processes. Wicksellian interest rate concepts (Trautwein 1996) may be explicitly adapted to the Austrian business cycle theory in developing empirical hypotheses. The value of the interest rate observed in the market when all monetary flows of funds are balanced is Wicksell's market rate. When asset stocks are unchanged and money supply and demand are balanced, the interest rate is Wicksell's natural rate which equates real flows of planned saving and investment. Only in general equilibrium will the natural rate be equal to the market rate.

An excess supply of money, due to a monetary shock, shifts the supply of loanable funds more than demand and depresses the market rate below the natural rate. The change in the value of the real money supply is temporary until the aggregate price level adjusts. The fall in the market interest rate may appear to be a permanent real change due to a change in the rate of savings and time preference. People may incorrectly perceive the lower, observable market rate to mean that the natural rate has fallen. People may view a change in the market interest rate as permanent or may incorrectly perceive the time path of the interest rate or the time length of the opportunity to profit from the low market rate. These sorts of monetary misperceptions are the origin of the cycle. The monetary shock version of the Austrian theory relies on the existence and empirical importance of the liquidity effect.

A business cycle fact is that rapid increases in the money supply constitute a shock and generate a liquidity effect. In the Wicksellian expression, the hypothesis is that a monetary shock causes the market interest rate to decrease relative to the natural interest rate during the expansion phase of the business cycle.

The credit market model can accommodate different interest rates for the short-term and long-term. The expectations hypothesis of the term structure of interest rates is that the interest rate on a long-term loan will equal the geometric average of expected interest rates on short-term loans over the intervening time period. Liquidity preference and related theories add a term premium for risk and liquidity adjustments. If market participants are risk averse and prefer more liquid to less liquid assets, the term premium reflects greater risk and less liquidity in long-term credit markets. The yield curve arrays rates of return by maturity of the financial instrument, and in general equilibrium, the yield curve would be characterized by a positive slope as term premiums increase with maturity. Then a monetary expansion will have a liquidity effect that lowers short-term interest rates to a greater degree than long-term interest rates (Romer 1996:395–396). Long-term interest rates are affected since they are an average of short-term rates, but the effect is moderated. Relative to its position and shape in equilibrium, the yield curve can be expected to shift down as both short-term and long-term rates fall, and to become steeper as short-term rates fall relative to long-term rates as a result of the monetary shock.

The Austrian concept of capital as multidimensional in value and time, heterogeneous in design, and inconvertible among uses requires a disaggregated model of investment. In the Asset Price model, as developed by Keynes and James Witte (1963), the supply of and demand for capital stock determine the asset price, desired capital stock and production of new capital. A fall in the market rate of interest increases the expected return to capital and increases both the asset demand and the asset price for capital. Given the higher asset price and the supply function for new capital goods, suppliers of new capital increase quantity supplied and the flow of investment increases. The business cycle should exhibit procyclical investment flows. With a heterogeneous concept of capital, there are differential shifts in demand by capital type, in response to a change in the interest rate, as illustrated by Hayek's graphs (1967:80). More capitalistic processes, with longer time periods until the final product is available, will experience a greater shift of demand for capital stock than will less capitalistic processes which are closer in time to final consumption. Hayek (1967: 82–83) related the interest rate directly to price margins between stages in the production structure: "The price of a factor which can be used in most early stages and whose marginal productivity there falls very slowly will rise more in consequence of a fall in the rate of interest than the price of a factor which can only be used in relatively lower stages of reproduction or whose marginal productivity in the earlier stages falls very rapidly."

The change in the interest rate causes a change in the allocation of investment resources, and cumulatively in the structure of capital stock. A distinctly Austrian hypothesis is that when the market rate is depressed below the natural rate, investment in more capital intensive production processes increases relative to investment in less capital intensive production processes. Sectoral patterns of resource use may be measured by labor unemployment rates and plant Capacity Utilization Rates; the proportion of an industry's estimated full capacity currently in use. In the expansion phase, the low market interest rate and relative increases in profit rates induce increases in plant capacity utilization rates in more capital intensive sectors relative to rates in less capital intensive sectors.

These sectoral shifts of investment and labor resources are patterned responses to the change in the interest rate. The differences in capital goods prices and investment flows are not random, and specifically, they are not the result of random productivity shocks. Contrary to the research on sectoral shifts and on real business cycles, the sectoral shifts implied by the Austrian theory are governed by relative prices, in particular the interest rate. The general hypothesis is that resource allocation responds to relative price changes as the main process of the cycle.

In a recent review of business cycle theory, Zarnowitz (1999:82–83) expressed his belief that the emphasis on shocks and exogenous causes of the cycles is excessive and it neglects the endogenous mechanisms that may generate the paths of cycles. The Austrian business cycle theory is an endogenous approach. Low short-term interest rates induce investment, which creates the macroeconomic phenomenon of cyclical aggregate income. However, the new investment is excessive and allocatively inefficient because of the inconsistency of plans for saving and investing, and that will ultimately reverse the growth of income and lead to the recession phase. The expansion phase of the cycle creates the conditions for the recession phase (Hayek 1967:54–62), and there is no requirement of an exogenous shock to convert expansion to recession. Another distinctly Austrian concept is the endogenous reversal of the expansion leading to recession, through the Ricardo Effect. Specifically, levels of interest rates should fall and the slope of the yield curve will increase during expansion, and these patterns are reversed during contraction. As resource use responds to the changes in relative prices of current and future goods, the ratio of more capital intensive to less capital intensive sector capacity utilization will follow the same pattern.

Excess demand for both consumer goods and producer goods will increase prices. Mises (1971:362) at first suggested that the expansion phase of the cycle should be characterized by a rise in final goods prices relative to investment goods and commodity prices: "The increased productivity that sets in when the banks start the policy of granting loans at less than the natural rate of interest at first causes the prices of production goods to rise while the prices of consumption goods, although they rise also, do so only in a moderate degree, viz., only in so far and they are raised by the rise in wages." Later statements by Mises (1966:553) were more ambiguous, perhaps because there is not a clear guideline for the timing and degree of these price changes. From the perspective of Real Business Cycle theory, Kydland and Prescott (1991:17) suggest that "any theory in which procyclical prices figure crucially in accounting for postwar business cycle fluctuations is doomed to failure." The notion that prices will not convey the signals of real behavior is one of several similarities between Austrian and Real business cycle theories, as Garrison (1991) noted. There may be no general hypothesis that can be stated about these relative prices during the phases of the cycle.

As the price level for final goods and services rises through the expansion phase, the real supply of credit decreases and the apparent additional supply represented by the monetary shock disappears. The liquidity effect is short-term; contained within the expansion phase of the cycle. Wicksell's cumulative process (Trautwein 1996:31–33) explains how the low market rate is raised and adjusted to the natural rate, through the actions of banks in response to endogenous currency and reserve shortages. The divergence of market and natural rates, which creates an increase in Aggregate Demand and the price level, also entails the means for resolving the interest rate difference.

Hayek added to that the role of relative factor prices through the Ricardo Effect. The growth of investment demand and of aggregate income at rates more rapid than the trend of potential income increases consumers' incomes. Rising consumer prices later in the expansion phase mean that profit rates for less capital intensive production, and the corresponding internal rates of return, increase. The inconsistency of plans implies that eventually there will be shortages of particular types of capital and raw materials for the production of consumer goods, raising the cost of production of current goods. In the Asset Price model of investment, quantity supplied of new capital goods has increased. But unless the supply curves for new capital are perfectly elastic, costs of resources for new investment projects increase as the expansion continues. In addition to rising demand for consumer goods, costs of production increase. Considering interest rates as the premium for current relative to future consumption, market interest rates rise also. Certainly the shape of this basic pattern, of the decline and then rise of market interest rates, will be affected by monetary policy. The difference between natural and market rates will depend on the magnitude of the shock, and can be prolonged or varied by repetitions of the monetary shock.

While real interest rates are often considered constant or acyclical (Mishkin 1981), the Austrian theory implies a pattern of interest rates over the cycle. An Austrian business cycle concept is that changes in income and the composition of Aggregate Demand affect the interest rate and are the mechanism for the adjustment of market to natural interest rates. Market forces cause the short-term and long-term rates to move toward the structure consistent with aggregate time preferences and the use of income for spending and saving. The implied hypothesis is that in the absence of a change in time preference or productivity, the recession phase of the cycle moves the level and term structure of interest rates toward the original position and slope of the yield curve. Since resource supplies of different types of capital have been altered during the cycle, the new equilibrium will be different.

According to Austrian business cycle theory, a cycle caused by a monetary shock should exhibit the following patterns: 1) the liquidity effect lowers market interest rates below the natural interest rate, and creates a steeper yield curve at a lower position; 2) investment flows and capacity utilization are systematically increased for more capitalistic production processes in the expansion; 3) short-term interest rates adjust to long-term interest rates with a mechanism related to the cycle; and 4) the expansion phase entails the contraction phase as resource allocations are reversed. These hypotheses emphasize the role of price signals; that the cycle is generated by a distortion of relative prices, the cycle is propagated by responses to relative price changes, and that the cycle is endogenously resolved by a price adjustment mechanism. Empirical evidence is necessary, if not to evaluate the validity of the theory, then to assess whether the processes identified by the theory are of sufficient magnitude to be observable and to account for business cycle behavior.

Measuring Austrian Macroeconomic Concepts

Interest rate behavior has been measured in a variety of ways: nominal, ex-post real or ex-ante real, or as a spread between interest rates on securities of different maturities. Burns and Mitchell (1946:191) examined several short-term and long-term rates in nominal form and found mild evidence that long-term railroad bond yields are pro-cyclical with a lag. However, across 15 cycles covering 1882–1929, long-term rates were often rather steady during the expansion, then displayed a great deal of variability in either rising or falling during contraction stages (Burns and Mitchell 1946:469–473). Their charts of the rates show much greater amplitude of short-term rates than for long-term rates (Burns and Mitchell 1946:247).

Mishkin's (1981:165–167, 191–192) analysis rejected the notion that real interest rates were constant over a long period (1953–1979). Significant changes in the level of long-term interest rates indicate that some changes in aggregate income had real causes; either changes in technological progress or time preferences would alter long-term rates. He found a negative relation between real short-term interest rates and the inflation rate, as well as with money supply growth rates, and although those influences could not easily be separated, they are consistent with a liquidity effect. He did not find a relation between real interest rates and other real variables, and ascribed that to the relatively small variation of the interest rates, which may have been peculiar to the sample period.

Zarnowitz (1992) noted that the distinction between real and nominal interest rates may have changed over time. When inflation was at low rates, the nominal interest rates could have been a reasonable proxy for real interest rates, but since the 1960s, higher actual and expected inflation rates have made that an unreliable indicator. He found "small cyclical variations" in ex-post real interest rates in general, as did Burns and Mitchell, and only "mixed and weak" evidence of a liquidity effect of a monetary shock on real interest rates or output.

Lionel Robbins (1934) analyzed the Great Depression as an illustration of Austrian business cycle theory. In describing the causes of the Depression and the subsequent decline in prices, he employed data primarily on the U.S. and Great Britain to show that resource use and consumption expenditure had changed as hypothesized. Robbins provided an extensive data appendix, but did not use statistical tests of hypotheses. Instead he treated the "case" of the Great Depression as more than a unique historical event, one from which behavior patterns could be identified and generalized. Hughes (1997) showed that in the expansion prior to the U.S. recession of 1990–91, credit flows went primarily to more capitalistic sectors, and that less capitalistic sectors increased borrowing late in the cycle. The monetary shock had predicted effects on allocation of credit and on relative prices between producers and consumers.

Wainhouse (1984) reviewed Austrian theory and identified nine hypotheses, six of which were tested using monthly data from January 1959 through June 1981. Granger causality tests identified a sequence of events beginning with monetary shocks and leading to changes in interest rates and output levels. Multiple definitions of the concepts of saving, credit, interest rates and outputs of specific producers' goods created the different test "cases" in the study, though clearly they were not independent samples. Null hypotheses, that monetary shocks do not affect interest rates and that interest rates do not affect output, were rejected in all or a high percent of "cases", and other hypotheses on relative price changes were qualitatively evaluated. He concluded that these results provide "substantial" support, again confirming Austrian theory. Le Roux and Levin (1998) have applied Wainhouse's

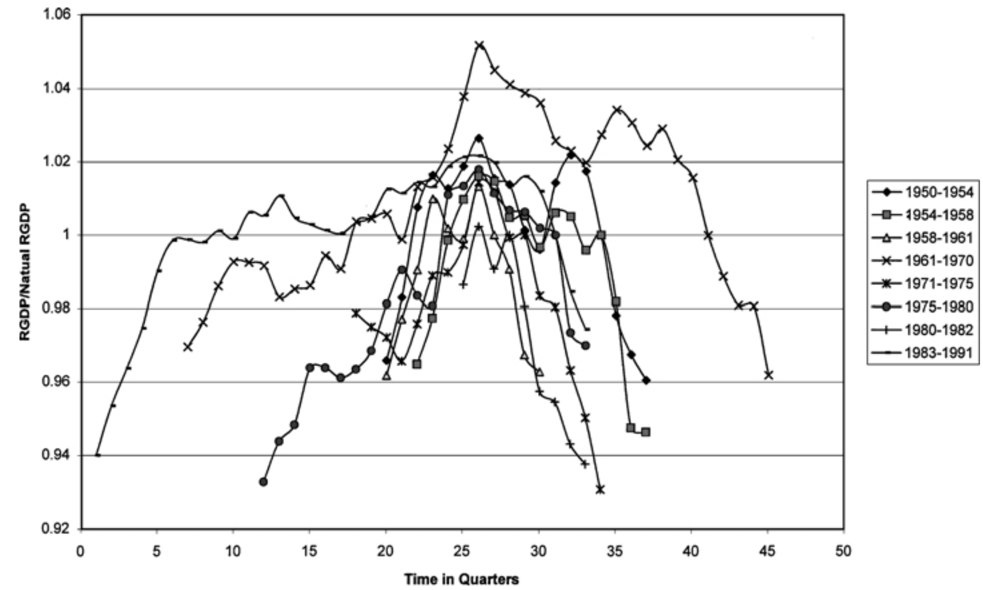

Figure 1. Business cycles.

approach to the South African economy for 1980–1996. With Granger causality tests, they found similar evidence of cycles caused by monetary shocks. Other evidence indicated the resulting distortion of price signals related to changes in credit.

These empirical studies provide confirming evidence, measurement and tests of the Austrian hypotheses about business cycle facts. The present paper contributes to this beginning in empirical analysis with an evaluation that covers the full range of the cycle, and which considers all the complete post-war cycles for the U.S. economy. The primary empirical question is whether the relations suggested by the theory can be observed in a reliable manner and with sufficient magnitude to account for macroeconomic cycles.

The pattern of economic activity in the aggregate defines the business cycle of expansion and recession. Real income can be conceptualized as occurring in relation to a natural income, where actual real income rises relative to natural real income and then declines through the cycle. The ratio of actual to natural real GDP allows for change during the cycle and variable growth rates of natural income across cycles. Figure 1 displays quarterly data on the ratio of actual real GDP to an estimate of natural real GDP for each of the eight U.S. cycles since 1950. The horizontal scale has been shifted so that the cycle peaks are aligned. The natural real GDP, measured on a constant growth path between business cycle peaks, is an ex-post estimate of natural real GDP, rather than an estimate based on resource quantity and productivity. This concept permits the possible non-neutrality of money in the long run following a monetary shock, and does not require real values to return to pre-shock values. The income ratio, as a representation of the aggregate cyclical activity, incorporates the change in the equilibrium and serves as a more appropriate measure of an Austrian concept of aggregate economic activity.

An important relative price is that between present and future consumption, expressed in the structure of short-term and long-term interest rates. The yield curve illustrates different interest rates by term, and also the notion of changes in relative prices as the level and slope of the yield curve change. Consider the short-term interest rate as representing the market rate in a short-term credit market and the long-term interest rate as representing the natural rate for the long-term market. Then the slope of the yield curve is offered in this analysis as a measure to capture Wicksell's concept of the interest rate differential. In the disequilibrium created by the monetary shock, short-term rates differ from the long-term rates by more than the risk and liquidity premiums justify, and the yield curve is steeper than in general equilibrium. The implied path of these rates is a steep yield curve (a large magnitude for the slope) early in the business cycle and a flatter or inverted yield curve (a smaller magnitude or negative slope) in the recession phase. The yield curve is expected to shift down early in the cycle as both short-term and long-term rates fall, and to shift up in the recession phase as both rates rise.

Figure 2 displays the slope of the yield curve, again with the peaks of the cycles aligned in time on the horizontal scale. Despite the variation across cycles, a pattern emerges that in the expansion phase, the short-term rate is low relative to the long-term rate, and late in the expansion and in the recession, the short-term rate rises relative to the long-term rate. Most of the cycles in Figure 2 display steep, positively-sloped yield curves initially, which flatten or invert over the course of the cycle. The nine-quarter cycle in the early 1980s is an exception. Just after the peak, which occurs at quarter 26 in the graph, all the cycles show a sharp increase in the slope of the yield curve. All of the cycles except the 1980–82 cycle and perhaps the 1961–70 cycle have remarkably similar slope values at the beginning

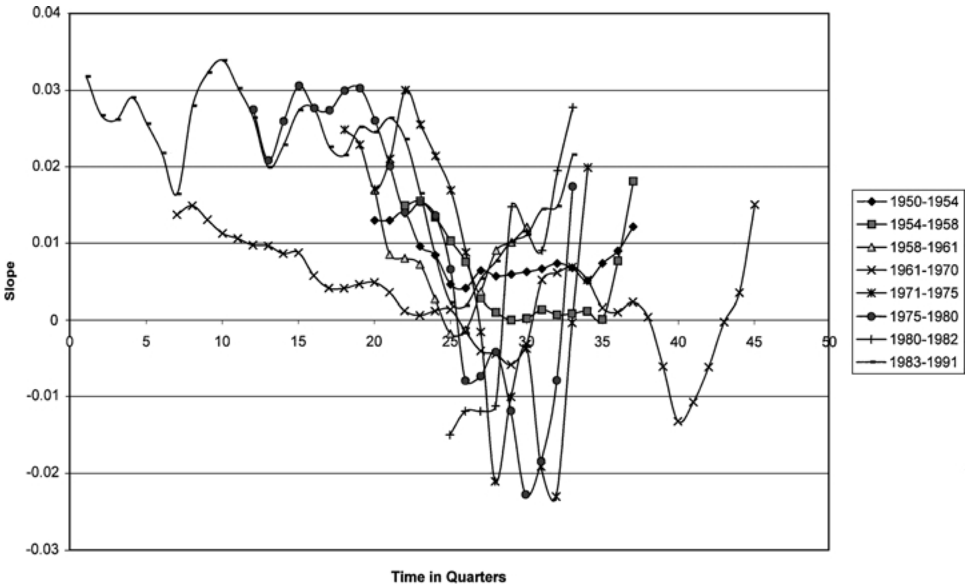

Figure 2. Slope of the yield curve.

and show convergence to a flat or inverted slope at the peak of the cycle. Both Figures 1 and 2 reveal the variety of business cycle experience within these basic patterns, in length, amplitude, and time profile.

Changes in short-term rates are volatile and temporary. Adjustments for inflation show that short-term real rates frequently take on positive and negative values. Bernanke (1990) surveys several interest rate concepts, and suggests that the changes in short-term rates, and especially the interest rate spread, are dominated by monetary policy and current default risk conditions. His correlations are confirmed by the data set for this study: levels of short-term interest rates are more highly correlated with the measure of money supply growth than are long-term interest rates (0.29–0.33 compared to 0.06–0.20). Bernanke found that two measures of the yield curve, the interest rate spread and the slope of the yield curve, were highly correlated with his measures of monetary policy. For the current data set, the slope of the yield curve shows the highest correlation with money supply growth at 0.55. Short-term rates are volatile and directly influenced by current credit market conditions.

The time period of long-term interest rates, ten years for corporate bonds and U.S. Treasury bond rates, corresponds to the longer time period for the life of capital goods. Assuming that changes in the marginal physical productivity of the existing capital stock are slow, of low volatility and long lived, that behavior is matched by market long-term interest rates. The misperceptions which cause business cycle phenomena, as discussed earlier, include errors in financing capital investments. One of the decisions that investors must make is matching the availability of funds with the cost requirements in the building process for a capital investment project. The risk of that choice may be reduced by aligning the term of borrowing with the occurrence of expected costs of the project during the time-to-build. Long-term financing for capital projects avoids the problems of increases in short-term interest rates before the completion of the project, and appropriate matching of flows of costs and benefits will immunize the project from interest rate risk. The demand for credit for financing capital projects with a long-term flow of benefits and with a long time-to-build will occur in long-term credit markets and be coordinated with the natural rate of interest or expected profit rate.

Long-term interest rates exhibit quite different behavior than short-term rates. Data for the eight U.S. business cycles show both nominal and real long-term interest rates to be comparatively stable during each cycle. Most cycles show a slight cyclical pattern of a slow and steady rise in the level of the rate through the business cycle peak and then a decline, but three of the eight cycles have long-term rates that are either flat or decrease steadily. Only two cycles exhibit a rise in long-term rates at the end of the cycle. Most cycles show nominal and real long-term rates in a similar range with the exception of the 1980–82 and 1983–91 cycles, which have much higher levels. A variety of inflation adjustments calculates a few negative real long-term rates during the 1950–54, 54–58, 71–75 and 75–80 cycles. The expectations hypothesis implies a pattern of a shift down of the yield curve at the start of the cycle followed by a shift up during the recession, and that is not apparent across the eight U.S. cycles. There is no consistent evidence that long-term rates respond to monetary shocks.

These data confirm earlier evaluations by Mishkin that long-term interest rates are acyclical but not constant, and by Burns and Mitchell that long-term interest rates have lower

Table 1. U.S. business cycles.

Cycle	Start	Peak	Trough	Quarters
1	1950:1	1953:2	1954:2	18
2	1954:3	1957:3	1958:2	16
3	1958:3	1960:2	1961:1	11
4	1961:2	1969:4	1970:4	39
5	1971:1	1973:4	1975:1	17
6	1975:2	1980:1	1980:3	22
7	1980:4	1981:3	1982:4	9
8	1983:1	1990:2	1991:1	33

Source: *Survey of Current Business*, October 1994, C-51.

variation than short-term rates. These characteristics indicate that the yield curve is not shifting during the cycle in a consistent pattern. The contrast in the behaviors of short-term and long-term interest rates supports the notion that observed long-term rates are a good representation of natural interest rates, and especially that the slope of the yield curve represents the Wicksellian notion of the differential between market and natural rates. The yield curve slope exhibits more regularity across cycles, in the magnitude of the slope, and patterns of change through the cycle than do the levels of interest rates. The current analysis will use the slope of the yield curve as the measure of interest rate behavior.

The data sample for examining business cycle hypotheses covers the eight complete postwar U.S. business cycles, quarterly from 1950:1 through 1991:1. The National Bureau of Economic Research business cycle reference dates, shown in Table 1, were used to specify the cycles as beginning with the first quarter after a trough and ending with the quarter of the next trough. The NBER determines the cycle dates on the basis of comovements of several macroeconomic aggregate measures, output, income, employment, trade when these changes are widely dispersed in the economy. As Wainhouse (1984: 56, 65) and others have noted, the cycles may not correspond to Austrian concepts of business cycles, given the emphasis of Austrian theory on the composition of aggregate expenditure. However, each of the cycles in Figure 1 displays the business cycle pattern of expansion, peak, contraction and trough, with variation. The current study uses the accepted cycle dates, though a task for further research is to consider the correspondence between NBER cycle dates and Austrian concepts of the beginning and end of cycles.

The variable definitions and data sources are presented in Table 2. The monetary shock is measured by the compound growth rate of the money supply over three periods, denoted MONEY. Interest rate behavior is measured by the slope of the yield curve, denoted YIELD. Several alternative measures of short-term and long-term interest rates were considered. Resource allocation is measured as the ratio of the plant capacity utilization rate in more capital intensive industries to the rate in less capital intensive industries, denoted CAPACITY. The Federal Reserve Board's primary processing industries, based on two-digit SIC codes, are used to measure more capital intensive production processes whose products are further in time from final consumption, and the advanced processing industries represent less capital

Table 2. Variable definitions.

MONEY	
Compound growth rate of the money supply for three periods	
M1	M1 definition of the Money Supply in billions Source: Federal Reserve Economic Data (FRED)
GDPD	GDP Deflator chain-type price index, 1992 = 100 Source: Survey of Current Business, August 1997.
YIELD	
Slope of the Yield Curve = ln[1+ (Long-term rate/100))/(1+ (Short-term rate/100))]	
Long-term interest rates:	
R10YR	Interest Rate on 10-year constant maturity U.S. Treasury Bonds, in percent, available from April 1953 Source: Federal Reserve Economic Data (FRED)
RAAA	Interest Rate on AAA rated long-term corporate bonds, in percent Source: Economic Report of the President
Short-term interest rates:	
RTB	Interest Rate on 3-Month Treasury Bills, in percent Source: Economic Report of the President
RFF	Federal Funds interest rate, in percent, available from July 1954 Source: Federal Reserve Economic Data (FRED)
RCP	Interest Rate on 4–6 month commercial paper, in percent Source: Economic Report of the President
CAPACITY	
Ratio of capacity utilization rate in long production processes to capacity utilization rate in short production processes = CAPPRI/CAPADV	
CAPPRI	Capacity Utilization Rate for Primary Processing Industries Source: Economic Report of the President, and Federal Reserve Bulletin
CAPADV	Capacity Utilization Rate for Advanced Processing Industries Source: Economic Report of the President, and Federal Reserve Bulletin
INCOME	
Ratio of real GDP to natural real GDP = RGDP/NRGDP	
RGDP	Real Gross Domestic Product, 1992 = 100, billions Source: Survey of Current Business
NRGDP	Natural Real GDP 1992 = 100, billions Calculated as the growth path between peak incomes

intensive production processes which are closer to final consumption. The overall measure of business cycle activity is the ratio of real GDP to natural real GDP, denoted INCOME.

One framework for data analysis is the familiar National Bureau of Economic Research nine-stage reference cycle. Original data are converted to nine periods and expressed as a percent of the mean value of the variable over the cycle, creating “cycle relatives” (Burns and Mitchell 1946: Ch. 2). The same general business cycle dates are used for all variables to identify the beginning, peak and end of business cycles. Nine stages within each cycle are created corresponding to the initial trough, three intervening periods of cycle expansion, the peak, three intervening periods of cycle contraction, and the terminal trough. For the trough and peak periods, three months' data are averaged or one quarterly observation is used directly as the value for the observation. For periods I (initial trough), V (peak) and IX (terminal trough), each observation always corresponds to one quarter of data. Whatever the time lengths between the initial trough and the peak and between the peak and the terminal trough, the observations were divided into three equal segments for the remaining periods, II–IV and VI–VIII.

Several problems are created by this method. The "cycle relatives", expressed as a percent of the average value for the variable over the cycle, assume stationarity. For data series that have a trend, the average value of the series for the cycle is meaningless in this use, unless the series have been detrended. Burns and Mitchell recognized that some variables exhibit a trend during the cycle, and included it as part of the calculation, but the trend was only evident in steps from one cycle to the next. Second, the variables often exhibit varying patterns across cycles. The "cycle pattern" tables and charts provide measures of the differences between a particular series and the general business cycle, and Burns and Mitchell identified regular occurrences of variables with turning points that lead or lag the business cycle. The NBER method revealed how the lead and lag structure of variables may change across cycles. However, the reference cycle method often uses data that are averages for each variable across all the cycles as the main unit of analysis. The greater degree of aggregation obscures the particular characteristics of a cycle, if all business cycles are not alike. Third, the reference cycle stages do not have a consistent time length across cycles. Since the time length of six of the nine intervals is not fixed, there can be variation within the cycle that would not appear in the reference cycle data. The Austrian theory in particular suggests that the magnitude of later changes in income depend on the length of time that an expansion and allocatively inefficient investment have occurred. The reference cycle method would not permit examination of that important relation. Burns and Mitchell (1946:185–197) recognized that the nine-stage reference cycles constrict this element of behavior, and considered alternatives that would standardize the time period, but their interest in long-term cycles and the characteristics of particular variables across cycles was a high priority in their choice of technique. The NBER business cycle relatives framework is a particularly poor method for analysis of Austrian business cycle theory because of its distortion of the timing of changes through the cycle. In the post-war cycles, policy influences are more important, and the length of the cycle may be affected, for example, if monetary policy stimulus were extended or repeated. Then the effect of a monetary shock may have a varying lag length which would be difficult to evaluate, given business cycles of such different length and time patterns.

Instead of the NBER reference cycle framework, the data for the present analysis were converted to a standardized cycle length to permit a more consistent exploration of the lag structure. Standardizing the period of the cycles, allowing each cycle and each variable to have its unique time profile, may reveal regularities in the time path of response. The data were standardized to 17 time periods for each cycle, chosen because it is the number of quarters for one of the cycles, 1971:1–1975:1, so that these data required no adjustment, and two other cycles of 16 and 18 quarters each, required little adjustment. For the three shorter cycles, each quarterly observation was extended to apply to more than one of the standardized observations to result in 17 periods. For the four longer cycles, two or more quarterly observations were averaged and condensed into fewer periods. Since all variables are standardized by the same weighted averages, this adjustment preserves the correspondence in timing across variables during each cycle. Each standardized time period refers to the same actual time period for each variable. Although across cycles, a standardized time period refers to different actual time lengths, each of the 17 periods within a cycle refers to a standard proportion of the cycle. This method of standardizing the time length preserves the original time pattern of each cycle and the relative movements of all variables within the cycle.

The method of standardization used in this analysis introduces some error and the loss of some information, though a comparison of descriptive statistics of the standardized and original data reveal a high correspondence. Fitted values from a regression model that used a fourth-degree polynomial in a time index did not correspond as well to the original data. Table 3 presents the mean, standard deviation, and autocorrelation coefficient for the

Table 3. Descriptive statistics on INCOME for 8 U.S. business cycles.

Cycle	Mean	Standard deviation	Auto-correlation	Correlation with capacity utilization	Correlation with yield slope	Correlation with money growth
1950:1–1954:2	1.0010	.0210	.626	.6021	−.5837	.0421
	1.0001	.0205	.617	.6113	−.7888	−.0609
	0.9913	.0233	.487	.3577	–	–
1954:3–1958:2	.9919	.0222	.630	.8868	−.5659	.2535
	.9919	.0217	.672	.9273	−.5744	.2296
	.9796	.0246	.617	.9711	–	–
1958:3–1961:1	.9885	.0186	.525	.3017	−.8247	.3516
	.9888	.0180	.739	.3888	−.8183	.0397
	.9841	.0177	.533	.3261	–	–
1961:2–1970:4	1.0084	.0232	.850	−.2870	−.5923	.3700
	1.0084	.0230	.702	−.3022	−.6022	.6838
	.9914	.0223	.470	−.3917	–	–
1971:1–1975:1	.9810	.0214	.693	.9203	−.1731	.7354
	.9810	.0214	.693	.9203	−.1731	7463
	.9758	.0240	.549	.9735	–	–
1975:2–1980:3	.9815	.0247	.806	.5281	−.7209	.5329
	.9815	.0243	.789	.5262	−.7428	.5988
	.9733	.0232	.467	.6231	–	–
1980:4–1982:4	.9725	.0247	.696	.9394	−.8912	−.6706
	.9725	.0235	.869	.9479	−.9095	−.7546
	.9770	.0250	.677	.9506	–	–
1983:1–1991:1	.9997	.0193	.759	.7199	−.5306	−.3147
	.9997	.0192	.551	.7466	−.5408	−.0519
	.9902	.0232	.333	.9333	–	–
All	.9946	.0243	.808	.2018	−.4016	.2196
observ.	.9906	.0238	.892	.3472	−.4047	.2902
	.9829	.0229	.727	.5751	–	–

Row 1: Quarterly data ($n = 165$).
Row 2: Standardized time period data ($n = 136$).
Row 3: Reference cycle data ($n = 72$).

INCOME variable and correlations between INCOME and the other three variables. For each cycle in the Table, the first row presents statistics on the original quarterly data, the second row is for the standardized data with 17 periods for each cycle, and the third row is for data constructed according to the NBER method with 9 observations (or stages) per cycle. Means for the standardized data are uniformly closer to those of the original data than are the NBER data. As a weighted average, the standardized series exhibits slightly less volatility on every cycle and throughout the sample. In contrast, the NBER reference cycle data are more volatile for cycles 1, 2, 5 and 7 but less volatile for others and for the series overall. For some reference cycles, only two quarterly observations were available for the three intervening periods between a trough and a peak, and for other reference cycles, as many as 11 quarterly observations were averaged into one of the intervening periods. That transformation did not preserve the volatility patterns as well as the standardized period method. The same distortion appears in the autocorrelations on INCOME and in the correlations between INCOME and CAPACITY (the only other variable with all positive values). For some cycles the correlations are more closely matched by the reference cycle data, but there are not cycles for which the reference cycle method is consistently more accurate across the measures. When the correlations of the reference cycle data differ from the original data, they often differ substantially. Judged by these summary statistics, the method of standardizing time periods retains more information and performs better than the NBER reference cycle method at preserving the time series characteristics of the original data.

The data transformed for a standardized time period are used to describe patterns of relative price changes, resource utilization and income that are common over the eight business cycles. Descriptive statistics for the variables used in the analysis are given in Table 4, for each cycle as well as the entire sample of 136 observations (eight cycles of 17 periods each). All the variables display significant differences in mean and all except INCOME display significant differences in variance across the eight cycles. No further adjustments were made for these differences. The variations in means for different cycles do not indicate a trend in any of the four variables across the full sample.

Empirical Evidence on the Austrian Business Cycle Facts

Time series properties of the variables were evaluated with correlograms and unit root tests. Many macroeconomic variables are nonstationary in their level form but are stationary when transformed. The measures described in Table 2 are expressed in growth rates and ratios, which contributes to their stationarity. The autocorrelation functions of each of the variables in the sample exhibit a taper from a significant autocorrelation at lag one to non-significant autocorrelation by lag five for INCOME, by lag six for MONEY and YIELD, and lag eight for CAPACITY. Each variable has significant partial autocorrelations only at lag one or lags one and two. Evidence from the correlograms indicates the variables are stationary.

Each variable was tested for the presence of a unit root. The null hypothesis of the available tests is that the variable has a unit root, and if true the behavior of the variable would be consistent with a random walk process. Then the changes in the value of the variable from one time period to the next would show non-stationarity. The Augmented Dickey-Fuller test was specified with only a constant since all series exhibit no trend but a non-zero

Table 4. Descriptive statistics for variables by cycle.

Cycle	MONEY	YIELD	CAPACITY	INCOME
1950:1–1954:2				
Mean	0.0918	0.0081	1.0255	1.0001
Standard dev.	0.6326	0.0030	0.0466	0.0205
1954:3–1958:2				
Mean	−0.2743	0.0060	1.0383	0.9919
Standard dev.	0.5565	0.0064	0.0316	0.0217
1958:3–1961:1				
Mean	0.1021	0.0070	1.0010	0.9888
Standard dev.	0.3991	0.0053	0.0485	0.0180
1961:2–1970:4				
Mean	0.8017	0.0031	1.0175	1.0084
Standard dev.	0.5652	0.0064	0.0262	0.0230
1971:1–1975:1				
Mean	−0.0600	0.0076	1.0981	0.9810
Standard dev.	0.9172	0.0179	0.0384	0.0214
1975:2–1980:2				
Mean	−0.1947	0.0115	1.0408	0.9815
Standard dev.	0.5379	0.0173	0.0238	0.0243
1980:3–1982:4				
Mean	−0.0663	0.0036	0.9949	0.9725
Standard dev.	0.4454	0.0154	0.0425	0.0235
1983:1–1991:1				
Mean	1.7072	0.0207	1.0406	0.9997
Standard dev.	2.0609	0.0085	0.0210	0.0192
All cycles				
Mean	0.2673	0.0084	1.0332	0.9906
Standard dev.	1.1022	0.0123	0.0456	0.0238

$n = 17$ for each cycle, $n = 136$ for all cycles, $n = 14$ for MONEY for 1950:1–1954:2.

mean, and the Phillips-Perron test was specified with a constant and a trend. Tests were performed with four lags. Results are presented in Table 5, including alternative measures of YIELD. The null hypothesis of a unit root is rejected at the 5% level of significance for all variables. The time trend variable is not significant for any of the variables at the 5% level in either the ADF or Phillips-Perron test. Rejecting the null hypothesis of a unit root implies that the variable does not follow a random walk process. The probability of Type II error is large for these tests, but the results, considered with the correlograms, support the notion that the variables are stationary in the forms presented in Table 2, despite the variation in means and variances across cycles.

Patterns of interrelation which reflect on cyclical behavior are examined with cross-correlations, as presented in Table 6. Percentage changes in the real money supply are positively and significantly correlated with changes in the slope of the yield curve (using Moody's AAA-rated corporate bond and 4–6 month Commercial Paper interest rates) for the current period and next two periods, reflecting a short but strong liquidity effect. The steeper

Table 5. Unit root tests.

t-statistics for the estimate of ρ with null hypothesis of unit root ($\rho = 1$)				
Variable	ADF without time trend	ADF with with time	Phillips-Perron without trend	Phillips-Perron with time trend
MONEY	−3.54[a]	−3.75[a]	−3.55[a]	−3.39[b]
YIELD (RAAA and RCP)	−4.09[a]	−4.26[a]	−3.60[a]	−3.70[a]
YIELD (R10YR and RFF)	−3.55[a]	−3.56[a]	−3.29[a]	−3.28[b]
YIELD (R10YR and RTB)	−3.15[a]	−3.29[b]	−3.24[a]	−3.33[b]
CAPACITY	−3.08[a]	−3.07	−3.25[a]	−3.24[b]
INCOME	−4.77[a]	−4.96[a]	−3.71[a]	−3.84[a]

[a]Significant at 5% level.
[b]Significant at 10% level.

yield curve is correlated with a rise in the capacity utilization in primary processing industries relative to that in advanced processing industries. The correlations between YIELD and CAPACITY are positive and statistically significant for the third period through the eleventh period. Thus the response requires several periods to appear, as might be expected, and then is consistent through the cycle, tapering off in the final five periods. The cross-correlations do not show significant reversals of correlation within the cycle, but a steeper yield curve is consistently correlated with higher capacity utilization in primary production processes. The slope of the yield curve has the same pattern of correlation, though more pronounced, with the INCOME variable, the ratio of real GDP to natural real GDP. After four periods, the correlations become positive and statistically significant, lasting through period 12, so that a steeper yield curve shows a strong correlation through the cycle with growth of income relative to the natural real GDP. Again, the correlations do not show a reversal within the cycle. Only the cross correlations between the CAPACITY and INCOME measures indicate that pattern. The correlation is positive contemporaneously and for the first three periods, reversing to significant negative correlations for periods eight through 16. Lags are apparent in each stage of the process. Changes in MONEY have an immediate effect on YIELD, and the changes in YIELD affect both CAPACITY and INCOME with lags. Table 6 shows that these lags are extended by each relationship. Granger causality tests show few significant F-values and no consistent effects.

The evidence of cross-correlations indicates several patterns. One cause of a business cycle, common to many theories, is a strong liquidity effect, and that is apparent in the relation between money supply growth and the interest rate differential. As in Figure 2, the expansion phase of the cycle is characterized by a steep yield curve and a gap between the market rate and the natural rate of interest. Resource allocation and income respond to price signals, and especially the relative price of current and future consumption expressed in the interest rate term structure. The cross-correlations of YIELD with CAPACITY and

Table 6. Cross correlations.

Lead	MONEY and YIELD	YIELD and CAPACITY	YIELD and INCOME	CAPACITY and INCOME
0	0.4125[a]	−0.1209	−0.4004[a]	0.3475[a]
1	0.2867[a]	0.0270	−0.2048[a]	0.3537[a]
2	0.2011[a]	0.1421	−0.0180	0.2714[a]
3	0.1210	0.2237[a]	0.1443	0.1789[a]
4	0.0404	0.2838[a]	0.2784[a]	0.1049
5	−0.0269	0.3236[a]	0.3603[a]	0.0383
6	−0.0604	0.3228[a]	0.4159[a]	−0.0378
7	−0.0470	0.2905[a]	0.4485[a]	−0.1156
8	−0.0114	0.2425[a]	0.4361[a]	−0.2122[a]
9	0.0251	0.2167[a]	0.3967[a]	−0.3249[a]
10	0.0406	0.2039[a]	0.3534[a]	−0.4481[a]
11	0.0664	0.1698[a]	0.2944[a]	−0.5429[a]
12	0.0783	0.1203	0.2092[a]	−0.5606[a]
13	0.1009	0.0814	0.1181	−0.5385[a]
14	0.1257	0.0578	0.0330	−0.4896[a]
15	0.1433	0.0313	−0.0311	−0.3999[a]
16	0.1292	0.0176	−0.0835	−0.2638[a]

[a]Exceeds 2 standard errors.

with INCOME confirm that relation. In similar correlation patterns, capacity utilization and real GDP respond as expected to the steeper yield curve with sustained reallocation of resources toward primary production processes and with growth of income relative to its trend. Finally, the cross-correlation between CAPACITY and INCOME suggests that the resource reallocation is unable to sustain income growth. In the expansion phase, increased use of resources in primary production processes precedes income growth, and that is reversed within the cycle as income declines relative to its trend in the late expansion and the contraction. The Austrian theory is distinctive in offering an endogenous theory of the cycle with the hypothesis that changes in resource use, initiated by a monetary shock, are the fundamental mechanism of the business cycle. A market rate below the natural rate has only temporary positive effects, and through the mechanism of resource constraints, the expansion becomes recession. The significant positive and then significant negative cross-correlations between measures of resource use and income confirm the influence of resource allocation in the cyclical process of aggregate income.

The Austrian business cycle theory also specifies a long-term relation between market interest rates and the natural rate of interest. The business cycle process is one of response to a divergence in these two interest rates, which culminates in a return to a stable term structure. The changes in sectoral resource use and in aggregate income, characteristics of the cycle, bring the market rate into long-term relation with the natural rate. An Error Corrections Model (ECM), using data on short-term and long-term interest rates, provides confirmation of this relation between the interest rate differential and the business cycle. On the assumption that there is a long-term proportional relation between short-term and long-term interest rates, the change in the short-term rate is modeled as a function of the change in the long-term rate, with a short-term adjustment mechanism based on the difference between the rates, the interest rate spread (SPREAD). The adjustment coefficient may depend on business cycle influences such as the growth rate of the real money supply or the relation between actual and natural real GDP. Table 7 presents the results for private market and for government securities interest rates. Significant F-values indicate the model

Table 7. Error correction models of interest rates.

Dependent variable is the change in the short-term interest rate on 4–6 month commercial paper
Long-term rate is the change in the rate on AAA corporate bonds (1950:1–1991:1)
SPREAD is the long-term interest rate minus the short-term interest rate
MONEY × SPREAD is the product of the MONEY and SPREAD variables
INCOME × SPREAD is the product of the INCOME and SPREAD variables

Variable	Coefficient	t-statistic
Intercept	0.0044	0.36
Long-term rate	1.715	7.33[a]
SPREAD	−0.5766	−2.22[a]
MONEY × SPREAD	0.0047	1.10
INCOME × SPREAD	0.5772	2.17[a]
$n = 133$	adjusted $R^2 = 0.41$ $F = 23.68$	

Dependent variable is the change in the short-term interest rate on 3-month treasury bills
Long-term rate is the change in the rate on constant maturity 10 year treasury bonds (1954:3–1991:1)

Variable	Coefficient	t-statistic
Intercept	0.0068	0.48
Long-term rate	1.7001	10.58[a]
SPREAD	−0.4357	−1.70[b]
MONEY × SPREAD	0.6855	1.49
INCOME × SPREAD	0.4321	1.65
$n = 118$	adjusted $R^2 = 0.54$ $F = 35.59$	

Dependent variable is the change in the short-term interest rate on federal funds (1954:3–1991:1)
Long-term interest rate is the change in the rate on constant maturity 10-year treasury bonds (1954:3–1991:1)

Variable	Coefficient	t-statistic
Intercept	0.0094	0.61
Long-term rate	1.6160	8.10[a]
SPREAD	−0.7518	−2.08[a]
MONEY × SPREAD	0.0003	0.05
INCOME × SPREAD	0.7539	2.05[a]
$n = 118$	adjusted $R^2 = 0.40$ $F = 20.87$	

[a]Significant at 5% level.
[b]Significant at 10% level.

contributes to the explanation of short-term rates, though the adjusted R^2 values show that a substantial portion of the variation is not explained. The simple ECM has statistically significant coefficient estimates for the change in the long-term interest rate and the short-term adjustment component. The magnitudes of these coefficients are large relative to the change in the short-term interest rate, and imply that the effects of one standard deviation changes in these influences are empirically important. The rate of real money supply growth does not have a statistically significant effect on the rate of adjustment between interest rates in any specification. For the YIELD measures using the private market interest rates and the Federal Funds rate, the phase of the business cycle, expressed through the INCOME X SPREAD variable, does affect adjustment. The ratio of actual to natural real GDP has a positive and significant effect on the rate of adjustment of the short-term rate toward the long-term rate, and again the magnitude of the effect of a one standard deviation change is substantial. As real income increases relative to its trend, short-term or market rates adjust faster toward the long-term or natural rate. The Austrian theory contains such an adjustment of market to natural rates of interest, and the ECM estimate exhibits not only a short-term adjustment mechanism but also an important role of income growth in resolving term structure distortions.

Conclusions

The Austrian theory offers distinctive hypotheses about economic behavior following a monetary shock. Misperceptions generate a change in relative prices, a distortion inconsistent with individuals' time preferences and rates of productivity of capital. The liquidity effect causes systematic changes in resource use, particularly in investment flows and the rates of utilization of capital. By that mechanism, the structure of the capital stock and consequently all real values are permanently changed. The expansion phase generates the forces which result in recession, through resource constraints and the pressure of income and price changes on interest rates. Rather than shocks such as changes in the productivity or scarcity of resources or changes in Aggregate Demand, changes in relative prices are the primary organizing principle of the business cycle. This paper has examined data on recent U.S. business cycles and develops evidence that confirms these hypotheses.

It has been suggested that "all business cycles are alike" in patterns of the co-movement of variables, but cycles with monetary causes of different degrees or sustain may have dramatically different effects and less uniformity across cycles. Changes in economic and historical conditions will alter the characteristics of cyclical behavior over time. Broad patterns of the co-movement of macroeconomic variables cannot capture the structure of responses to relative price changes. Empirical analysis should express Austrian macroeconomic concepts in terms of available data measures and still permit non-neutrality as a result of the monetary cycle. To a large extent the empirical concepts in the present analysis have allowed for that by using measures such as the ratio of actual income to a changing natural income and the slope of the yield curve which permits the levels of interest rates to change across cycles.

There is evidence of consistent behavior across the eight complete post-war U.S. business cycles. Stationary measures of interest rates are offered to express Wicksell's notion of the relation between market and natural rates of interest. That concept is shown here to be cyclically related to capacity utilization rates and to real GDP through time-series cross-correlations. The estimate of an Error Correction Model indicates that short-term interest rates have a strong adjustment process toward long-term interest rates, and that the cyclical behavior of income is an element of that adjustment. The empirical evidence available in these estimates suggests that there are consistent patterns of relative price change, as exhibited by interest rate adjustment, and that there are systematic changes in the utilization of resources and the cyclical behavior of income. The evidence confirms the Austrian hypothesis that relative price changes, expressed in the structure of interest rates, induce a systematic response in resource utilization and income.

A common criticism of the Austrian theory is that while relative price changes may exist, they and the changes in investment flows are not large enough to cause the business cycle movements of aggregate economic activity. The evidence of cross-correlations and error correction is significant and substantial in magnitude, and indicates the contribution of these effects. The major finding of this paper is that there are reliable and empirically important relations among Austrian macroeconomic concepts. It provides a basis for measuring the magnitude of these effects, by identifying the sequence of macroeconomic measures that exhibit cyclical behavior. Estimation of a more complete model is necessary to evaluate whether the Austrian process can account for business cycle behavior.

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