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ABSTRACT

Business Cycles, Stylized Facts, and the Exchange Rate Regime: Evidence from the United States

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This paper investigates the robustness of central macroeconomic "stylized facts" to (i) commonly-employed detrending methods, and (ii) the exchange rate regime. We find that the stylized facts are not at all robust to the choice of detrending method, with the most important variations occurring in the cyclic behavior of hours and productivity. With respect to the exchange rate regime, we find that the volatility of investment has been lower in the recent flexible rate period compared with the Bretton Woods period, and that the volatility of GNP has fallen while the volatility of consumption has increased.

1. Introduction

The practice of macroeconomics consists of two complementary activities: the development of stylized facts about the macroeconomy, and the development of theoretical models which attempt to explain these facts. For the United States, the stylized facts are usually taken to be a set of summary statistics describing the postwar behavior of consumption, investment, and the like. With the development of equilibrium theories of business cycles and related improvements in techniques for solving and simulating these models, replicating the stylized facts has taken on renewed importance for macroeconomists.[1]

Therefore, the purpose of this paper is to investigate the robustness of these stylized facts to (i) methods of filtering the data to achieve stationarity, and (ii) the exchange rate regime. These may appear to be unlikely bedfellows, but they both potentially are major sources of instability in the stylized facts.

The paper proceeds as follows. Section 2 reviews construction of business-cycle summary statistics for the United States in the post-war period. The study of business cycles and their international transmission is one of the oldest topics in economics; the first detailed statistical analyses of business cycles were undertaken in the 1920's by the National Bureau of Economic Research under the leadership of Wesley Clair Mitchell. Eschewing traditional statistical methodology, Mitchell and his collaborators developed new methods for summarizing business cycle phenomena. They found

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[1]See, for example, the work of Hodrick and Prescott (1980), Kydland and Prescott (1982), Long and Plosser (1983), Hansen (1985), Prescott (1986), King, Plosser, and Rebelo (1988a,b), and King and Rebelo (1988b).

that the empirical regularities of economic fluctuations lay not in the length of cycle or its amplitude, but rather in the patterns of comovement and relative amplitude of economic variables. Oskar Morgenstern (1959) carried out detailed analyses of international business cycles, and raised the question of whether the international character and transmission of cycles depended on the exchange rate regime.

More recently, the neoclassical approach to studying business cycles was motivated by the perspective that "*business cycles are all alike*" (Lucas (1981), p. 218, italics in original). Lucas states that "There is, so far as I know, no need to qualify these observations [about cycles] by restricting them to particular countries or time periods: they appear to be regularities common to all decentralized market economies."[2] Explaining these patterns of co-movement and relative amplitude has become the chief aim of neoclassical business cycle theory. Neoclassical business cycle research has also sought to improve on the methods of Mitchell and his collaborators. By using formal statistical procedures, their "results are replicatable and criticizable at a level at which Mitchell's are not."[3] Development of statistical procedures and stylized facts has led naturally to efforts to develop quantitatively restricted models that can reproduce the observed covariation of economic aggregates. This paper follows the original NBER strategy of describing the statistical character of cycles while abstaining from imposition of a specific theoretical structure, but employs modern time series methods.

Section 2 examines the implications for business cycle summary statistics of several alternative methods of detrending the data. The chief conclusion

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[2]Lucas (1981), page 218.

[3]Lucas (1981), page 236, ff. 4.

from this section is that many stylized facts of the business cycle are not robust to different methods of detrending the data. For example, cyclic hours can be more or less volatile than cyclic productivity, depending on the detrending method.

Section 3 investigates whether the character of business fluctuations in the United States differed substantially across two major exchange rate regimes: the fixed rate regime associated with the Bretton Woods period and the flexible rate regime experienced since about 1973. Standard theories of transmission under alternative exchange rate regime predict that, holding fixed the source and magnitude of shocks to the economy, the character of fluctuations should differ markedly across regimes. Nevertheless, most empirical macroeconomic research treats the entire postwar period as a single unit. This approach imposes the restriction that the statistical character of aggregate time series is the same in the fixed and flexible rate periods. Whether this restriction is justified is an open question which this section of the paper attempts to answer.

Whether one concludes that particular statistical properties of the data have changed across exchange rate regimes often depends critically on the detrending procedure employed. Clearly, one would like to have a theory that implied a particular method of achieving stationarity was the appropriate one; such a theory, however, is presently unavailable. Without such a unified theory in hand, we proceed by analyzing the results for a number of common detrending procedures. Section 4 concludes with a brief summary of the paper's main results.

2. Detrending procedures and the stylized facts

Mitchell's method of summarizing business fluctuations involved computing statistics based on the reference cycle construct. The dates of business cycle peaks and troughs were first determined with a procedure that involved a substantial degree of judgment which, consequently, is difficult to replicate. Then, individual series were examined for "specific cycles." Each time series was expressed as a deviation from its specific cycle average, removing aspects of trend. Various measures of amplitude, comovement, and lead-lag relations were then computed.

Recent business cycle research has generally abstained from dating of cycles and has used more conventional statistical measures, after applying a transformation to render the data stationary. Two standard transformations aimed at achieving stationarity are removal of a linear trend and first differencing. An alternative method is proposed in Hodrick and Prescott (1980), perhaps the most widely-cited unpublished paper in macroeconomics. Their stated objective was "to examine the magnitudes and stability of covariances between various economic time series and real output and the autocovariances of real output."[4] Hodrick and Prescott used an unusual filter—their filter removes a "trend" that resembles a smooth curve drawn through the data. The filter is two-sided; application of the filter removes a trend component which resembles a smooth curve drawn through the data. Figure 1 graphs the log of U.S. real exports and the trend component which would be removed by application of the Hodrick-Prescott (HP) filter. This figure clearly shows the potential for the HP method to produce a nonmonotonic trend component.

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[4]Hodrick and Prescott (1980), page 2.

Volatility

Measures of volatility have long been important business cycle statistics— Mitchell discussed volatility in terms of the "amplitude" of a variable. Volatility statistics are intended to measure the extent of fluctuation in a variable over the business cycle. The volatility measure employed in this paper is the standard deviation of detrended data.

Table 1 presents the standard deviations and correlations with real GNP of thirteen U.S. aggregate time series. Three filters were used: a linear trend, first-differencing, and the HP filter (all variables were in logs before filtering). Because the HP filter is less commonly used than these other filters, and because recent work by Eichenbaum and Singleton (1986) and Christiano and Ljundquist (1988) have suggested that covariances between economic variables are sensitive to the detrending procedure, this is a natural first check on the stability of Hodrick and Prescott's "empirical regularities."

Not surprisingly, the variances of the "cyclic" components of the variables depends on the detrending procedure. Because most of these series are highly serially correlated, the largest variances are associated with the linear trend, the smallest variances are associated with differencing, with the variances associated with the Hodrick-Prescott filter lying in between but generally closer to those of the differenced series.

To help explain why this is true, we note first that most macroeconomic variables are characterized by low order autoregressive processes, i.e., they have Granger's (1966) typical spectral shape. For such series, most of the power is in the lowest frequencies. Figure 2, which plots the squared gain (or transfer function) of the three filters, illustrates the differences

between the three filters.[5] Apparently, the biggest differences between the filters are concentrated in the critical low frequencies. The differencing filter permits the smallest proportion of the low frequency components to pass through, with the HP filter transferring more, and the linear trend transferring the most. This explains why the volatility statistics exhibit a uniform ordering across filtering methods.

At very low frequencies, Figure 2 shows that the transfer functions of the differencing filter and the HP filter are very similar. This suggests that the HP filter and the first difference filter should produce similar business cycle statistics. However, this is very often not the case.

Correlation with GNP

While the variance of HP filtered data in every case lies between the variances of the linearly detrended data and the differenced data (under the high, positive, low-order serial correlation assumption), correlations between the filtered series and GNP do not exhibit the same ordering. Compare, for example, the correlation of hours with GNP. For the linearly detrended data, the correlation is -.18, while for the differenced data the correlation is .68, and for the HP filter, the correlation is .85. For productivity, the ordering is reversed. The HP filtered data shows the lowest correlation of productivity[6] with GNP (.46), with the differencing filter next (.48), and the linear trend highest (.60).

Another variable for which filtering makes a big difference for the correlations with GNP is gross private domestic investment, for which the

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[5]This graph is taken from Singleton (1988).

[6]Productivity is computed as output per man hour in the manufacturing sector.

linear trend filter produces a contemporaneous correlation with GNP of -.12, while the differencing and HP filters produce correlations of .73 and .75, respectively. Most other variables also show significant variation across filtering methods in correlations with GNP.

Relative volatility

Another statistic often used to summarize cyclic behavior is a variable's cyclic variance relative to that of GNP. Burns and Mitchell examined individual series for their conformity to the reference cycle and their relatic amplitude. More recently, Kydland and Prescott ((1982), page 1360) state that "One cyclical observation is that, in percentage terms, investment varies three times as much as output does and consumption only half as much."[7] We have seen that volatility measures are not robust to the detrending method. However, it might still be true that relative variances are roughly the same across detrending methods even though the levels of volatility differ as exhibited in Table 1.

Table 2 presents relative volatility measures for the three detrending procedures. Although the HP filter yields levels of volatility which are intermediate between those produced by the linear trend and differencing filters, this ordering is not preserved when looking at relative volatilities. The biggest differences across filtering methods in the relative volatility measures occur for consumption of services and of durables, productivity, and all investment measures—but especially gross private investment.

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[7]The statistics which are the basis for this statement are found in the third and fourth columns of Table 1.

Thus we see that many simple "stylized facts" of the business cycle are not invariant to the method used to achieve stationarity. While it is true, regardless of the detrending method, that consumption is less volatile than GNP and investment is more volatile, the magnitude of the relative volatility statistics for these variables is quite sensitive to the detrending method.

The results for hours and productivity are even more extreme. Cyclic hours can be more or less volatile than productivity, depending on the detrending method. Hours are about 50% more volatile than productivity under the linear trend filter, about 20% more volatile with the HP filter, and about 20% less volatile than productivity with the differencing filter.

Temporal stability of the stylized facts

Hodrick and Prescott (1980) studied quarterly data from 1950:1-1979:2. As part of their analysis, they constructed a statistic which measures the stability across the two halves of the sample of the relationship between the variable in question and GNP. (All variables are logged, then detrended using the Hodrick-Prescott filter.) This statistic was constructed as follows. First, run the following regression:

$$X_t = \alpha + \sum_{i=-2}^{2} \beta_i Y_{t+i} + u_t$$

where X_t is the variable in question (e.g., real consumption, investment, etc.) and where Y_t is real output. Next break the sample into two periods (roughly 1950-1964 and 1965-1979), and test the equality of the β_i across the two time periods. Under the assumption that the u_t are i.i.d. normal random variables, this statistic has an F distribution. Except for consumption of services and non-durables and non-residential structures, the hypothesis that the coefficients are equal across the two halves of the sample was rejected

at standard significance levels. While this does not constitute proof that the difference between the two halves of the sample is due to the switch to floating exchange rates in 1971-73, it suggests that a closer look at the data is warranted. This is the subject of the remainder of the paper.

3. Stylized facts and the exchange rate regime

This section investigates whether the cyclic behavior of U.S. aggregate variables differed across the fixed and flexible rate periods. The variables of interest are those studied in Section 2, together with trade and government policy variables. Since the analysis of Section 2 suggests that the conclusions will likely depend on the detrending procedure, the same three detrending procedures are used throughout this section. For the purpose of this investigation, the fixed rate period ends in 1970:4, and the flexible rate period begins in 1973:1. The intervening period is not included since it was a transition period during which a variety of exchange regimes were temporarily in place.

Tables 3-5 present summary statistics for the fixed and flexible rate periods separately, using three detrending methods or filters.[8] The first filter (Table 3) is a linear trend fitted to the fixed and flexible rate periods together. The second filter (Table 4) is the Hodrick-Prescott (HP) filter, and the third filter (Table 5) is the first difference filter.

Figures 3-5 display these statistics as scatterplots. These figures are read as follows. On the vertical axis is the statistic (standard deviation, correlation with output, or relative volatility) for a particular variable

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[8]All data are from the Citibase database, and all variables are in real terms (deflated by their own implicit price deflators) unless otherwise noted.

(consumption, investment, etc.) for the fixed rate period. On the horizontal axis is the same statistic for the same variable and detrending method, but for the flexible rate period. Thus, a point on the 45^0 line means no change in the statistic for that variable between fixed and flexible rate regimes.

Volatility

Figure 3 plots standard deviations of various aggregates after removing a linear trend. The volatility of GNP fell slightly in the flexible rate period; from 4.5 percent per quarter to 4.2 percent. All measures of investment all show declines in volatility, with the declines in the plant and equipment measures registering the most dramatic changes. Hours and productivity show modest declines in volatility. By contrast, all measures of consumption show increases in volatility in the flexible rate period. The volatility of exports fell slightly in the flexible rate period, while the volatility of imports rose substantially.

Figure 4 investigates the volatility question using the HP filter. In contrast to the linear trend filter, using the HP filter leads to the conclusion that GNP and hours increased in volatility during the flexible rate period. For the other variables, the results are broadly consistent with those yielded by the linear trend filter: consumption increases in volatility while investment volatility declines. Exports show a small decline in volatility and imports show a substantial increase.

Figure 5 shows that, for the differenced data, all variables except imports show decreases in volatility in the flexible rate period. This includes the consumption measures, which showed increases in volatility for the other two detrending methods.

A natural next question is whether any of the documented changes in volatility is statistically significant. However, most of the detrended series are not serially uncorrelated, which invalicates standard F-tests for the hypothesis of no change in volatility across the two exchange rate regimes. Differences in volatility in the detrended series could be due to one or both of (i) differences across exchange rate regime in autoregressive or moving average coefficients, and (ii) differences across exchange rate regimes in the variances of the innovations.

Visual inspection of Figures 3-5 suggest that significant declines in the volatility of investment have occurred in the flexible rate period. Two of the three detrending methods suggest that consumption may have become more volatile in the flexible rate period and that GNP has become less volatile. These results are less clear-cut, however, than those for investment. The evidence on hours and productivity is similarly mixed.

Correlations with GNP

An important class of business cycle stylized facts involves the correlations of various aggregates with GNP. Figures 6-8 plot the correlations of these variables with GNP.[9] All three figures show that correlations of the various U.S. aggregates with GNP have on average risen from the fixed rate period to the flexible rate period. The changes in the correlations between the two regimes are, on average, smallest for the first-difference filter.

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[9]Tables 3-5 contain the values of the correlation coefficients used in constructing these plots.

Looking more closely at the various aggregates, we see that all three filtering methods show increases in the correlation between consumption and GNP in the flexible rate period. The only decline (and it is a small one) is for consumption of services computed with the first difference filter. The increase in consumption correlatedness is especially strong for the linear trend filter.

The results for investment are mixed; whether one concludes that the correlation between investment and GNP has risen or fallen in the post-1973 period depends on the investment measure selected, but not the detrending procedure. All three detrending procedures show increases in correlation for gross productive investment and total investment in plant and equipment; all three detrending procedures show no change or decreases in correlatedness for the nondurable and durable components of investment in plant and equipment. Hours show increases in correlatedness in the post-1973 period for all three detrending methods. Productivity exhibits declines in correlatedness for the linear trend and first difference filters, but an increase in correlatedness with the HP filter.

The correlations between GNP and the trade measures (exports and imports) are sensitive both to the time period and the detrending method. Looking first at exports, two detrending methods—the linear trend and the first difference filters—show increased correlatedness with GNP in the flexible rate period. With the HP filter, the correlation between exports and GNP declines in this period and actually becomes negative. Further, the magnitude of the correlation between exports and GNP in the flexible rate period varies widely according to choice of detrending method. Looking at the statistics for imports, we see that all three detrending methods yield the result that the correlation between imports and GNP has increased in the

post-1973 period. The magnitudes of the correlations, however, are very sensitive to the detrending method.

Relative volatility

In this subsection, we study a third type of business cycle stylized fact: the volatility of economic aggregates relative to that of GNP. As discussed in the introduction, relative volatility has interested business cycle researchers at least since the time of Burns and Mitchell. Matching relative volatility statistics is a key concern of business cycle research as undertaken, for example, by Kydland and Prescott (1982), Hansen (1985), and Prescott (1986).

Figures 9-11 plot relative volatility statistics for each variable relative to GNP, defined as the variable's standard deviation (after detrending) divided by the standard deviation of GNP (similarly detrended).[10] These figures show that the relative volatility of the various measures of investment declined uniformly in the flexible rate period, as did the relative volatility of productivity. In addition, imports show increases in relative volatility for all detrending methods.

On the other hand, relative volatility statistics for several variables exhibit sensitivity to the detrending method. For instance, the consumption measures show increases in relative volatility with the linear trend and HP filters, and (small) decreases with the first difference filter. Hours register a decrease in volatility with the linear trend filter, an increase with the HP filter, and virtually no change with the first difference filter.

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[10]Tables 3-5 contain the values of the relative volatility statistics used in constructing these plots.

Finally, Figure 12 plots mean growth rates of the variables for the two regimes (units are percentage points per quarter). This plot shows that most variables' average growth rates declined in the flexible rate regime, notable exceptions being gross productive investment, investment in nondurable plant and equipment, and hours.

Ratios

Table 6 presents summary statistics for ratios of various components of GNP to the level of GNP. These statistics are stationary when there is a common stochastic trend. The existence of common stochastic trends is a feature of real business cycle models of the type developed, for example, by King, Plosser, Stock, and Watson (1987), and King, Plosser, and Rebelo (1988a,b).

Table 6 shows that shares of GNP accounted for by most variables have been quite stable over time. The obvious exceptions are exports and imports, whose shares have risen substantially in the post-1973 period. Consumption as a fraction of GNP has risen slightly in the flexible rate period,[11] and consumer durables account for a larger proportion of total consumption in this period. A new variable, aggregate nondurables, has been constructed by adding together services and other nondurables and deflating appropriately. Although the share of services has increased in the flexible rate period and the share of other nondurables has declined, the share of GNP accounted for by consumption of aggregate nondurables is relatively constant across the two

[11]This is largely due to the fact that consumption as a share of GNP was unusually low during the Korean War.

time periods. A potential explanation for this fact is that some nondurables may have been reclassified over time as services.

Figure 13 plots the consumption/GNP ratios. This figure shows the secular increase in services and the decline in other nondurables, together with the remarkable stability of the share of aggregate nondurables. Figure 14 plots the relative price of aggregate nondurables to durables. Clearly, this relative price has not been constant over time. The last row of Table 6 gives the mean and standard deviation of the growth rate of this relative price in the two exchange rate periods. The mean growth rate of this relative price is 67% higher in the flexible rate period as compared with the fixed rate period, but with a standard deviation that is only half as large.[12]

Table 6 shows that the volatility of the investment share is higher in the flexible rate period. This is surprising, since Tables 3-5 showed that the volatility of the <u>level</u> of investment declined in the flexible rate period for all detrending methods. Furthermore, the relative volatility of this investment measure also showed uniform declines in the flexible rate period.

The shares of nondurables and services are substantially lower in the flexible rate period; however, the share of durables became more volatile. Both the shares and the volatility of the trade measures (exports and imports) have increased in the flexible rate period.

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[12]The constancy of the shares of durables and aggregate nondurables may seem surprising in light of these data. But, in fact, this is exactly what is predicted by a two sector neoclassical growth model which is characterized by balanced growth (see Baxter (1988)).

Policy variables

Table 7 presents results for monetary and fiscal policy variables. The volatility of real government purchases and their mean growth rate are substantially lower in the flexible rate period. Presumably this reflects the fact that the Korean and Vietnam wars occurred during the fixed rate period. More important, perhaps, is the fact that the correlation between government purchases and GNP has not changed substantially across the two regimes. This suggests that the use of government purchases as a stabilization tool has not been substantially different under the flexible rate regime.

The two monetary variables considered are M1 and the monetary base, M0 (both in nominal terms). The growth rates of these two variables are about double in the flexible rate period compared with the fixed rate period, and two of the three filters show increases in variance as well (the linear trend filter shows a decrease in variance). The correlations of these variables with GNP are weak in both time periods under the HP and differencing filters.[13] With the linear trend filter, monetary policy appears strongly countercyclical; perhaps slightly less so in the flexible rate period. Nevertheless, the difference between the two time periods appears slight. If monetary and fiscal policies have been substantially different in the flexible rate period, these simple statistics do not reveal this fact.

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[13]Christiano and Ljungqvist examine the money-output relation with linearly detrended and differenced data. They find that money Granger causes output at standard significance levels with linearly detrended data, but that conventional F-tests lead to rejection of the hypothesis that money Granger causes output if the data is differenced. Christiano and Ljungqvist argue that the difference is caused by lack of power in the first difference F-statistic, and conclude that money does Granger cause output.

4. Summary and Conclusions

This section briefly summarizes the mian results of this investigation. In section 2, we found that different methods of detrending the data to achieve stationarity often led to substantial differences in the stylized facts. For instance, whether hours are viewed as more or less cyclically volatile than productivity depends on the detrending method. Further, stylized facts concerning relative volatility, such as the widely cited regularity that "...in percentage terms, investment varies three times as much as output does"[14] is not robust to the detrending method or the choice of investment measure. A relative volatility statistic of about five is obtained when detrending gross productive investment with the HP filter, but the statistic is only three and half with a linear trend filter, and is about six with the differencing filter.

Similar instability is observed in the correlations of some aggregates with GNP. Notable examples are gross investment and hours; both variables are negatively contemporaneously correlated with GNP under the linear trend filter, but are strongly positively correlated with GNP with the HP and differencing filters (with correlation coefficients in excess of .6). The instability of the stylized facts with respect to detrending procedures highlights the importance of treating symmetrically the simulated time series of a model economy and the data to which one compares the model.[15]

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[14]Kydland and Prescott (1982), page 1360.

[15]Researchers in the area of of equilibrium business cycle theory generally do treat their actual and simulated data symmetrically, although it may not always be obvious that they have done so. See King and Rebelo (1988a) for more discussion of this point, especially as it relates to use of the HP filter.

Recently, several researchers have recently begun to develop unified theories of growth and cycles.[16] In these models there is no sensible way to separate the data into "growth" and "cyclic" components, since shocks to the economic system typically affect both long run growth and short run cyclic fluctuations. These theories typically have strong cross-frequency restrictions, and imply that some detrending methods are appropriate for the purpose of achieving stationarity, while others are not. With a unified theory of growth and cycles, the theory itself has implications for appropriate transformations of the data.

Section 3 investigated whether the stylized facts are robust to the exchange rate regime, or more precisely, whether the stylized facts are substantially different in the post-1973 period than in the earlier period. In many cases the results are mixed, with different detrending methods yielding different conclusions about whether, and in what direction, the stylized facts are different in the post-1973 period. Results that appear robust to the detrending method are as follows. First, the volatility of investment was lower in the flexible rate period, and import volatility was substantially higher. There is weaker evidence that GNP volatility fell, and that consumption volatility increased in the post-1973 period. More work needs to be done to determine whether these changes in volatility are in fact attributable to changes in the exchange rate regime.

Correlations between GNP and consumption, investment, hours, and imports all rose in the post-1973 period. Given the increased openness of capital markets in this later period, one interpretation of this result is that the

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[16]See, for example, King and Rebelo (1988b).

shocks to national economies were more highly correlated in the flexible rate period. Investigating this possibility more thoroughly is an important area for future research.

References

Baxter, Marianne. (1988) "Dynamic Real Trade Models: New Directions for Open Economy Macroeconomics," Rochester Center for Economic Research Working Paper #167.

Burns, Arthur and Wesley C. Mitchell. (1941) Measuring Business Cycles, New York, National Bureau of Economic Research.

Christiano, Lawrence and Lars Ljunqvist (1988) "Money Does Granger-Cause Output in the Bivariate Money-Output Relation," Journal of Monetary Economics 22, 217-235.

CITIBASE: Citibank economic database. 1946-1986. [machine-readable magnetic data file]. New York, Citibank, N.A. 1978.

Eichenbaum, Martin and Kenneth Singleton. (1986) "Do Equilibrium Real Business Cycle Theories Explain Postwar U.S. Business Cycles?", in S. Fischer, ed., *NBER Macroeconomics Annual 1986* (MIT Press, Cambridge, Massachusetts) 139-145.

Granger, Clive. (1966) "The Typical Spectral Shape of an Economic Variable," Econometrica 34:1 (January 1966), 150-161.

Hansen, Gary. (1985) "Indivisible Labor and the Business Cycle,"Journal of Monetary Economics 16, 309-27.

Hodrick, Robert and Edward Prescott. (1980) "Post-war U.S. Business Cycles: An Empirical Investigation," working paper, Carnegie Mellon University.

King, Robert G., C.I. Plosser and S.T. Rebelo (1988a) "Production, Growth, and Business Cycles: I. The Basic Neoclassical Model," Journal of Monetary Economics 21:2/3, 195-232.

_____ (1988b) "Production, Growth, and Business Cycles: II. New Directions," Journal of Monetary Economics 21:2/3, 309-342.

King, Robert, Charles Plosser, James Stock, and Mark Watson. (1987) "Stochastic Trends and Economic Fluctuations," Rochester Center for Economic Research Working Paper #79.

King, Robert and Sergio Rebelo (1988a) "Low Frequency Filtering and Real Business Cycles", manuscript.

_____ (1988b) "Public Policy and Economic Growth: Developing Neoclassical Perspectives," manuscript.

Kydland, Finn and Edward Prescott. (1982) "Time to Build and Aggregate Fluctuations," Econometrica 50, 1345-70.

Long, John and Charles Plosser. (1983) "Real Business Cycles," Journal of Political Economy 91:1 (February 1983), 39-69.

Lucas, Robert E., Jr. (1981) "Understanding Business Cycles," in *Studies in Business Cycle Theory*, by R.E. Lucas, Jr., Cambridge, Massachusetts: MIT Press. Reprinted from *Stabilization of the Domestic and International Economy*, Carnegie-Rochester Series on Public Policy, eds., Karl Brunner and Allan Meltzer, Amsterdam: North-Holland Publishing Company, 1977, pp. 7-29.

Mitchell, Wesley C. (1927) Business Cycles: The Problem and Its Setting, New York, National Bureau of Economic Research.

_____. (1951) What Happens During Business Cycles, New York, National Bureau of Economic Research.

Morgenstern, Oskar (1959) International Financial Transactions and Business Cycles, New York, National Bureau of Economic Research.

Nelson, Charles and Charles Plosser (1982) "Trends and Random Walks in Macroeconomic Time Series," Journal of Monetary Economics 10, 139-67.

Prescott, Edward. (1986) "Theory Ahead of Business Cycle Measurement," Carnegie-Rochester Conference Series on Public Policy 25, 11-66.

Singleton, Kenneth (1988). "Econometric Issues in the Analysis of Equilibrium Business Cycle Models," Journal of Monetary Economics 21,2/3, 361-86.

Stock, James and Mark Watson. (1987) "Testing for Common Trends," Hoover Institution Discussion Paper #E-87-2.

TABLE 1

SUMMARY STATISTICS FOR DIFFERENT FILTERS

Quarterly data, 1947:1–1986:3
All variables in real terms, natural logs taken
ρ denotes correlation of variable with GNP

Variable	linear trend σ (%)	linear trend ρ	HP filter σ (%)	HP filter ρ	first difference σ (%)	first difference ρ
GNP	4.4	1.00	2.0	1.00	1.1	1.00
Consumption: total	2.9	0.75	1.2	0.67	0.8	0.50
Consumption: services	3.0	0.70	0.7	0.67	0.5	0.35
Consumption: nondurable	3.1	0.79	1.2	0.63	0.9	0.32
Consumption: durables	8.4	0.41	5.5	0.42	4.2	0.42
Gross private domestic investment	15.9	−0.12	9.7	0.75	6.8	0.73
Inv. in P&E: total[1]	10.0	0.47	6.0	0.67	3.0	0.47
Inv. in P&E: nondurable	11.6	0.07	7.3	0.40	4.2	0.24
Inv. in P&E: durable	18.1	0.70	11.9	0.65	5.5	0.38
Hours[2]	4.1	−0.18	1.9	0.85	1.0	0.68
Productivity[3]	2.9	0.60	1.6	0.46	1.2	0.49

[1]Investment in plant and equipment

[2]Hours of all persons: business sector

[3]Output per man hour in manufacturing

TABLE 2

RELATIVE VOLATILITY STATISTICS FOR DIFFERENT FILTERS[1]

Quarterly data, 1950:1–1979:2
All variables in real terms, natural logs taken

Variable	linear trend	HP filter	first difference
GNP	1.00	1.00	1.00
Consumption: total	0.66	0.60	0.73
Consumption: services	0.68	0.35	0.45
Consumption: nondur.	0.70	0.60	0.82
Consumption: durables	1.91	2.75	3.82
Gross investment[2]	3.61	4.85	6.18
Inv. in P&E: total[3]	2.27	3.00	2.73
Inv. in P&E: nondur.	2.64	3.65	3.82
Inv. in P&E: durable	4.11	5.95	5.00
Hours	0.93	0.95	0.91
Productivity	0.66	0.80	1.09

[1]Relative volatility defined as variable's standard deviation divided by the standard deviation of GNP

[2]Gross private domestic investment

[3]Investment in plant and equipment

TABLE 3

STATISTICS FOR LINEAR TREND FILTER

	fixed rate period			flexible rate period		
Variable	σ (%)	ρ	rel. vol.	σ (%)	ρ	rel. vol.
GNP	4.5	1.00	1.00	4.2	1.00	1.00
C:TOT	2.3	0.61	0.51	3.4	0.94	0.81
C:S	2.3	0.57	0.51	3.7	0.89	0.88
C:ND	2.7	0.69	0.60	3.2	0.92	0.76
C:D	8.4	0.28	1.87	8.5	0.69	2.02
GPI	16.6	−0.11	3.69	13.2	0.12	3.14
I:TOT	11.6	0.42	2.58	7.3	0.76	1.74
I:ND	13.3	0.26	2.96	7.4	−0.25	1.76
I:D	21.2	0.77	4.70	11.3	0.67	2.69
HRS	4.2	−0.12	0.93	3.6	−0.06	0.86
PROD	3.0	0.65	0.67	2.8	0.46	0.67
EXP	13.2	−0.31	2.93	11.0	0.65	2.62
IMP	6.7	0.57	1.49	10.4	0.84	2.48

Abbreviations:

Variable	Abbreviation in Tables and Figures
GNP	GNP
Consumption: total	C:TOT
Consumption: services	C:S
Consumption: nondurables	C:ND
Consumption: durables	C:D
Gross productive domestic investment	GPI
Investment in P&E: total	I:TOT
Investment in P&E: nondurable	I:ND
Investment in P&E: durable	I:D
Hours	HRS
Productivity	PROD
Exports	EXP
Imports	IMP

TABLE 4

STATISTICS FOR THE HODRICK–PRESCOTT FILTER

	fixed rate period			flexible rate period		
Variable	σ (%)	ρ	rel. vol.	σ (%)	ρ	rel. vol.
GNP	1.89	1.00	1.00	2.19	1.00	1.00
C:TOT	1.01	0.52	0.53	1.58	0.82	0.72
C:S	0.69	0.56	0.37	0.76	0.81	0.35
C:ND	1.01	0.53	0.53	1.55	0.72	0.71
C:D	5.50	0.16	2.91	5.73	0.78	2.62
GPI	10.10	0.65	5.34	9.81	0.92	4.48
I:TOT	6.08	0.61	3.22	5.82	0.76	2.66
I:ND	7.82	0.49	4.14	6.20	0.24	2.83
I:D	12.88	0.67	6.81	9.34	0.67	4.26
HRS	1.65	0.78	0.87	2.28	0.93	1.04
PROD	1.64	0.41	0.87	1.67	0.56	0.76
EXP	6.53	0.08	3.46	5.54	−0.11	2.53
IMP	4.32	0.04	2.29	6.80	0.19	3.11

TABLE 5

STATISTICS FOR FIRST-DIFFERENCE FILTER

	fixed rate period				flexible rate period			
Variable	μ	σ (%)	ρ	rel. vol.	μ	σ (%)	ρ	rel. vol.
GNP	0.87	1.10	1.00	1.00	0.58	1.10	1.00	1.00
C:TOT	0.87	0.82	0.42	0.75	0.70	0.79	0.61	0.72
C:S	1.00	0.60	0.34	0.55	0.77	0.47	0.31	0.43
C:ND	0.68	0.87	0.27	0.79	0.45	0.82	0.34	0.75
C:D	1.10	4.41	0.31	4.01	1.11	3.89	0.61	3.54
GPI	1.55	7.25	0.71	6.59	2.08	6.11	0.82	5.55
I:TOT	0.85	3.27	0.48	2.97	0.73	2.71	0.53	2.46
I:ND	0.45	4.54	0.25	4.13	0.82	3.69	0.25	3.35
I:D	0.91	6.14	0.43	5.58	0.80	4.33	0.40	3.94
HRS	0.11	1.03	0.67	0.94	0.40	1.02	0.81	0.93
PROD	0.68	1.25	0.52	1.14	0.58	1.02	0.42	0.93
EXP	0.79	4.96	0.14	4.51	1.09	3.05	0.47	2.77
IMP	1.76	4.17	0.19	3.79	1.32	4.36	0.55	3.96

TABLE 6

STATISTICS FOR RATIOS OF VARIABLES TO GNP

	fixed rate period		flexible rate period	
Variable	μ (%)	σ (%)	μ (%)	σ (%)
C:TOT	59.5	1.8	63.6	1.5
C:D	6.0	0.5	8.4	0.8
C:ND	27.6	1.7	24.3	0.6
C:S	25.9	1.4	30.9	1.1
Cons: agg. ndur.[1]	53.7	1.9	55.2	1.2
GPI	16.5	1.4	17.0	1.7
EXP	5.9	0.8	10.4	1.0
IMP	5.8	1.3	11.0	1.4
relative price[2]	0.3	1.3	0.5	0.7

[1]consumption of aggregate nondurables (services plus other nondurables)

[2]growth rate of relative price of aggregate nondurables to durables (% per qtr)

TABLE 7

STATISTICS FOR GOVERNMENT POLICY VARIABLES

linear trend

Variable	fixed rate period σ (%)	ρ	rel. vol.	flexible rate period σ (%)	ρ	rel. vol.
GOV	17.60	0.79	3.91	4.10	0.65	0.98
M1	7.20	−0.80	1.60	6.20	−0.63	1.48
M0	8.10	−0.80	1.80	4.40	−0.72	1.05

Hodrick–Prescott filter

Variable	fixed rate period σ (%)	ρ	rel. vol.	flexible rate period σ (%)	ρ	rel. vol.
GOV	5.83	0.12	3.08	1.40	0.17	0.64
M1	0.90	−0.10	0.48	1.32	0.09	0.60
M0	0.90	−0.07	0.48	0.71	0.02	0.32

growth rates

Variable	fixed rate period σ (%)	ρ	rel. vol.		flexible rate period σ (%)	ρ	rel. vol.	
GOV	1.22	2.80	0.33	2.55	0.55	1.30	0.12	1.18
M1	0.91	0.69	0.21	0.63	1.84	1.10	0.19	1.00
M0	1.01	0.60	0.02	0.55	1.92	0.39	0.34	0.35

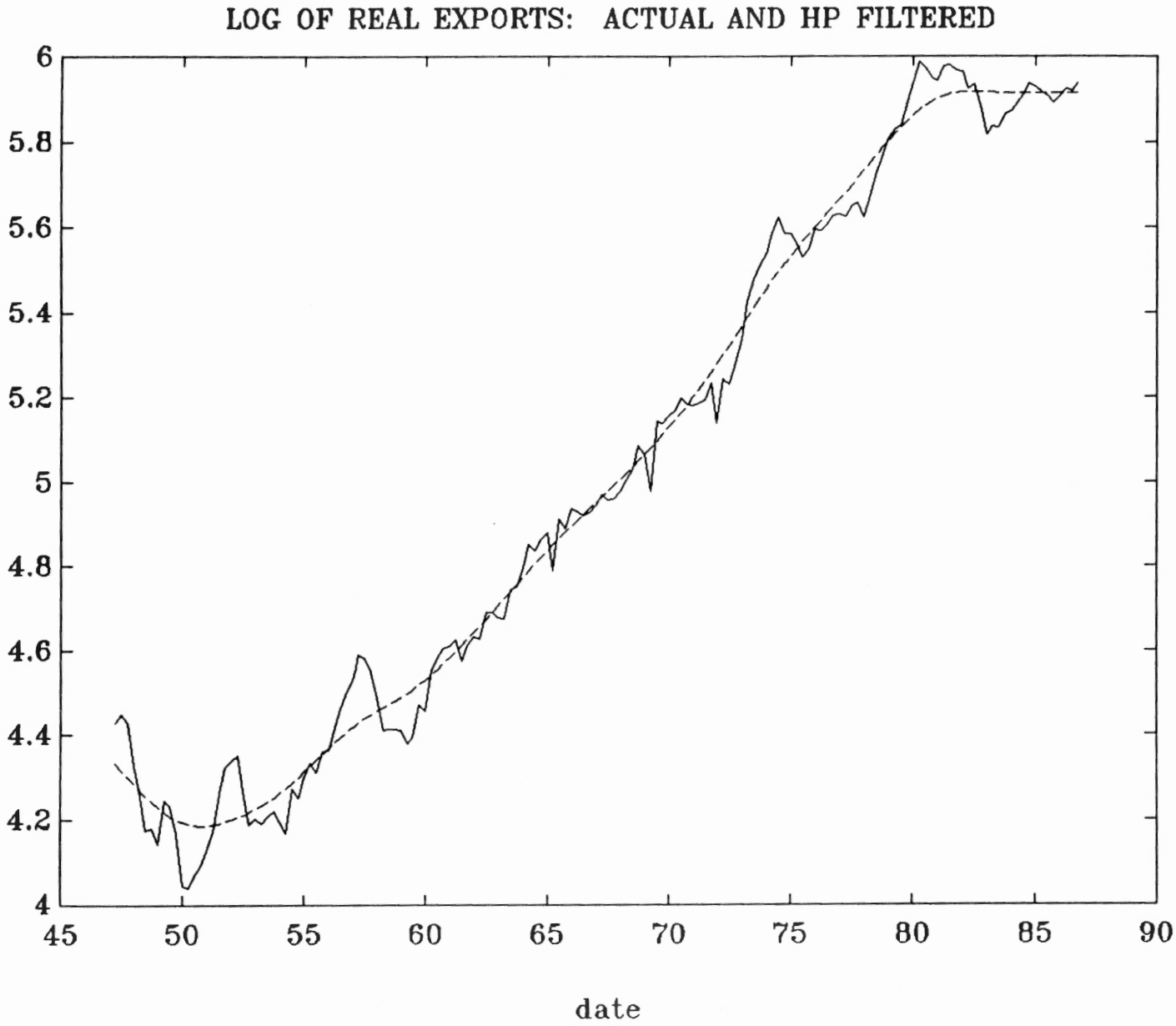


Figure 1: The Hodrick-Prescott Filter

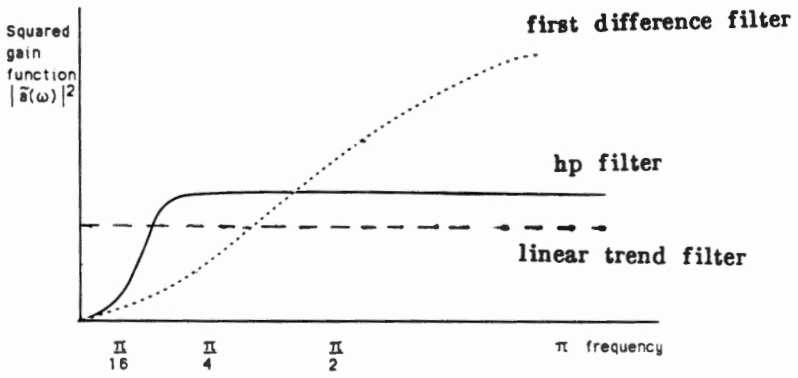

Squared
gain
function
$|\tilde{a}(\omega)|^2$
first difference filter
hp filter
linear trend filter
π/16
π/4
π/2
π frequency

FIGURE 2

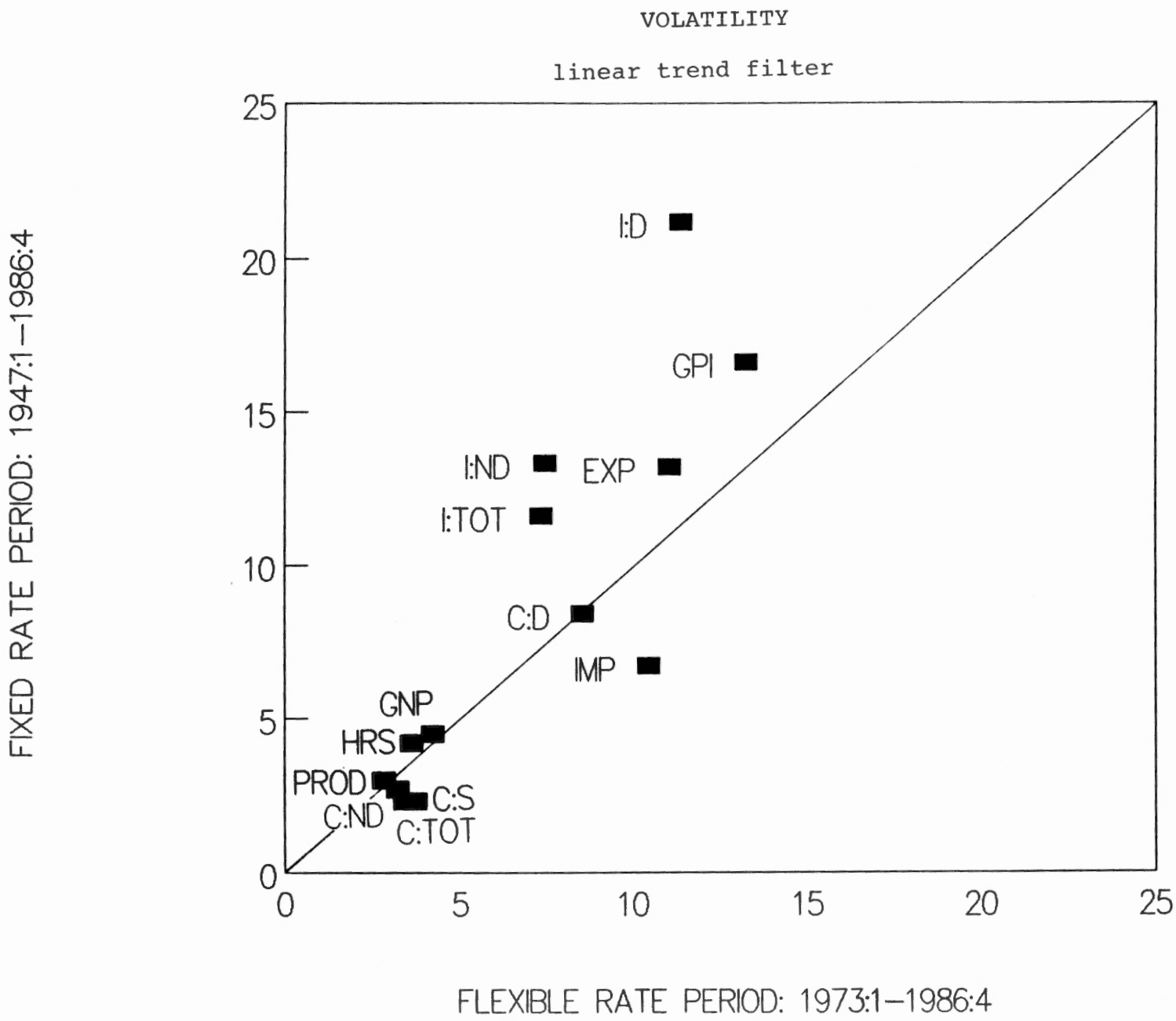

VOLATILITY
linear trend filter
FIXED RATE PERIOD: 1947:1–1986:4
FLEXIBLE RATE PERIOD: 1973:1–1986:4
0
5
10
15
20
25
I:D
GPI
I:ND
EXP
I:TOT
C:D
IMP
GNP
HRS
PROD
C:S
C:ND
C:TOT

FIGURE 3

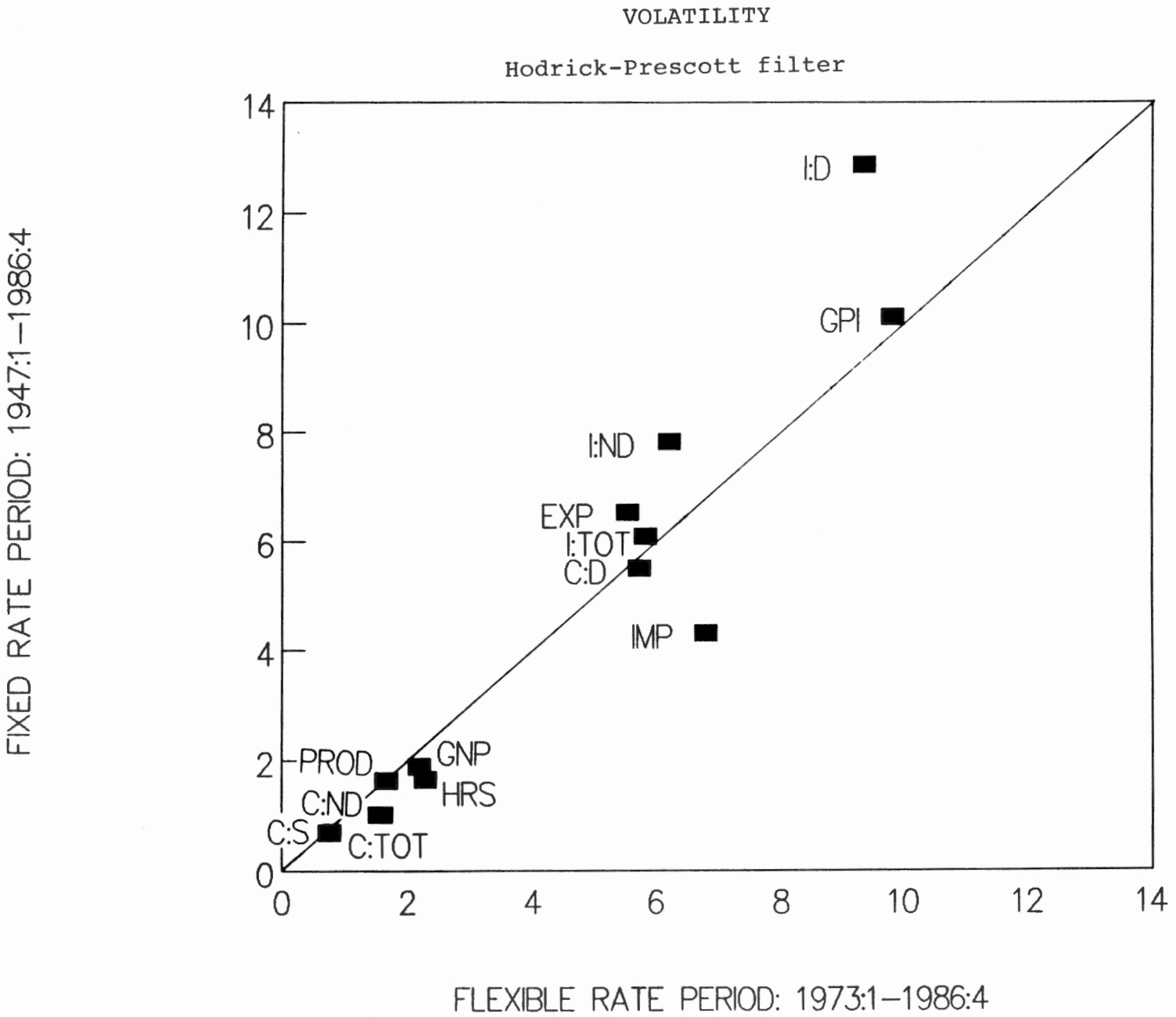
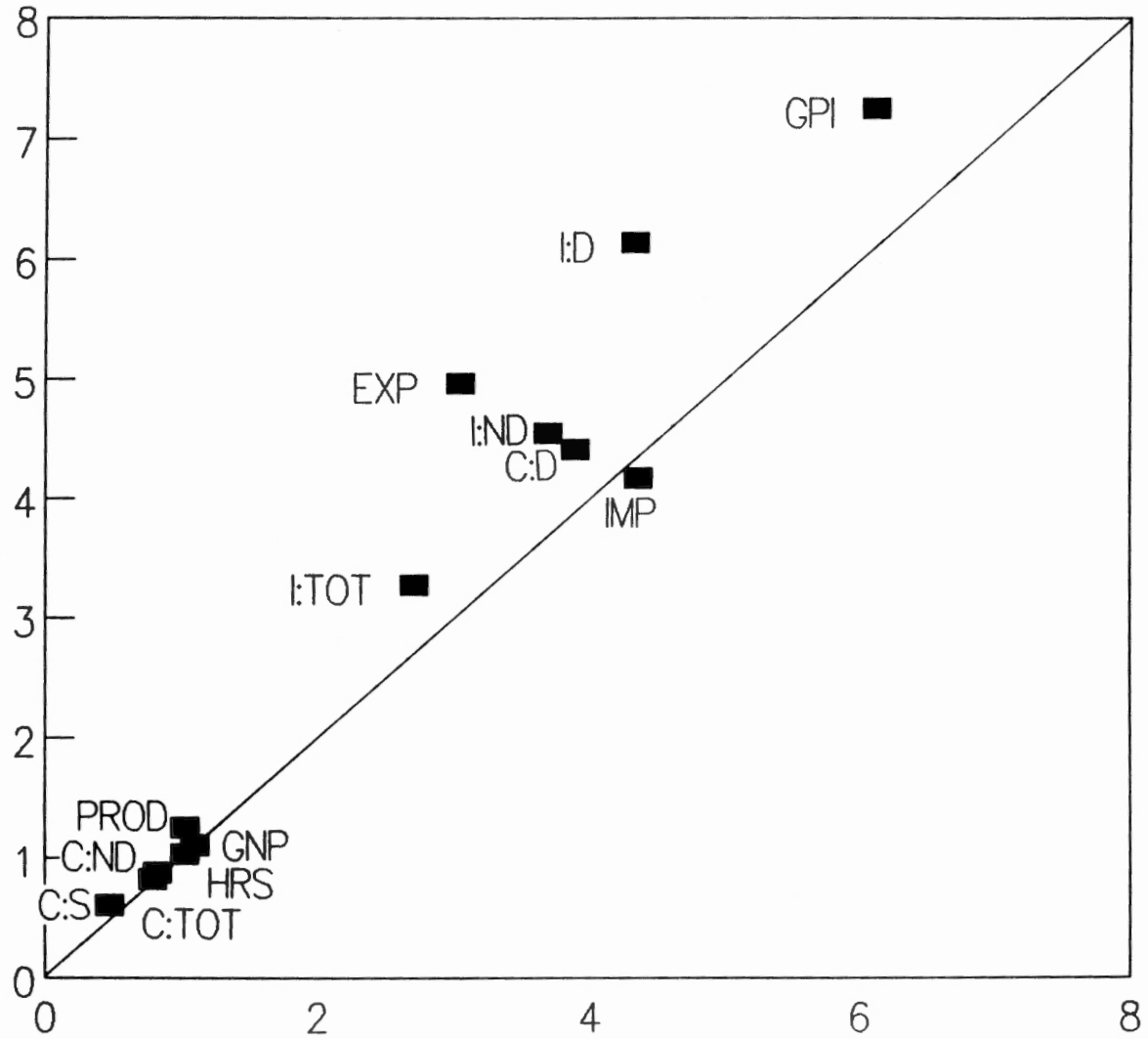

VOLATILITY
Hodrick-Prescott filter
FIXED RATE PERIOD: 1947:1–1986:4
FLEXIBLE RATE PERIOD: 1973:1–1986:4
I:D
GPI
I:ND
EXP
I:TOT
C:D
IMP
PROD
GNP
HRS
C:ND
C:S
C:TOT
0
2
4
6
8
10
12
14

FIGURE 4

VOLATILITY

first difference filter



FIXED RATE PERIOD: 1947:1–1986:4

FLEXIBLE RATE PERIOD: 1973:1–1986:4

FIGURE 5

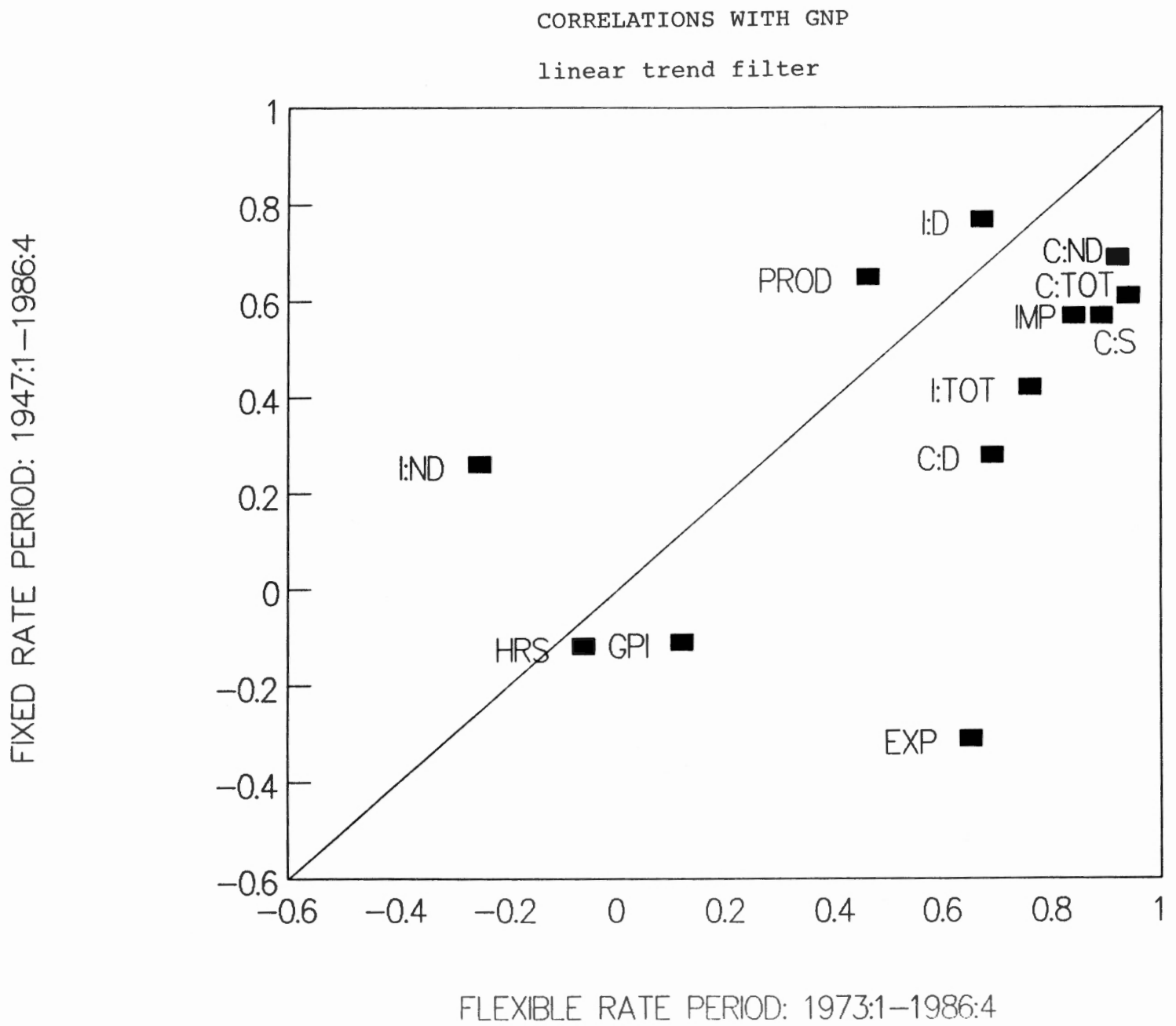
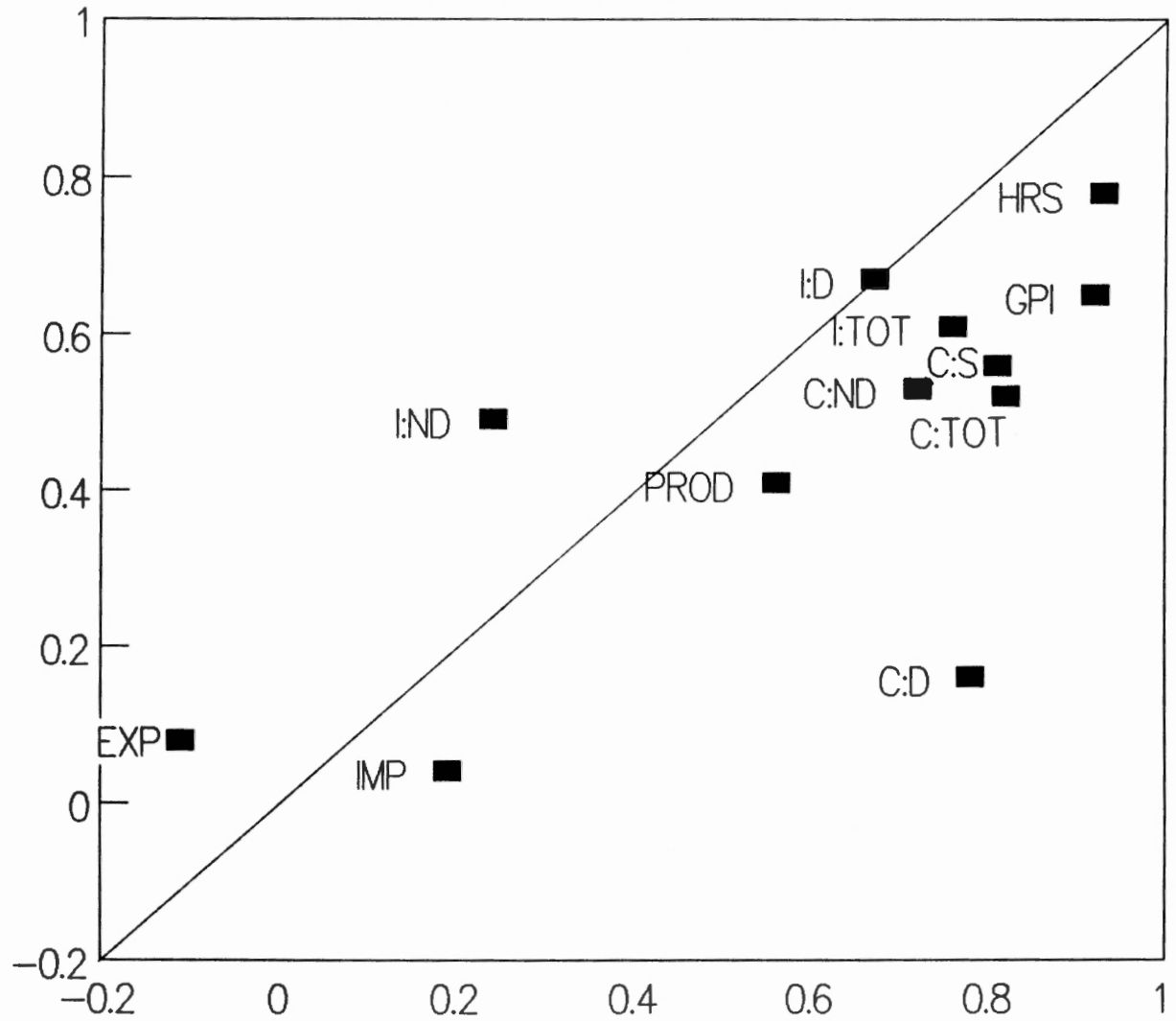

CORRELATIONS WITH GNP
linear trend filter
FIXED RATE PERIOD: 1947:1–1986:4
FLEXIBLE RATE PERIOD: 1973:1–1986:4
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
I:D
C:ND
C:TOT
PROD
IMP
C:S
I:TOT
C:D
I:ND
HRS
GPI
EXP

FIGURE 6

CORRELATIONS WITH GNP

Hodrick-Prescott filter



FIXED RATE PERIOD: 1947:1–1986:4

FLEXIBLE RATE PERIOD: 1973:1–1986:4

FIGURE 7

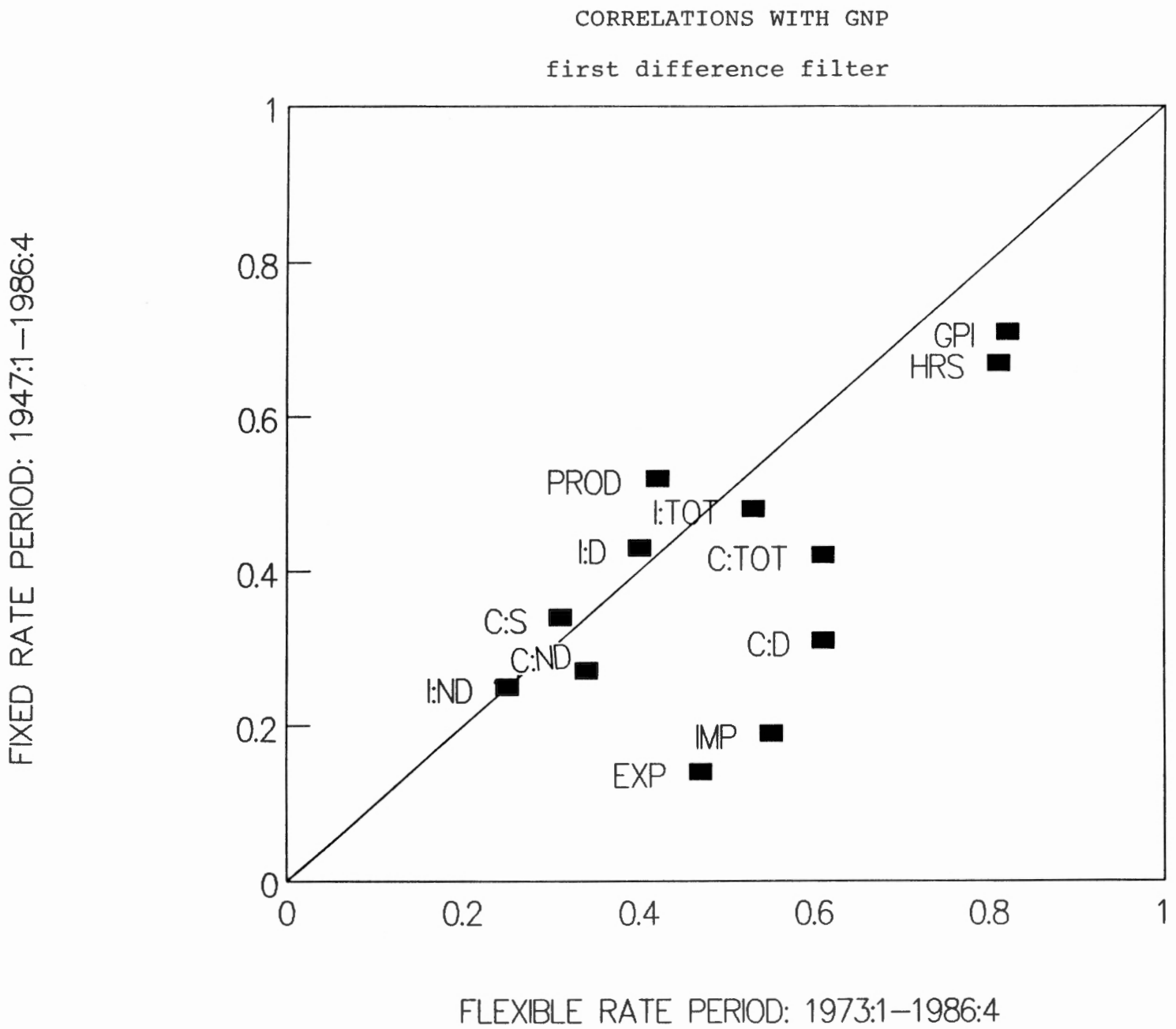

CORRELATIONS WITH GNP
first difference filter
FIXED RATE PERIOD: 1947:1–1986:4
FLEXIBLE RATE PERIOD: 1973:1–1986:4
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
GPI
HRS
PROD
I:TOT
I:D
C:TOT
C:S
C:D
C:ND
I:ND
IMP
EXP

FIGURE 8

RELATIVE VOLATILITY

linear trend filter

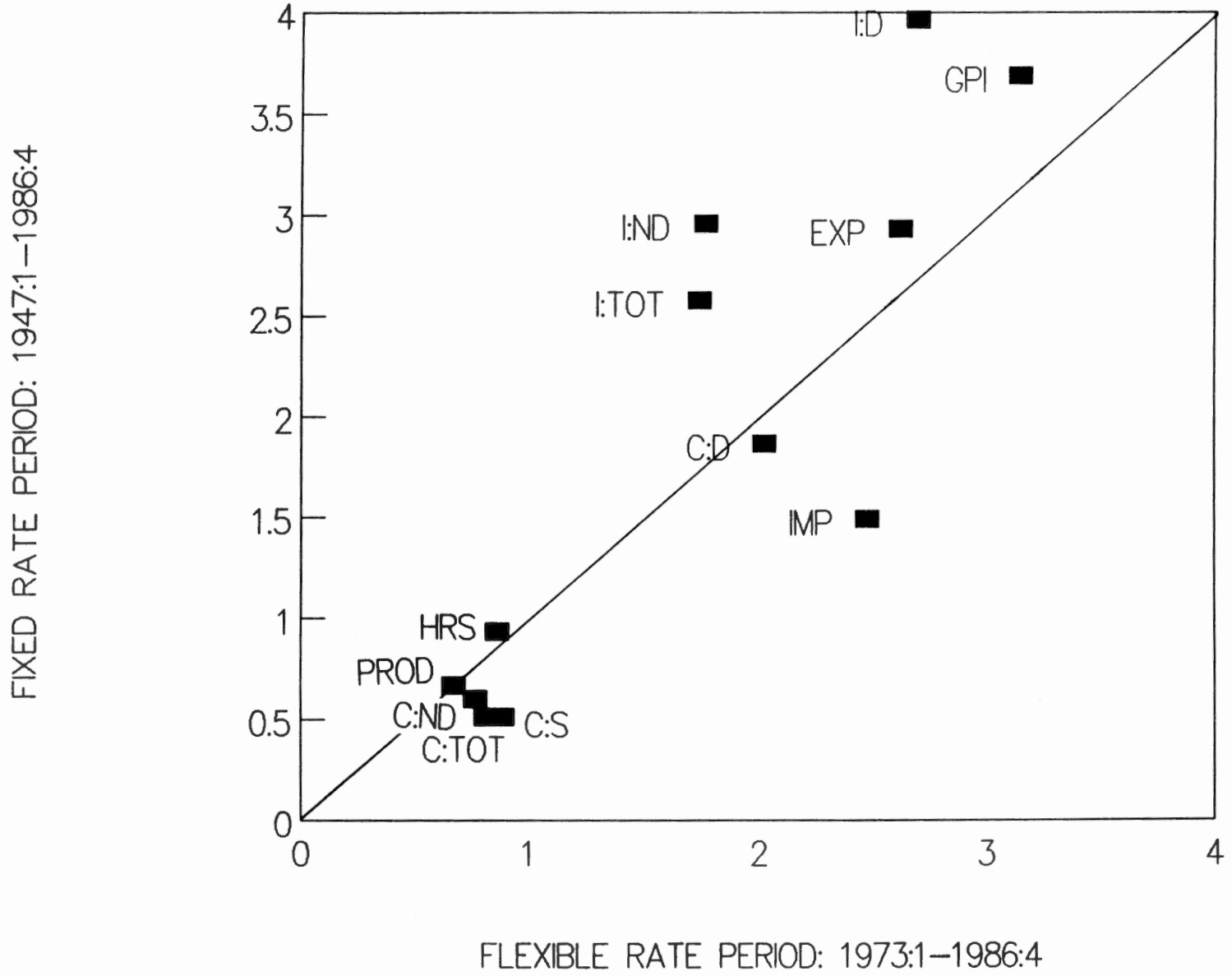
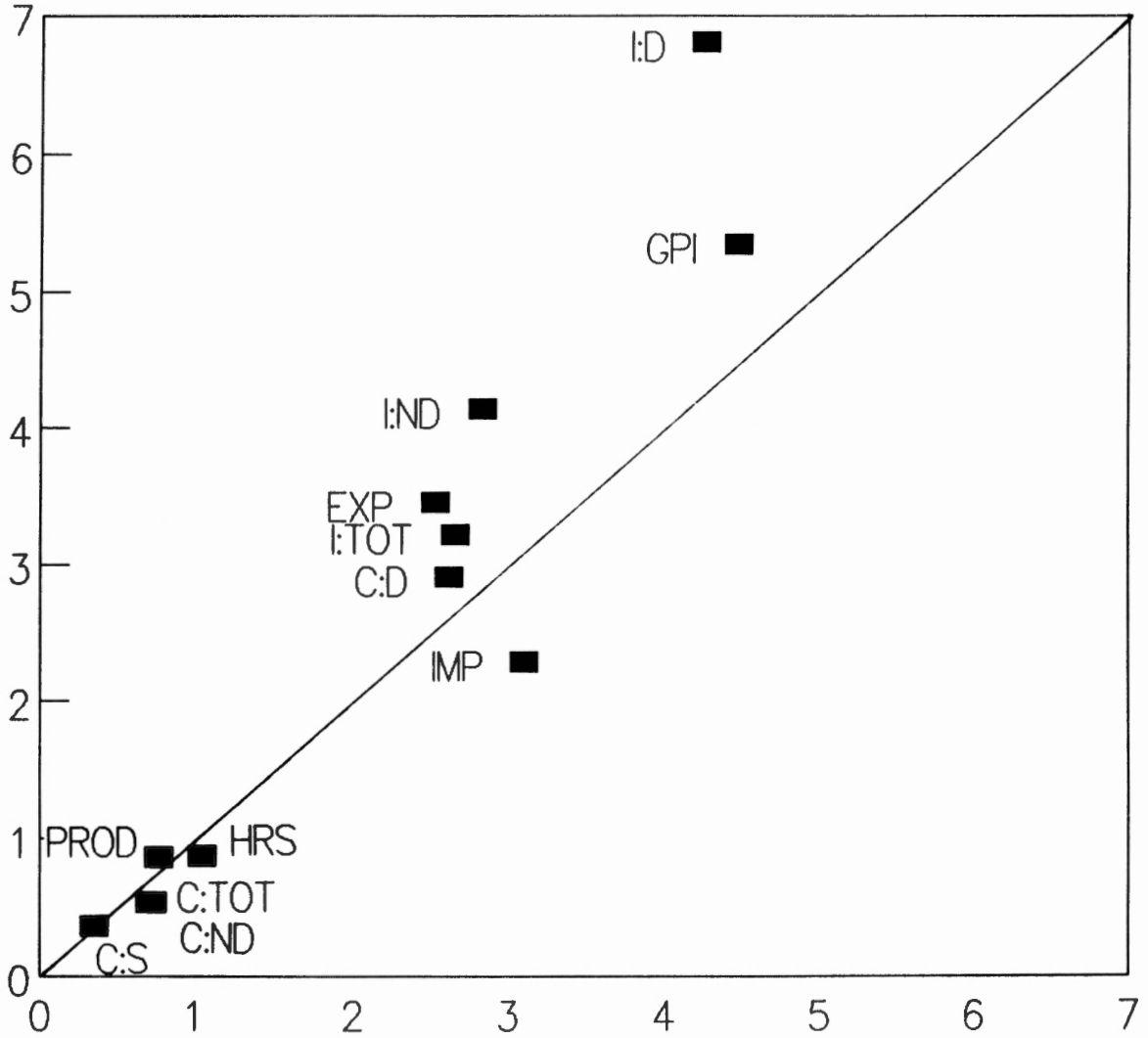


FIGURE 9

RELATIVE VOLATILITY

Hodrick-Prescott filter



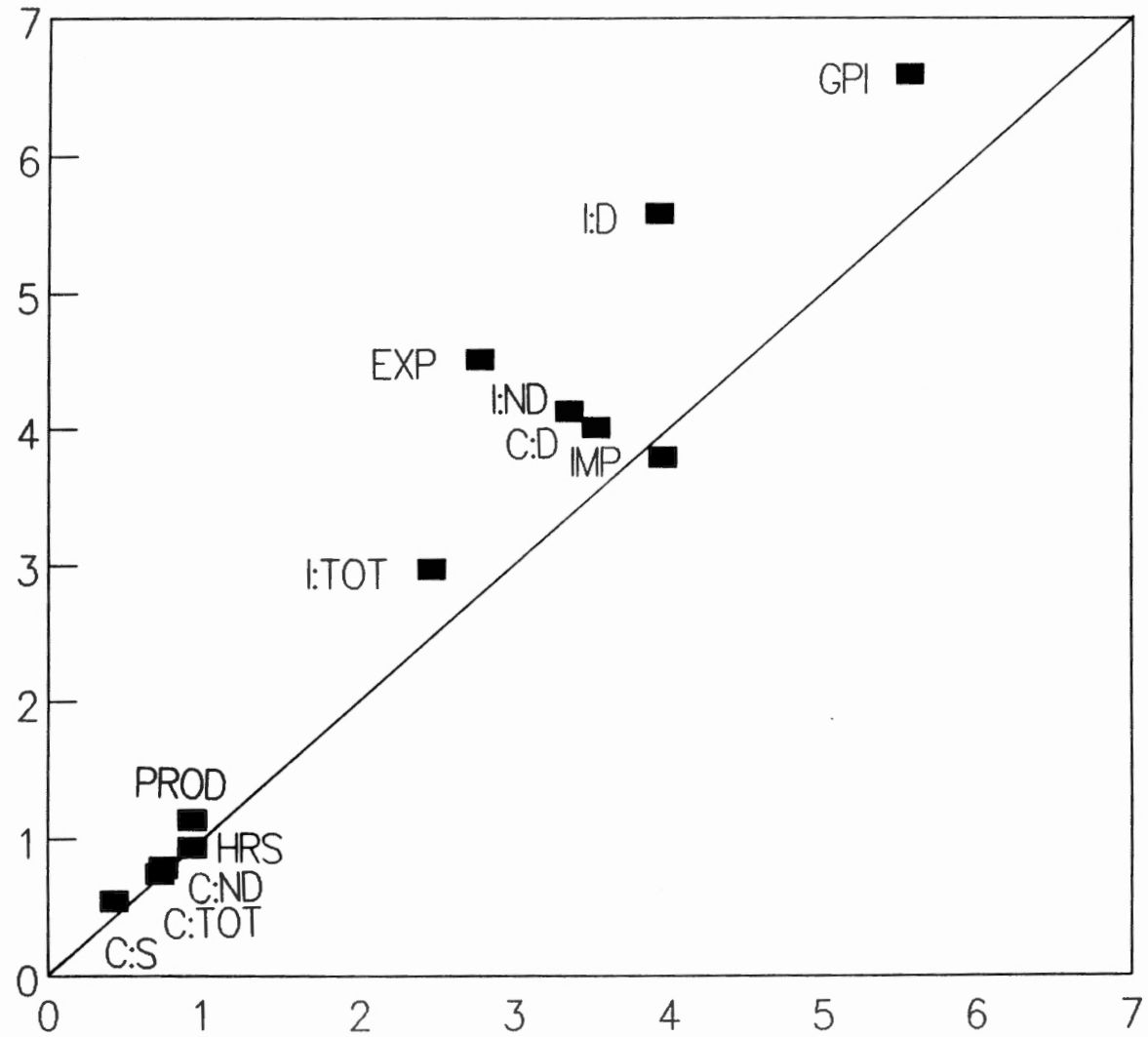
FIXED RATE PERIOD: 1947:1–1986:4

FLEXIBLE RATE PERIOD: 1973:1–1986:4

FIGURE 10

RELATIVE VOLATILITY

first difference filter



FIXED RATE PERIOD: 1947:1–1986:4

FLEXIBLE RATE PERIOD: 1973:1–1986:4

FIGURE 11

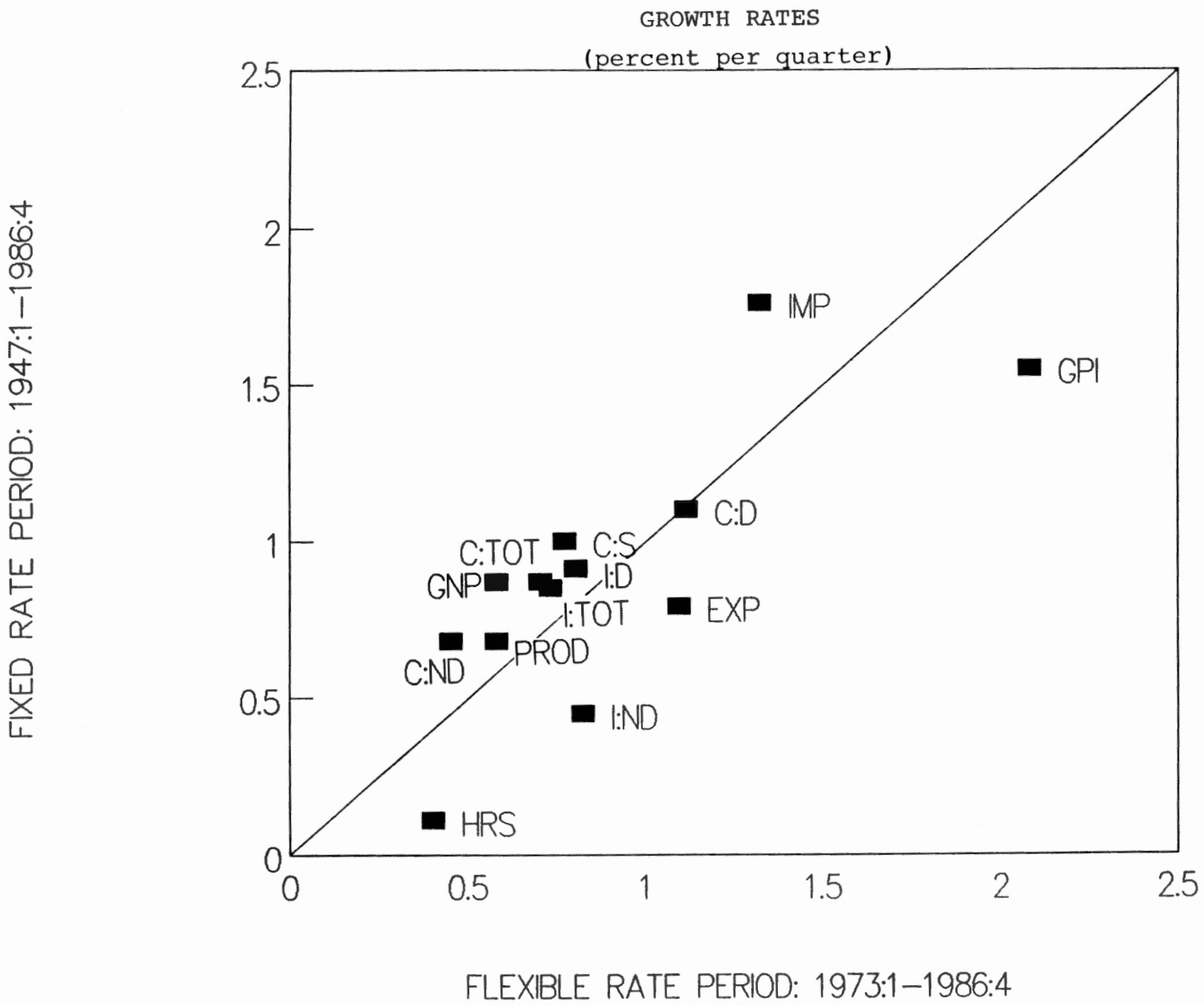

GROWTH RATES
(percent per quarter)
FIXED RATE PERIOD: 1947:1–1986:4
FLEXIBLE RATE PERIOD: 1973:1–1986:4
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
IMP
GPI
C:D
C:TOT
C:S
I:D
GNP
I:TOT
EXP
PROD
C:ND
I:ND
HRS

FIGURE 12

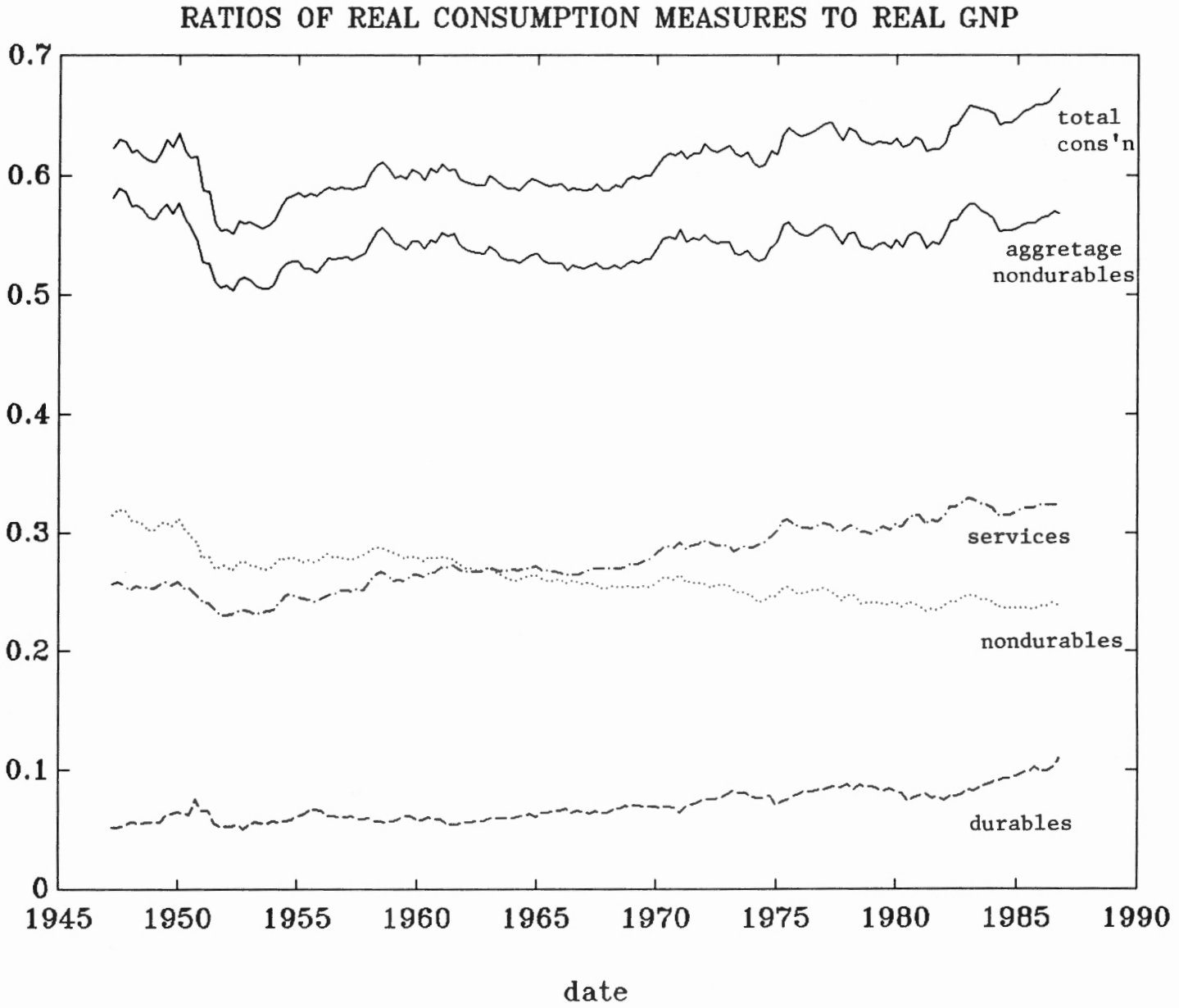

RATIOS OF REAL CONSUMPTION MEASURES TO REAL GNP
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
date
total cons'n
aggretage nondurables
services
nondurables
durables

FIGURE 13

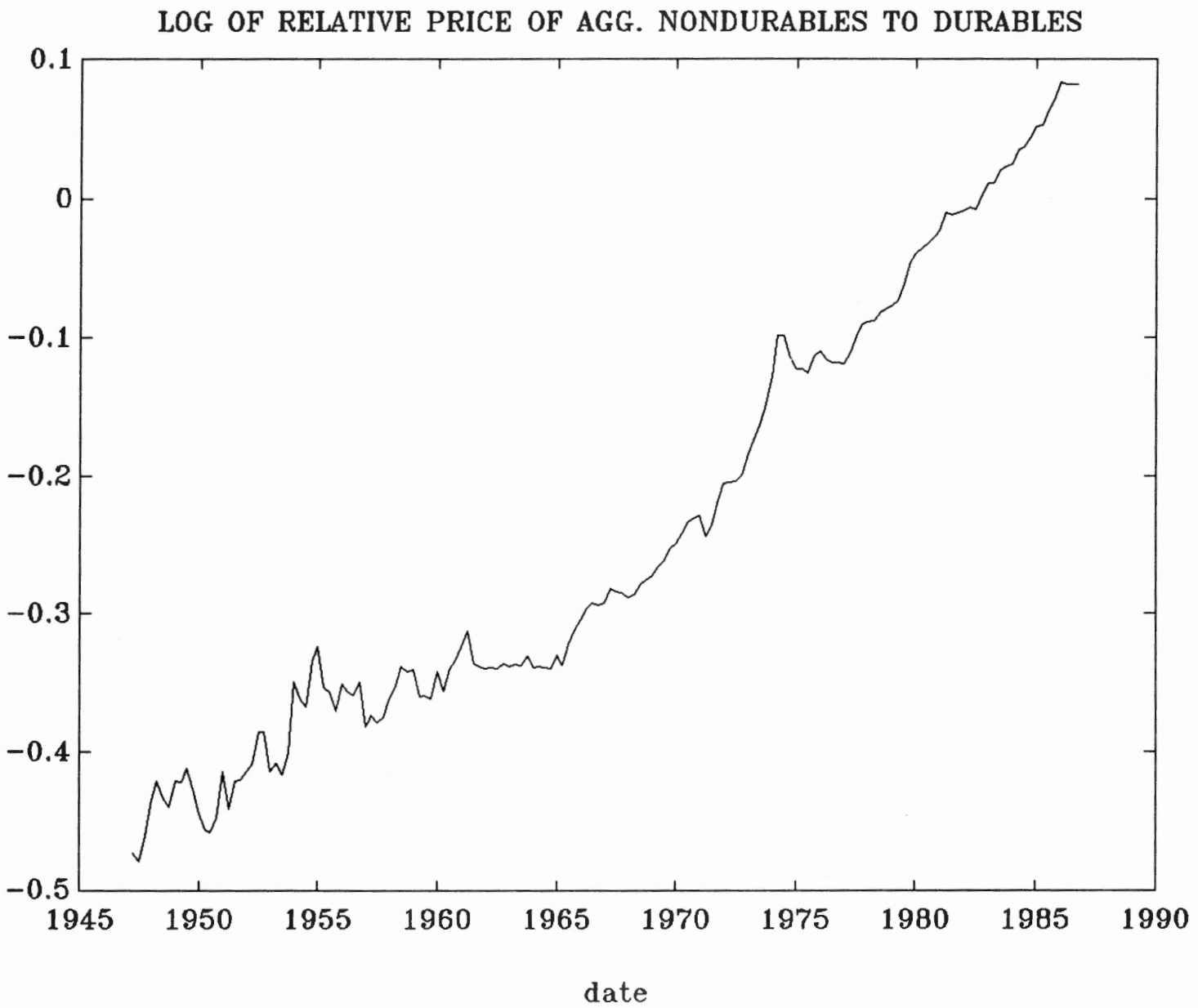

LOG OF RELATIVE PRICE OF AGG. NONDURABLES TO DURABLES
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
date

FIGURE 14

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