The Cyclical Behaviour of the Canadian Prices for the Period 1947:1-1994:2

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Abstract:

The behaviour of prices over the business cycle has received increasing attention in recent years. For long time the procyclicality of prices use to play a major role in the construction of business cycle models. However, RBC theorists recently challenged this assumption. Their empirical researches with United States postwar data revealed that the prices were acting countercyclically. This paper, examines this fact using Canadian quarterly time series data for the period 1947Q1-1994Q2. It uses the Hodrick-Prescott filtering technique to decompose the series into stationary and nonstationary components. The principal finding is that, Canadian prices were acting countercyclically during the entire period under study and various sub-periods.

1- Introduction

A fundamental question in explaining fluctuations in some macroeconomic aggregates is whether short-run deviations of output from the long-run (deterministic or stochastic) trend are caused primarily by movements in or shocks to demand or supply. If temporary shocks or movements of output stem primarily from shocks to demand, prices would be expected to be procyclical. On the other side, if output fluctuations result from shocks to supply, prices would be expected to be countercyclical. Given the preponderance of the evidence, most economists have accepted the notion that prices are procyclical. For example, Lucas (1981, p.90);

> "Before addressing these issues, however, it is well to acknowledge, or rather to emphasize, the degree to which the existence of an inflation-real output trade-off is grounded in accepted econometric methodology. It is an observed fact that, in U.S. time series, inflation rates and

> unemployment are negatively correlated. This remains true (with the obvious sign change) if unemployment is replaced by detrended real output, if price inflation is replaced by money wage inflation, and so forth. It follows that this short-run...(whatever this ambiguous qualification means) trade off will be exhibited in any econometric model estimated from these time series, regardless of its complexity, lag structure, or theoretical motivations."

Olson(1989, p.377) states that;

> "Both new-classical and Keynesian macroeconomists usually agree that the price level and real output tend to move in the same direction...By standing on this widely accepted fact, the economist can see macroeconomics from an original angle, even though the two schools of thought disagree on the causes of this procyclicality and on whether activist fiscal and monetary policies are justified."

Mankiw (1989, p.88) in response to King and C. Plosser (1984) has argued:

> "While the story of King and Plosser can explain the procyclical behaviour of money, it cannot explain the procyclical behaviour of prices. It is a well documented fact that, in the absence of identifiable real shocks such as the OPEC oil price changes, inflation tends to rise in boom and fall in recession."

However during the 1980s real business cycle (RBC) models emerged as a new approach to the analysis of macroeconomic fluctuations. They claim that real shocks (such as technological or fiscal shocks) rather than monetary shocks can explain economic fluctuations. For example Kydland and Prescott (1982) explain the dynamics of business cycles as individuals' optimal responses to changes in factor productivities. Positive technology shocks increase output and employment as workers intertemporally substitute labour toward periods of higher productivity. Recently Kydland and Prescott (1990) and Cooley and Ohanian (1991) have reported negative correlations between the detrended natural log of output and the detrended natural log of the price level as well as between inflation and output growth. Economists such as Barro (1993) interpreted these results as evidence against traditional models and in favour of real business cycle models, in which productivity shocks generate countercyclical price movements.

These conflicting results increased the rift between macro economists on the best way to explain short-run economic fluctuations. One group believes that monetary policy affects real economic activity and the other does not believe so.

The purpose of this paper is to examine the historical relationship of output-prices and unemployment-prices using Canadian time series data for the period 1947Q1-1994Q2 and 1966Q1-1994Q2 respectively. The underlying assumption is that the Canadian time series data of output, prices, and unemployment are better characterized as nonstationary stochastic processes that have no tendency to return to a deterministic time path.

Starting from this assumption, it is necessary to find and implement a reliable methodology to detrend each series into its stationary and nonstationary components. The linear filtering technique is likely to confound the two sources of variation, greatly overstating the magnitude and duration of the cyclical component and understating the importance of the growth component. The first differencing technique does not remove a stochastic growth component although it may render the series stationary. The first differences of the series under analysis will consist of the sum of the first differences of both the growth and cyclical components. Thus it will not discard variation in the growth component, which means that the problem of inferring the behaviour of each unobserved component from the aggregate still remains. Furthermore, if the series is nonstationary, by differencing one is still creating problems, as the differenced data will be devoid of any long-run information it had previously demonstrated. This is due to the fact, after differencing the series only measures the change between observations (or the rate of change if the series are expressed in logs).

Harvey (1990), explains an important problem associated with differencing two or more time series and then performing an OLS regression upon them. He states that if the true model postulated by economic theory is actually expressed in levels, then by differencing an additional Moving Average (MA) term is introduced to the disturbance term. For example, if one has the differenced relationship:

$$\Delta Y_t = B\ \Delta X_t + V_t \qquad t = 2,\ldots T \qquad 1.1$$

where V_t is actually a noninvertible MA(1) process:

$$V_t = \xi_t - \xi_{t-1} \qquad 1.2$$

then one can see a significant problem associated with differencing, as the intent of econometric modelling is usually to find a relationship between the levels of economic time series. This implies that in econometric modelling one prefers to have a stationary, not an MA, disturbance term.

As an alternative technique, the results of this paper have been obtained, using the Hodrick-Prescott (HP) filtering methodology to decompose the series into stationary and nonstationary components. The principal finding is that there exists a robust negative correlation between the detrended cyclical components of output, prices, and unemployment. These negative correlations have been interpreted as evidence of prices acting countercyclically during business cycles. This is contrary to the long standing belief in macroeconomics about prices behaving procyclically. It lends further support to the arguments of real business cycle theorists. Nonetheless these results should not be taken as a base for rejection or nonrejection to the belief of any school of business cycles. As such, it should cast doubt on the common practice of assuming a prominent role for the procyclical nature of prices in constructing business cycle models.

The paper is structured as follows. In the second section, a literature survey on business cycles and prices (Phillips curve) is presented. The third section contains a reflection on the data and the detrending methodology. The fourth section describes the empirical results. The fifth section contains concluding remarks, followed by endnotes. Finally the appendices include linear and differenced filtering results, illustrated graphics, regression results and tables, followed by the bibliography.

Section II: Literature Survey

II- From Irving Fisher and A.W. Phillips to Real Business Cycle Theorists

II.1 Phillips and the Cyclical Behaviour of Wage Inflation

In the late 1950s, A.W. Phillips (1958) published an influential paper on the relationship between unemployment and the rate of change of money wage rates in the United Kingdom (U.K.), 1861-1957. Since then countless studies have been appeared explaining the rates of change in wage rates and the price level. According to Phillips, the percentage rate of change of money wage rates ($\dot{W}$) in the U.K. depends on the percentage of labour force unemployed (U), and the rate of change of unemployment ($\dot{U}$). He argued that (1958, p.183):

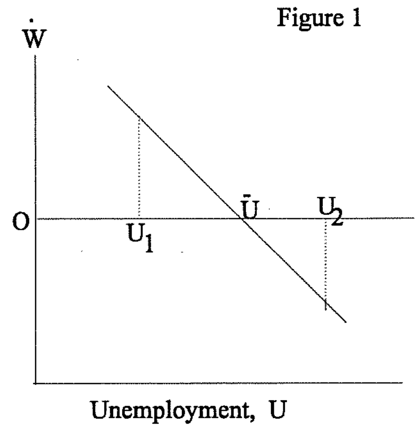
> "when the demand for labour is high and there are very few unemployed we should expect employers to bid wage rates up quite rapidly, each firm and industry being continually tempted to offer a little above the prevailing rates to attract the most suitable labour from other firms and industries. On the other hand it appears that workers are reluctant to offer their services at less than the prevailing rates when the demand for labour is low and unemployment is high so that wage rates fall only very slowly. The relation between unemployment and the rate of change of

wage rates is therefore likely to be highly non-linear."

Phillips' approach is based on a standard demand-supply model. If the quantity of labour demanded exceeds the quantity supplied, wages will be below their equilibrium level, and there will be upward pressure on them. If the quantity of labour supplied is more than the quantity demanded, there is a surplus of labour. Wages will be above their equilibrium level and there will be downward pressure on them. The larger the gap between the demand and supply of labour, the stronger the pressure and hence the faster the wages will rise or fall.

Based on this analysis, Phillips plotted the rate of change of money wage rates over time on the vertical axis and unemployment on the horizontal axis, and observed the relationship for various sub-periods of the entire period. This can be illustrated graphically as in Figure 1.

Figure 1



At point $\bar{U}$, unemployment is at its "natural"[1] rate, so wages are stable. At point U_1 unemployment is less than its "natural" rate, so there is over employment and wages are rising. At point U_2 unemployment exceeds its "natural" rate so wages are falling. For $\dot{U}$ Phillips noted that the actual values for $\dot{W}$ tended to be above the curve relating $\dot{W}$ to U when U was falling and below the curve when U was rising. He therefore postulated a relationship between the rate of change of wages $\dot{W}$, and the rate of change of unemployment $\dot{U}$, according to which $\dot{W}$ will be higher, for any given level of U, the larger is $\dot{U}$. Phillips also observed that the relationship between $\dot{W}$, U, and $\dot{U}$ had been remarkably stable over the study period which is nearly 100 years.

Later Lipsey (1960) reconsidered Phillips' work in more detail. Lipsey hypothesized that, the more unemployment reduced the more pressure on employers to raise wages in order to attract new employees and retain old ones. This means that the percentage rate of increase of the wage rate $\dot{W}$ depends on the magnitude of the excess demand for labour, $N^d - N^s$. That is:

$$\dot{W} = f(N^d - N^s); \quad \text{where } f'>0 \qquad 2.1$$

with $\dot{W}$ rising with excess demand. As Phillips observed Lipsey assumed that the relationship was non-linear, as well as different in the short run than in the long run. In order to capture these features, he transformed the excess demand expression in equation (2.1) into one based on the unemployment rate (U). To begin with, we can note that excess supply in the labour market, $N^s - N^d$, is just the negative of excess demand, that is:

$$Excess\ Supply = N^s - N^d = -(N^d - N^s) \qquad 2.2$$

Using this relationship, we can rewrite the wage adjustment equation (2.1) as:

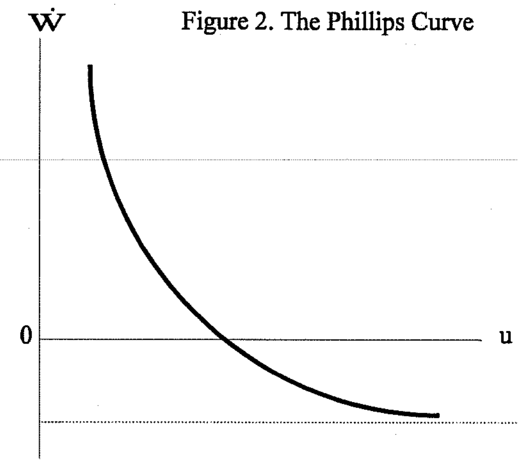
$$\dot{W} = -f(N^s - N^d) \quad \text{where } f' > 0 \qquad 2.3$$

Then he introduced the unemployment rate U as a proxy for excess supply. As excess supply rises, the unemployment rate rises. Substituting the unemployment rate for excess supply in equation (2.3) gives us the wage adjustment equation:

$$\dot{W} = g(U) \quad \text{where } g' < 0 \qquad 2.4$$

Since $\dot{W}$ falls with an increase in excess supply, it also falls with an increase in U. Thus as unemployment rises, the rate of increase of wages falls, and vise versa as unemployment falls. Equation (2.4) is what Lipsey had introduced, aversion of which had been investigated by Phillips. Figure (2) shows the basic Phillips curve equation (2.4).

Figure 2. The Phillips Curve



II.2 From Wages and Prices to Inflation

Phillips and Lipsey talked about wage changes. But both considered that wages are a major component of total cost and that prices and wages would tend to move together. Long before them Irving Fisher (1926) has also investigated the relationship between unemployment and price changes. Fisher, as with Phillips 32 years later, was impressed with the empirical observation that inflation tended to be associated with low levels of unemployment and deflation with high levels. In Fishers' words (1926, p. 497):

> "The fact that deflation causes unemployment has been well recognized for many years in isolated instances, such as the great deflation of 1921 in America or the corresponding post-war deflation in Great Britain, Czecho-Slovakia, or Norway. It has likewise been recognized that inflation carries with it a great stimulation to trade and an increase in employment(or decrease in

unemployment."

Fisher considered the rate of change of prices as an independent variable and unemployment as the dependant variable. He argued that a high spending period generates more revenue to businessmen. Each businessman considers this as an increase in the real demand for his own product. This will encourage each of them to expand output and also to allow prices to rise. At first the increase in nominal demand will result in more increases in output and employment rather than in an increase in prices. If the rate of spending slows down the converse will take place.

Fisher distinguished between the price level and changes in the price level, between high and low prices on the one hand and the rise and fall of prices on the other. Friedman (1991, p. 64) explains this in the following terms:

> "He was writing at a time when a stable level of prices was taken to be the norm. Were he writing today he would emphasise the distinction between the rate of inflation and changes in the rate of inflation."

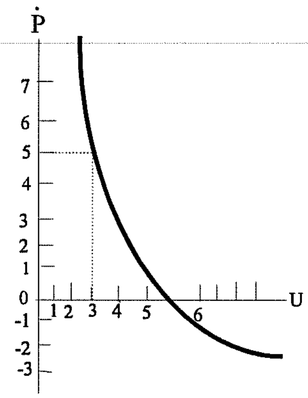
Thus both Phillips and Fisher were making linkages among wages, prices and inflation. For example the convex shape of the Phillips curve (Figure 2) suggests that, on average, the economy will have less inflation if the level of unemployment has narrow fluctuations about some average $\bar{u}$, than if the fluctuations are wider with the same mean $\bar{u}$. If unemployment is fluctuating symmetrically about the 5 percent level, for example, the average pressure on prices goes up more below the 5 percent level than it goes down above 5 percent, because of the convex nature of the curve. Thus, the broader the fluctuation in unemployment levels at any given average unemployment rate, the greater will be the cost-push inflationary pressure on the economy. However, because Phillips excluded periods of high inflation from his estimates, any estimated Phillips curve would not then be expected to remain stable during cycles of high inflation.

Samuelson and Solow (1960) extended Phillips' analysis to link prices and wages so that the Phillips curve can be stated in terms of prices as well as wages. If we assume that the distribution of income to labour and capital is constant over time, that is relative shares are constant, the percentage rate of change of prices should equal $\dot{W} - (y/N)^2$, that is:

$$\dot{P} = \dot{W} - (y/N) \qquad 2.5$$

where y is total output, and N is the labour force. Equation (5) implies that the rate of growth of the price level is equal to the rate of growth of the money wage rate less that of productivity. An example of their modified Phillips curve is presented in Figure 3.

Figure 3. The Phillips Curve: Linking Prices & Unemployment



The curve in Figure 3 indicates that the economy depicted would have to accept a 5 percent annual increase in prices if it desires to maintain a 3 percent level of unemployment. Based on their findings of the United States' past experience, Samuelson and Solow (1960) initially estimated that the American economy would have to have a 4-5 percent annual increase in prices if it were to have a 3 percent rate of unemployment. Following in their footstep, economists estimated Phillips curves for almost every country. The inverse relationship between inflation and unemployment was firmly established empirically. Thus in the 1960s and 1970s the Phillips curve became the pillar of government macroeconomic policy analysis. However by the late 60s and early 70s, the U.S. economy started experiencing a period of stagflation.

This has led many economists to theorize that the curve had shifted out, that, the cost of a given rate of inflation had risen in terms of unemployment.

II.3 The Friedman-Phelps Criticism and Contribution

The criticism to the theory underlying the Phillips curve began in earnest with the publication of a number of articles written by Friedman (1968) and Phelps (1967, 1968). They argued with great conviction that the historical Phillips curve is not a menu for policy choice because it is traced out by relations between the level of unemployment and unexpected rates of inflation or deflation. Once a position on the Phillips curve is chosen as a matter of policy, and adhered to firmly enough so that it comes to be anticipated, the historical relation will no longer hold and the curve will shift. Thus, as the element of surprises diminishes, the Phillips curve is said to be a vertical line at some "natural" rate of unemployment ($\bar{U}$). Therefore in the long run policy makers have no choice at all, at whatever rate of inflation they choose, the rate of unemployment will be the same.

According to Friedman (1991), two major defects underlie Phillips analysis:

(1) Phillips failed to distinguish between nominal and real wages. In Friedman's words (1991, p. 67):

> "Every economic theorist from Adam Smith to the present would have told you that the vertical axis in figure 1 should refer not to the nominal wage rate but to the real wage rate."

(2) The long-run relationship should be between the level of the wage rate and the rate of unemployment and not between changes in the wage rate and the rate of unemployment.

Based on these criticism Phelps and Friedman introduced the so called "expectations" approach. They modelled expectations by the then popular adaptive expectations formula (or any fixed distributed lag specification)[3], and introduced what has become known as the augmented Phillips curve. It is stated as follow:

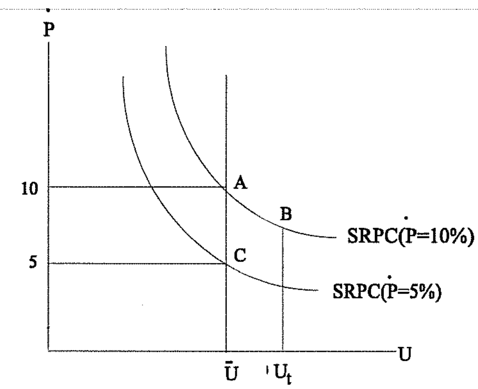
$$U_t - \bar{U}_t = -B\ (\dot{P}_t - {}_t\dot{P}^e_{t-1}) + \epsilon_t \qquad 2.6$$

$$B > 0$$

where ${}_t\dot{P}^e_{t-1}$ is the expectation formed at time t-1 of the inflation rate at time t, $\dot{P}_t$ = inflation rate at time t, and $\bar{U}_t$ = natural rate of unemployment, U_t = unemployment rate at time t and ϵ_t is a random disturbance.

Thus the stimulating effect of a rise in money demand will be felt only if it is unanticipated; once it is expected, it ceases to have a stimulating effect (unless it proceeds at an accelerating rate). This can be illustrated graphically by the following figure:

Figure 4. Augumented Phillips Curve



where SRPC = short run Phillips curve.

For example if we assume that the inflation rate ($\dot{P}$) is equal to the growth rate of the money supply ($\dot{M}$), which is to equal 10% that is:

$$\dot{M} = \dot{P} = 10\% \qquad 2.7$$

Suppose that the policy maker wants to pursue a policy of reducing the inflation rate to 5%, then:

$$\dot{M} = \dot{P} = 5\% \qquad 2.8$$

According to Friedman if the expectations formed one period earlier about the inflation rate is more than the inflation rate one period later, that is $\dot{P}_t < {}_t\dot{P}^e_{t-1}$, the economy will move from point A to point B on the SRPC. As a result unemployment will deviate from its natural rate ($\bar{U}_t$) temporarily. But as soon as the expectations adjust the economy will move from point B to point C, and unemployment will revert to its natural rate.

As Friedman predicted, when inflation accelerated in the early 1970s, the Phillips curve broke down. Nonetheless many economists criticized the augmented Phillips curve. The Keynesians who adapted the Friedman's expectations-augmented Phillips curve underplayed the voluntary or equilibrium nature of unemployment embodied in Friedman's analysis. They challenged the natural-rate hypothesis by suggesting that the aggregate demand may affect the real variables even in the long run[4].

Some New Classical theorists took it as an incomplete work and built upon it. Lucas and Rapping (1969) pointed out that Friedman's analysis was fairly informal. It was based on a simple assumption from static neoclassical economic theory, namely that the higher the real wage, the more labour would be supplied. Since according to static analysis any increase in real wages will be sustained indefinetly, Friedman's interpretation of the Phillips curve implicitly assumed that the supply of labour was elastic in the long run. But the supply of labour depends exogenously on the growth of population and long-term demographic changes, and is therefore inelastic with respect to the real wage in the long run, and elastic in the short run. To reconcile Friedman's analysis with this long/short run inelastic/elastic argument, they introduced a utility function of workers in which current and future leisure are close substitutes. Lucas also was unsatisfied with the adaptive expectations approach. He argued that under the adaptive expectations approach agents persistently and systematically make mistakes in their expectations. This would be avoided by rational agents who form their expectations rationally. Even worse from Lucas' point of view, under adaptive expectations, Friedman's natural rate hypothesis would never materialize. According to the adaptive expectations hypothesis, workers' expectations will always lag the initial rise in inflation and the supply of their labour will never adjust back to its initial level. As a result Lucas supplanted the adaptive expectations approach with the rational expectations approach in his labour market analysis.

II.4 From the Phillips Curve to the Supply Curve

As we have seen so far the Phillips curve took several related forms since its introduction in 1958. Nonetheless its essence remains that it relates the rate of inflation to the level of capacity utilization. The expectations augmented Phillips curve (EAPC) which has become popular denied this possibility of a useable long-run trade-off between inflation and capacity utilization. A rearranged version of the EAPC can be expressed by the following equation:

$$\dot{P}_t = \dot{P}^e_t - B(U_t - \bar{U}_t) + \xi_t \qquad 2.9$$

where $B > 0$

The Phillips curve presented in the above equation express essentially the same relationship as that of aggregate supply curve. Given the assumption of adaptive expectations and of a positive relation between the price level and the level of capacity utilization, this can be shown in the following way. The expectations augmented aggregate supply curve can be expressed by the following equation:

$$P_t = P^e_t + 1/\lambda(Y_t - \bar{Y}_t) \qquad 2.10$$

Subtracting last year's price level, P_{t-1}, from both sides of the equation (2.10), gives us the following equation:

$$P_t - P_{t-1} = (P_t^e - P_{t-1}) + 1/\lambda(Y_t - \bar{Y}_t) \qquad 2.11$$

The term $P_t - P_{t-1}$ represents the difference between the current price level and last year's price level, which is the rate of inflation ($\dot{P}_t$). The term $P_t^e - P_{t-1}$ represents the difference between the expected price level and last year's price level, which is the expected rate of inflation ($\dot{P}^e$). Therefore, we can rewrite equation (2.11) as follows:

$$\dot{P} = \dot{P}^e + 1/\lambda(Y_t - \bar{Y}_t) \qquad 2.12$$

The preceding equation gives us the Phillips curve in inflation-real output space. To arrive at the Phillips curve in inflation-unemployment space we have to resort to Okun's law (Okun,1970).

Okun's law is one of the tools widely used by policy makers to measure the costs of unemployment and the gains of economic growth. It can be stated in several different ways. In one version, it states that deviations of output from its natural rate are inversely related to the deviation of unemployment from it natural rate; that is, when output is higher than the natural rate of output, unemployment is lower than the natural rate of unemployment. We can use this relationship to substitute $-B(U_t - \bar{U}_t)$ in equation (2.12) for $1/\lambda(Y_t - \bar{Y}_t)$ and the equation (2.12) becomes:

$$\dot{P}_t = \dot{P}_t^e - B(U_t - \bar{U}_t). \qquad 2.13$$

Adding a disturbance term (supply shocks) ξ_t to the above equation we obtain the expectation augmented Phillips curve equation (2.13) as an aggregate supply equation.

In an attempt to overcome the dichotomies created by their assumptions about changes in the general price level and money wages Keynesians enthusiastically accepted this analysis of combined Okun's law and the Phillips curve. The concept of potential output embodied in Okun's law became the basis of their inflationary-gap and demand-pull theories of inflation. The reasons for this were two important implications of the potential output concept. When aggregate demand is in equilibrium with potential output:

(1) the corresponding unemployment rate is, in a sense, an optimal rate; and

(2) the rate of change in the general price level (inflation rate) is null.

If the concept of potential output is replaced by that of full-employment output, the excess of potential output over aggregate demand is called the GNP gap. The GNP gap can be negative without reaching a zero unemployment rate. The implication is that a rise in the general price level is admissible even before the economy reaches full employment. This came to be known as the phenomenon of creeping inflation.

As a result of this combination of the GNP gap and the Phillips curve in the keynesian analysis of aggregate supply, equilibrium no longer means determining the output level and the rate of change in the inflation rate. Consequently, Keynesian policy recommendations would be reformulated on a new theoretical basis. In fact, policy-makers could now choose the best combination of inflation and unemployment rates because the existence of a trade-off between inflation and unemployment had been shown to exist (Samuelson and Solow, 1960; Rees, 1970).

II.5 Rational Expectations and the Lucas Supply Curve

Lucas (1972a, 1972b, 1973) argued that if people's expectations were persistently and systematically mistaken as they would be on Friedman's or Phelp's hypotheses about their formation, they could not be considered rational. Rational economic agents would not persist in mainly systematic mistakes, because doing so would be expensive. They will correct these mistakes as soon as they become aware of them. According to the rational expectations approach, expectations are based on the assumed efficient use of all the available information. Therefore they may be randomly incorrect but not be so systematically. The most significant implication of rational expectations approach is that the policy cannot rely for its effectiveness on systematic misunderstandings by economic agents. The best option for policy makers when formulating policy is to assume that agents will soon understand how a particular policy is working. Also policy makers should understand that, a policy that works for some time only because the economic agents does not correctly anticipate its effects is doomed to eventual failure. This implies that in the Phillips curve scenario as soon as workers discover their mistakes about their expectations of the real wages, they will reduce their labour supply to its equilibrium level. In Contrast to Friedman's analysis the distinction between the long run and the short run is not very useful. In Lucas' analysis the long run collapses to the short run as soon as workers adjust their expectations. In his (1972a) econometric model of the labour market, Lucas managed to show that, if economic agents have perfect information, money is neutral and there is no deviation from the natural rate of unemployment or in other words there is no Phillips curve. However, the inverse relationship between inflation and unemployment exists if the perfect information assumption is relaxed. For example let the workers and firms have the following two types of expectations:

(1) expectations of the nominal wage rate and the price of the

goods being produced in their own industry;

(2) expectations of the general level of prices (prices of all other goods).

According to rational expectations these expectations are correct on average, but workers lack information about the aggregate price level and do not know the real wage. Since it is the real wage and not the nominal wage that determines their supply of labour, workers will have to negotiate on the basis of their expectations concerning the aggregate price level. If the price level is correctly predicted, then the real wage will adjust to its equilibrium level and output will be at its full employment level. Suppose now that the price level turns out to be higher than anticipated by the workers ($P^e < P$). At any given nominal wage, workers will now supply more labour than they would have if they had correctly predicted the price level. This follows from the fact that the workers perceive a higher real wage, that is $(W/P^e) > (W/P)$. However, the demand for labour will increase because firms know the price of their own product, when the demand for labour is aggregated across firms, it will be the actual price level in their industry and therefore the actual real wage that will determine demand. It follows that firms will employ more workers and raise employment above its equilibrium level. If the actual price level turns out to be below the predicted level ($P < P^e$), then $(W/P) > (W/P^e)$ and employment and output would be below their full-employment levels. This means that the inverse relationship between inflation and unemployment exists.

Lucas summarized his analysis in the following aggregate supply equation which has become known as the Lucas supply curve:

$$Y = \bar{Y} + \lambda(P - P^e) \qquad 2.14$$

which shows that the amount of output that firms are willing to supply increases as the gap between the actual and the expected price level increases. The key element in the existence of the above curve is the confusion by economic agents of absolute changes in the general level of prices with changes in relative prices[5]. When inflation rises or falls the rational agent will try as best he can to discern what fraction of the change in his own price due to changes in the real demand for his product and what fraction was inflation. He will try to form his judgement as efficiently as possible, given the available information. This what is called signal extraction. The more volatile the inflation the less easy it will be for economic agents to differentiate between changes in relative prices and changes in the general level of prices. Therefore, the greater the possibility of misinterpreting the price movements they observe.

Lucas did not escape criticisim. Keynesians undermined his imperfect information approach by referring to the availability of information on the aggregate price level and money supply over much shorter time periods than the duration of the average business cycle. Another critique is that, rational microeconomic agents care about the relation of their own price to their own costs, not to aggregate nominal demand. Fortin (1991) provides a good summary of critiques of rational expectation theories of inflation and their empirical failures.

II.6 The Contributions of Real Business Cycle Theorists

Real business cycle (RBC) theorists form a small but influential offshoot group of New Classical economists. They use the same assumptions of the classical model, especially flexible prices and monetary neutrality. Their idiosyncrasy is the complete absence of the influence of nominal variables such as money supply and the price level on output and related real variables in both long and short run. Nonetheless, some advocates of RBC theory have pointed out that they do not completely rule out the influence of money on output in principal (Prescott, 1986), but argu that it is relatively small. According to them, the main sources of economic fluctuations stem from technological changes. Individuals respond to these technological changes by intertemporal substitutions of work and leisure. Because of these intertemporal substitutions, economic booms occurs during periods of technological progress and lead to increased employment. While recessions occur during technological regresses which reduce output and employment. Another cause of economic fluctuations, according to RBC theory, is fiscal shocks. For example, changes in the level of government purchases or in investment tax credit alter the demand for goods and services, and therefore affects output and employment. However, the RBC economists' explanation of why fiscal shocks affects outputs and employment is different from the explanation provided by IS-LM models. In the IS-LM model, prices are sticky, and aggregate demand determines output and employment. In the RBC model, prices are flexible and workers engage in intertemporal substitution. An increase in government purchases increases the demand for goods. The result is a higher output level and interest rate, which reduces consumption and investment. In addition the higher interest rate alters the relative value of options open to workers, and leads them to choose to defer leisure and to work longer hours, which increases labour supply. As a result of this type of analysis, RBC models do not allow for the possibility of involuntary unemployment. Based on these analysis, RBC theorists conclude that economic fluctuations are corrections for economic imbalances and therefore there is no need for stabilization policies.

Many economists do not agree with the concept of intertemporal substitution embodied in RBC models. According to economic theories, consumption and leisure are normal goods that move together during business cycles. But RBC economists explain that by stating that during recessions real wages falls and therefore workers elect to consume more leisure and work less, which means that real wages are procyclical.

Many economists also disagree with the validity of real business cycle theory. The main criticisms are:

(1) The importance of technological shocks, especially their duration and size. Critics argue that the economy does not experience large shocks to technology, and when they occur, their evolution will occur gradually over extended periods of time. Critics are also skeptical about interpreting recessions as a result of technological regressions. Technological knowledge may slow down, but it is hard to imagine that it would go in reverse.

(2) Cycles are efficient or Pareto optimal, which implies there is

no involuntary behaviour. As Mankiw (1989, p. 83) puts it:

> "of all the implications of real business cycle theory, the optimality of economic fluctuations is perhaps the most shocking. It seems undeniable that the level of welfare is lower in a recession than in the boom that preceded it. Keynesian theory explains the reduction in welfare by failure in economic coordination: because wages and prices do not adjust instantaneously to equate supply and demand in all markets, some gains from trade go unrealized in a recession. In contrast, real business cycle theory allows no unrealized gains from trade. The reason welfare is lower in a recession is, according to these theories, that the technological capabilities of society have declined."

(3) The intertemporal substitution assumption does not constitute a solid argument, and needs a lot of explanation to justify its plausiblity. Critics believe that fluctuations in employment do not reflect changes in the amount people want to work. They believe that desired employment is not very sensitive to the real wage and the real interest rate. They point out that the unemployment rate fluctuates substantially over the business cycle. The high unemployment in recessions suggests that the labour market does not clear. These critics conclude that wages do not adjust to equilibrate labour supply and labour demand, as real business cycle models assume.

(4) Absence of a demand side from the model: critics argue that the

evidence does not support the assumption of monetary neutrality. They point out that reductions in money growth and inflation are almost always associated with periods of high unemployment. Monetary policy appears to have a strong influence on the real economy.

II.7 The New Keynesian Counter Attack

The views of New Classical economists about business cycles, have been challenged by New Keynesian economists.[6] New Keynesians believe that market-clearing models can not explain short-run economic fluctuations, and so they advocate models with sticky wages and prices. They distinguish between price setting in product markets and wage setting in labour markets, and between nominal rigidity and real rigidity. The rigidity of nominal prices stems from unequiproportionate adjustment of these nominal prices to changes in nominal demand. In Gordon's words (1990 p.1149),

> "However some of the new-Keynesian theories explain real rigidities as the stickiness of a wage relative to another wage, of a wage relative to a price, or of a price relative to another price."

The rigidities in the product markets involves customer markets, inventory models, and theories of markups under imperfect competition. Those in the labour markets involves implicit contracts, efficiency wages, and insider-outsider models (Gordon 1990). The stickiness of nominal prices in the product market stems from the stickiness of marginal costs in imperfectly competitive markets. Gordon (1990) argued that the marginal cost can not fall proportionately equal to the fall in demand. Mankiw (1985) assumes that nominal demand shocks affect demand curves and marginal cost curves equiproporionably. Therefore, marginal cost fall to the required marginal cost that keeps output unchanged. Then he carries out his analysis with two of his fundamental building blocks of his theory. First he proposes a flat profit function:

$$\partial \pi / \partial P |_{P=\hat{P}} \approx 0 \qquad 2.15$$

where π is profit, p is prices and $\hat{p}$ is the profit maximizing price. The profit function at $\hat{P}$ is nearly flat, if a small deviation in the price is affecting profits, firms may not change the price. Second menu costs include such costs as printing new catalogues, informing salesmen of the new prices and the entire range of costs that managers must incur whenever nominal prices are changed. These costs are small but according to Mankiw can cause price stickiness. The nominal rigidity also stems from what is called staggered contracts. A change in nominal demand can affect output for a period that exceeds the length of the interval during which prices are predetermined, which is called contract interval even though there is no necessity that explicit or implicit contracts be involved.[7]

Most of the preceding analysis also applies to labour markets as Gordon (1990 p.1124) stated:

> "For new-Keynesian models to avoid inconsistency, their distinction between small menu costs of price changes and large social costs output changes must apply equally in the labour and product markets. The same costs of adjustment that inhibit price changes must apply equally to wages, which are just another price."

Also they have distinguished between nominal and real rigidity of wages. Workers care mostly about the stability of real wages. One source of real wage rigidity stems from the monopoly power of workers' unions. The wages of these workers are determined by collective bargaining between union leaders and firms management. In most cases, the final agreement raises the wage above its equilibrium level and allows the employers to decide how many workers to employ. Another source of real wage rigidity is the cost involved in replacing experienced incumbent workers which is the key feature of insider-outsider models. The insiders or incumbents receive a higher real wage $(W/P > (W/P)_f)$. The outsiders who are unemployed or work in causal or secondary jobs have no control over the wage setting mechanism. This creates imperfectly competitive markets because the insiders gain market power and can raise their real wages. If the outsiders try to underbidd them, the insiders cooperate among themselves by influencing turnover costs, leading to involuntary unemployment. Other sources of real wage rigidity is the so called efficiency wage. For example:

$$L^{*} = f\left(\frac{W}{P}\right) L \quad w \qquad 2.16$$
$$where \quad f' > 0 \quad f'' < 0$$

$$Y = f(L^{*}, K) \qquad 2.17$$

where L^{*}= efficiency labour units, w/p = real wage rate, L = Labour unit.

According to this theory efficiency labour units are an increasing function of real wages times labour units. So a firm can set the real wage higher than the market-clearing level to attract more efficient workers. If there are negative demand shocks, firms do not reduce real wages because this may lower the productivity of existing workers, so instead they lay off workers.

The main source of nominal wage rigidities stems from staggered wage contracts. Suppose there is two periods of wage contract, t+1 and t+2. ½ the firms sign wage contract each period

${}_{t+1}W_t$ so that:

$$\frac{[{}_{t+1}W_t]}{[{}_{t+1}P^*_t]} = (\frac{W}{P})_f \qquad 2.18$$

where $(W/P)_f$ is the market clearing real wage.

The other ½ set their wages next period so that ${}_{t+2}W_t$ is set as:

$$\frac{[{}_{t+2}W_t]}{[{}_{t+2}P^*_t]} = (\frac{W}{P})_f \qquad 2.19$$

If the price level in time t+1 is equal to what economic agents expected one period earlier then:

$$P_{t+1} = {}_{t+1}P^*_t \text{ then } \frac{[{}_{t+1}W_t]}{[P_{t+1}]} = (\frac{W}{P})_f \qquad 2.20$$

employment will be at its full equilibrium level, which is $N = N_f$. However, if the price level at time t+1 is less than what was expected:

$$P_{t+1} < {}_{t+1}P^*_t \text{ then } \frac{[{}_{t+1}W_t]}{[P_{t+1}]} > (\frac{W}{P})_f \qquad 2.21$$

Employment will be less than its full equilibrium level, that is $N < N_f$.

Thus workers are trying to obtain all the time, the market clearing wage $(W/P)_f$. Firms are always on their demand schedules. As a result lay offs can occur.

Section III: The Data and the Methodology

III.1 The Time Series

The empirical analysis of this paper is based on the following three series:

1) Monthly data on the Consumer Price Index (CPI) from 1947:1 to 1994:2 (Cansim number P484549), seasonally adjusted, 1986=100.

2) Quarterly, Real Gross Domestic Product, expenditure based 1986 prices, seasonally adjusted at annual rate (SAAR), from 1947Q1 to 1994Q2, (Cansim number D20463).

3) Monthly Unemployment rates for 15 years and over, seasonally adjusted , from 1961Q1 to 1994Q2, (Cansim number D767611).

Both monthly series were transformed to quarterly series using a moving average method. The tendency of economic time series to exhibit variation that increases in mean and dispersion in proportion to absolute level motivates the transformation to natural logs and the assumption that trends are linear in the transformed data. Therefore all series are analysed using a logarithmic transformation.

The levels of these series are illustrated in graph 1, 2, and 3 (see appendix #3 for graphics), and a summary of statistics about the means and standard deviations for the full and several subsamples are presented in table 1 (see appendix #2 for tables).

The average level for the entire period 1947Q1-1994Q2 for RGDP and CPI is 12.48, and 3.72 respectively. For the unemployment series the average level for the entire period 1966Q1-1994Q2 is 2.00. For each of the series the highest average is at sub-period 1982Q1-1994Q2, which is 13.16 for RGDP, 4.68 for CPI, and 2.29 for the unemployment. The lowest average for RGDP and CPI is in the sub-period 1947Q1-1959Q4, which is 11.71 and 3.05 respectively. The unemployment series do not cover this sub-period, therefore the lowest mean is at the sub-period 1966Q1-1972Q4, which is 1.56.

Based on these statistics one can infer that almost the same pattern of shifts in means was present in each of the three series. Both graphs 1 and 2 for RGDP and CPI exhibit strong upward trends over the entire period under analysis. The unemployment series, which is plotted in graph 3, exhibits also an upward trend but not as strongly as do the output and prices series.

To detect whether these series contain a unit root, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests have been conducted. The following regression is used to check for these unit roots:

$$\Delta y_t = \alpha_0 + \beta_t(t) + (\rho-1)y_{t-1} + \sum_{i=1}^{K} \gamma_i \Delta y_{t-i} + \varepsilon_i \qquad 3.1$$

Equation (3.1) is known as the ADF test (Said and Dickey 1984). The null hypothesis in the ADF test is a unit root ($\rho=1$). For y_t to be stationary, $(\rho-1)$ should be negative and significantly different from zero. The PP test (1988) is applied whenever it is suspected that the errors are autocorrelated or heteroscedastic. It proceeds by running the same auxiliary regression (3.1) and obtaining DF statistics and then adjusting these statistics before consulting the critical values appropriate for that version of the DF test. The necessary critical values required for the unit root hypothesis testing are provided in Hamilton (1994).

The recommended test for the RGDP and CPI series for the presence of a unit root is case (4)(Hamilton 1994, p.497), which state that the regression should include a constant term and a time trend, the true process is random walk with or without drift. An example of a random walk with zero drift can be described by the following equation:

$$y_t = y_{t-1} + \varepsilon_t \qquad 3.2$$

by repeated substitution for y_{t-1} $i = 1,2,\ldots,t$, equation (3.2) can be written as:

$$y_t = y_0 + \Sigma e_{t-i} \qquad 3.3$$

A random walk with drift can be described by the following equation:

$$y_t = \mu + y_{t-1} + \epsilon_t \qquad 3.4$$

where μ is constant. Also by repeated substitution equation (3.4) can be written as:

$$y_t = y_0 + \mu t + \Sigma \epsilon_{t-i} \qquad 3.5$$

From equation (3.3) and (3.5), we can see that an impact of an exogenous shock to ξ_t, does not die out, it is permanent. This is because y_t depends on y_{t-1}, the shocks are transmitted to future periods as well, generating the serial correlation typical of business cycles.

On the other hand, the stationary process can be described by the following equation:

$$y_t = \mu + \alpha y_{t-1} + \epsilon_t \qquad 3.6$$

where $|\alpha|<1$.

By repeated substitution equation (3.6) can be written as following:

$$y_t = \Sigma \alpha^i \mu + \alpha^t y_0 + \Sigma \alpha^i \epsilon_{t-i} \qquad 3.7$$

As we can see in equation (3.7) an impact of exogenous shock to ε_t has a transitory effect on y_t, gradually diminshing as time passes.

Nelson and Plosser (1982), test statistical specifications similar to equation (3.6) against specifications similar to equation (3.4) for output, employment, industrial production and many other important aggregates. They conclude that most aggregates are better described as random walks than as fluctuations about deterministic trends.

For the unemployment series, the recommended test for unit roots is case 2 (Hamilton 1994, p. 490), which state that, the regression should include a constant term but no time trend, and the true process is a random walk.

The three seasonally adjusted quarterly series have been tested. Table (2) and (3) present the unit root test results for the ADF and PP tests respectively. The lags for the ADF test are selected based on the Akaike information criterion (AIC) and the Schwarz criterion (SC)[8]. For PP tests, they are selected by default in shazam. These lags seem reasonable hence the seasonality is already eliminated from the series[9]. For all the series, both ADF and PP tests indicated that the unit root null hypotheses cannot be rejected for the (log) level of the series at the 5% significant level, which implies nonstationarity.

III.2 The Hodrick-Prescott (HP) Filter Methodology

Hodrick and Prescott (1980) proposed a linear filter (HP filter) to decompose nonstationary macroeconomic time series into a stationary business-cycle component and a nonstationary trend component. It is based on the assumption that nonstationary movements in time series are captured by smooth and slowly changing trends. Recently the HP filter has been widely used in empirical researches. For instance, in the vast literature on stylized business-cycle facts, the HP filter is used to isolate movements about trends in macroeconomic variables (see, among others, Brandner and Neusser 1992, Danthine and Girardin 1989, Backhus and Kehoe 1992, and Kydland and Prescott 1990). Applied macroeconomists have also started to use the HP filter frequently to extract the cyclical component of time series. For example, Torres and Martin (1990) report estimates of potential output based on HP Filter estimates of the trend in total factor productivity for various OECD countries. Hoeller and Poret (1991) use HP filtering to isolate cyclical movements in prices, income velocity and real output.

The HP filter can be derived by minimizing the sum of the squared deviations of a variable from its trend subject to a smooth trend. For example if the trend component, denoted τ_t, for t = 1,2,...,T, is the one that minimizes:

$$\sum_{t=1}^{T}(X_t - \tau_t)^2 + \mu\sum_{t=2}^{T-1}[(\tau_{t+1} - \tau_t)-(\tau_t - \tau_{t-1})]^2 \qquad 3.8$$

where X_t is a macroeconomic time series for t = 1,2...,T, and μ is a fixed parameter. Both X_t and τ_t are logged series. μ can be interpreted as a penalty on movements in the growth rate of the trend component. If $\mu = 0$, the growth component series coincides with the observed series and the cyclical component is zero. If μ goes to infinity, the trend component approaches a linear deterministic time trend. Hodrick and Prescott (1980) proposed a value of $\mu = 1600$ for quarterly time series data as reasonable. For the minimization problem (HP), the first-order condition takes the form:

$$\begin{aligned} 0 = -2(x_t - \tau_t) &+ 2\mu[(\tau_t - \tau_{t-1}) - (\tau_{t-1} - \tau_{t-2}] \\ &- 4\mu[(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})] \\ &+ 2\mu[(\tau_{t+2} - \tau_{t+1}) - (\tau_{t+1} - \tau_t)]. \end{aligned} \qquad 3.9$$

If we assume e_t is the cyclical component, then the first-order condition links $e_t = X_t - \tau_t$ to changes in the growth component in both past and future periods.

To solve this first-order condition consider the optimal linear filter that can be obtained as the time series variable length (T) is driven to infinity. In this case, the first-order condition can be written in the form $A(L)\tau_t = X_t$, where the polynomial in the lag operator L with $L^n\tau_t = \tau_{t-n}$ is defined:

$$A(L)=\sum_{j=-\infty}^{\infty} a_j L^j \qquad 3.10$$

The A(L) polynomial associated with this first-order minimization problem is:

$$\begin{aligned} A(L) &= [\mu L^{-2} - 4\mu L^{-1} + (6\mu + 1) - 4\mu L + \mu L^2 \\ &= [\mu(1 - L)^2(1 - L^{-1})^2 + 1] \end{aligned} \qquad 3.11$$

In order to find the growth and cyclical filter, we need to invert A(L), since $A(L)\tau_t = X_t$ then $\tau_t = A(L)^{-1}X_t$. The row of A serve to impose a two-sided filter on each data point in the series X_t. The rate at which the weights decline is determined by the parameter μ.

King and Rebelo (1993) show that for the special case of the HP filter, the preceding equation takes the form:

$$\epsilon_t = A(L)X_t = [\frac{\mu(1 - L)^2(1 - L^{-1})^2}{1 + \mu(1 - L)^2(1 - L^{-1})^2}]X_t \qquad 3.12$$

Lépine (1994, p.1) summarized the advantages summarized the advantages and disadvantages of HP filter as follows:

> "This univariate filter has a number of advantages over alternative methods (such as linear time trends). First, the HP filter is structural (i.e.

> a single parameter can be estimated). Second, it treats fluctuations in the variable of interest as stochastic phenomena. Finally, it requires weak prior knowledge, since it is based on a simple intuitive assumption that the trend component is affected by permanent shocks while the cyclical component is only affected by transitory shocks. The HP filter also has a number of weakness, however. To estimate potential output, for instance, it may be difficult to distinguish between demand (temporary) and supply (permanent) shocks. This problem is even more severe at the end of the sample, since most information is not available about the long-run effects of the latest shocks".

However Jaeger (1994 p.494), cautiones that the use of HP filter to decompose a random walk time series can generate spurious cycles. He stated that:

> "The spectrum of a HP-filtered random walk process has a peak at the frequencies typically associated with business-cycle movements and its autocorrelation function has the appearance of a damped sine wave".

Section IV: Time Series Analysis of Prices, Output, and Unemployment

IV.1 Motivations

The objective of this section is to examine which argument of the different schools of macroeconomic thought of business cycles presented in section 2 is supported by Canadian time series data. Primrly the paper raises and attempts to answer two interrelated questions. First, do business cycle components (level) of prices, output, and unemployment series exhibit any sort of significant and consistent relationship? Second, what is the sign of the empirical cross-correlation between these business cycle components? The premise of these questions is that the significant and consistent relationship among output, unemployment and the price level lends important evidence on sluggish price adjustment and therefore a monetary non-neutrality. While a positive correlation among the levels of these series lends great support to business cycle theories based on aggregate demand fluctuations, it lends no support for theories based on aggregate supply fluctuations.

Many recent researches have attempted to answer these questions and to reinforce belief in a specific business cycle theory. In particular, the empirical results of some real business cycle (RBC) theorists have motivated me to pursue the task of this paper. Prescott (1986) investigated the importance of technological shocks. He examined changes in total factor productivity (Solow residuals) for the United States economy. He uncovered substantial fluctuations in the Solow residuals. He interpreted this finding as an indicator of the important role of technological shocks as a source of business cycle fluctuations. Kydland and Prescott (1990), Cooley and Ohanion (1991), studied the behavior of prices in the postwar United States. Their findings call into question the traditional belief that shifts in aggregate demand generate procyclical movements in prices. They reach this conclusion by detrending the price level and real output using the Hodrick-Prescott filter technique, and then showing that the correlation between the cyclical components of the two series is negative. This is a crucial difference from previously established methodology of detrending aggregate macroeconomics datat. Specifically from the log differenced methodology, which have been used extensively in researches aimed at testing the existence of the Phillips curve. Historically, no concern was given to differencing the data and all analysis was performed even when series were nonstationary, and not cointegrated, as it was implicitly assumed that all economic data was stationary ("nicely behaved") or at least stationary about a deterministic time trend (Kennedy, 1992). Even, then for example differencing price series will change the series and gives us new series, which will be devoid of any long-run information. The model will be fine statistically, but the problem arise when we use it for economic enterpretation. For example let us assume the relationship between two time series as following:

$$y_t = \alpha + BX_t + \gamma X_{t-1} + \delta y_{t-1} + \epsilon_t \qquad 4.1$$

we know that in steady state, the long-run equilibrium economic variables take on the same values from period to period, which is $z_t = Z_{t-1} = Z_{t-2} = Z^*$. Hence in the steady state equation (4.1) becomes:

$$y^* = \alpha + BX^* + \gamma X^* + \delta y^* \qquad 4.2$$

taking the differences, equation (4.1) becomes:

$$\Delta y_t = \alpha + B\Delta X_t + \gamma \Delta X_{t-1} + \delta \Delta y_{t-1} + V_t \qquad 4.3$$

but in steady state $y_t - y_{t-1} = y^* - y^* = 0$. If we take the differences equation (4.2) will become zeros, and will have no random shocks.

Indeed for this reason, the price level (P_t) will convey more information than the new series generated by differencing (ΔP_t). This conviction has been the main motivation for me to select the HP filter technique to detrend the series into their trend and level components. As far as I know this is the first attempt to carry out such research using the HP filter with Canadian time series. The purpose is to find out whether the Canadian time series data exhibit any evidence in favour or against the RBC approach. However, this paper does not try to build a standard RBC model to test. Instead it simply tests these models' predictions. Therefore the primary aim is to establish the stylized facts; their full explanation goes beyond the scope of this paper.

To facilitate comparison, Appendix 1 contains the linear filtering and log differenced results, but only the HP filter results will be analyzed in detail in the following section.

IV.2 Time Series Analysis

Graphs 4, 5, and 6 plot the natural log of output, prices and unemployment deviation from their HP filtered trend, respectively. Among the three series the unemployment rate fluctuates substantially around its trend. Until 1968Q2 it was below trend then it rises above trend for a short period. It continues this pattern of movement throughout the period of analysis and is never at the trend. Prices were initially fluctuating around the trend Until 1957Q1, then continued at trend up to 1971Q3, when they started fluctuating again, and continued its fluctuation until 1985Q1. After 1985Q1 and up to 1991Q1 it was continuing at trend and then rises above trend up to 1992Q4. The output also fluctuates around trend almost for the entire period (1947Q1-1994Q2), but do not wander far compared to the unemployment rate. During the periods of 1958Q2-1960Q3, 1962Q2-1970Q4, and 1984Q1-1985Q2 it was at trend.

Visually inspecting both output and prices movements around trend, one can possibly detect a negative correlation between these two detrended series.

Graph 7 plots the HP filter stationary component of RGDP and CPI for the entire period 1947Q1-1994Q2. It is clear that the same pattern of movement exists between the two cyclical components. Nonetheless, they are negatively correlated except for the period 1970Q2-1978Q1. Graph 8 shows the behaviour of the cyclical component of prices and unemployment for the period 1966Q1-1994Q3.

It is notable that the HP filtered cyclical component of unemployment wanders far from the mean, while the HP filtered cyclical component of prices fluctuates close to the mean. Except during the periods of 1975Q2-1977Q1 and 1990Q1-1993Q2, an inverse correlation between the two cyclical components is obvious. Graph 9 shows the correlations between the HP filtered cyclical components of output and unemployment for the period 1966Q1-1994Q2. Again the unemployment wanders far from the mean, while output fluctuates around the mean. The negative correlation is clearly depictable between the two series. Graph 10 and 11 capture prices and output movements around trend for the same period. Visually inspecting these two figures, one can easily detect that output lies below trend when the prices are above trend which indicate a negative correlation between output and prices for this period.

Because visual inspection can be deceiving in the following part, I am going to examine the relation between the HP filtered cyclical component of these series in more details. The data which presented in section III.1 for output, prices, and unemployment is divided into four groups:

(1)1947Q1-1994Q2

(2)1947Q1-1971Q4

(3)1966Q1-1994Q2

(4)1972Q1-1994Q2

I examine a simple cross-correlation between the cyclical components of the two series (output and prices) for each period. Then I examine cross-correlation between the cyclical component of prices, output, and unemployment for the period 1966Q1-1994Q3. The cyclical component of all series is divided by their respective trend component in order to evaluate the relation among these series in percentage term.

IV.3 Price-Output Cross-Correlation Analysis:

Table 4 presents Cross-Correlation between detrended output and prices and vise versa for the period 1947Q1-1994Q2.

The estimates include one lag and one lead.[10] The most striking feature of these estimates is the strong and consistent negative relationship between detrended prices and output. The immediate effect of prices on output ranges between 12% and 9% and it is significant at 5% level. The correlation between output and one period lagged prices ranged between 1% and 2% and it is insignificant. The detrended output and one period lead are positively correlated and significant at 5% level. The immediate effect of output on prices ranges from 17% to 15%. It is significant at 5% level in equation (4), and at 10% level in equation (5) and (6). The effect of one period lag of output on the prices is 2%, but it is insignificant. No significant relation exists between one period lead of output and the prices.

Table 5 presents cross-correlation between detrended output and prices and vise versa for the sub-period 1947Q1-1971Q4. The results of this sub-period is also consistent with the previous results for the entire period. The strong negative correlation between the detrended series of output and prices is very evident. All the relations are insignificant but immediate prices shock on output in equation (1). The one period lagged output is positively correlated with prices in equation (5) and (6), but nonetheless is highly insignificant.

Table 6 presents the cross-correlation between detrended output and prices and vise versa for sub-period 1972Q1-1994Q2. Remarkably again for this sub-period (1972Q1-1994Q2), there exists strong negative correlation between detrended output and prices.

The effect of prices on output is quite significant for both contemporaneous and one period lagged output, but the effect of one period lead prices is insignificant. The effect of immediate shock of output on prices is significant at 5% level, insignificant for one period lag, and only significant at 10% level for one period lead.

IV.4 Price-Unemployment Cross-Correlation Analysis

Graph 4 shows substantial fluctuations in RGDP growth over time. Associated with these fluctuations in output are movements in unemployment which are plotted for the period 1966Q1-1994Q2 in graph 9. The principal question here is, what are the sources of these fluctuations and movements? From introductroy macroeconomics we know that the production function of any economy depends on capital, labor and technology:

$$Y = AF(K,L) \qquad 4.4$$

where Y is the output, K and L are capital and labor inputs respectively, and A measure the current level of technology called total factor productivity.

According to the above production function changes in Y equal to the total of marginal productivity of capital (MPK) times the change in capital, plus the marginal productivity of labor times the change in labor, Plus the change in total factor productivity, that is:

$$\frac{\Delta Y}{Y} = \alpha \frac{\Delta K}{K} + (1-\alpha)\frac{\Delta L}{L} + \frac{\Delta A}{A} \qquad 4.5$$

which mean that the growth in output can be attributed to the contribution of capital, labor and growth in total factor productivity. The change in total productivity($\frac{\Delta A}{A}$) is the change that can not be explained by changes in inputs and can be calculated as follow:

$$\frac{\Delta A}{A} = \frac{\Delta Y}{Y} - \alpha \frac{\Delta K}{K} - (1-\alpha)\frac{\Delta L}{L} \qquad 4.6$$

Equation (4.3) is known as Solow residual after Robert Solow (1957) who was the first economist reveal its calculations. From the above analysis of output growth, it is obvious that the Solow residual plays an important role in growth. As stated before RBC theory emphasises that the main sources of fluctuations and movements in output and employment stems from technological shocks. In order to demonstrate this assumption, Edward Prescott (1986) measured the Solow residual for the United States economy. He found that both output and Solow residual fluctuate substantially together. Therefore he concluded that technological shocks are important factor in business cycle fluctuations.

To explore more of this cyclicality of output and employment, this paper have extended the analysis by estimating the relation between detrended unemployment rate and prices. The results of this estimates are presented in table (7).

Once again the results are identical to what previously discovered. As we note there is strong negative relation between detrended unemployment rate and prices in all the equations. The contemporaneous, lagged and lead effect of prices on unemployment level is significant, while the effect of unemployment on prices is highly insignificant.

IV.5 Evaluation and Comparison Of the Empirical Results

The countercyclical behaviour of prices unfolded by the empirical work of this paper is contrary to procyclicality of prices which natural rate-nominal demand shock models advocate. Notwithstanding the findings are consistent with several recent empirical studies results. For example Kydland and Prescott (1990) showed that during the 35 years (1954-1989) since the Korean War, the price level has displayed a clear countercyclical pattern. They used quartely HP filtered series in their analysis. Based on their results they strongly rejected models based on prices procyclicality (1990, p.17):

> "We caution that any theory in which procyclical prices figure crucially in accounting for postwar business cycle fluctuations is doomed to failture. The fact we report indicate that the price level since the Korean war moves countercyclically".

In the most comprehensive of these studies for the United States, Cooley and Ohanian (1991), using both postwar and historical quartely data computed the three alternative (Linear, Differencing, and HP filters) cyclical measures of output and prices. Their empirical results indicates clearly that procyclical prices movements have not been a stable feature of business cycle in the United States. They also strongly casted doubt on models that assumes prices procyclicality (91, p.57):

> "The empirical results presented in this paper suggest that much of the emphasis on developing models that feature a positive relationship between output and prices may have been unnecessary".

Many other economists counter argued these studies. Hall (1995, p.259) argued that both Cooley and Ohanian, Kydland and Prescott conclusions are flawed:

> "It is one thing to report, say, a negative correlation between detrended output and detrended prices and quite another to imply that this evidence suggests that we should discard models, of which the natural rate-nominal demand shock model is presumably one, that predict "procyclical prices". The flaw in their approaches is that a negative correlation between detrended output and detrended prices, is, in fact predicted by the natural rate-nominal demand shock model under reasonable assumptions."

Also Laurence and Mankiw (1994,p.11) argued that:

> "We are not persuaded by this evidence for two reasons. First, even traditional macroeconomists believe that supply shocks, such as the oil shocks of the 1970s, are important in some historical periods and can move prices and output in opposite directions. Second we believe that the statistical methodology in recent studies is misleading. This point is made by Chadha and Prasad (1993), who perform stochastic simulations of traditional model. The shocks in the model are shifts in aggregate demand, and they affect output because nominal prices adjust slowly. Nonetheless, when the simulated data are detrended, the model yields a negative correlation between the price level and output. Thus recent empirical results are consistent with traditional models."

However with mounting empirical evidence it is becoming more increasingly difficult to sustain the traditional views that prices tend to rise in booms and tend to fall in recession. Thus putting tremendous pressure on die-hard traditionalists to come-up with more convincing evidence for their belief.

Concluding Remarks:

This paper has examined the co-movements of the cyclical components of the Canadian prices, output and unemployment. The time period involved ranges from 1947Q1 to 1994Q2. During the stated period, Canada experienced high and variable inflation. Therefore the entire period have been divided into various sub-periods. It is assumed that, the time series data of all variables under examination, are more characterized by random walks rather than deterministic trends. Therefore I selected the HP filter technique to decompose the series into trend and deviation from trend components. The results have shown that the prices were acting countercyclically during those periods. This can be taken as evidence that most of the temporary movements in Canadian output are primally associated with supply shocks. This is the principal claim of real business cycle school. The other finding of this paper is that the contemporaneous cross-relationship between price and output level is mostly significant at 5% and 10% level, while it is insignificant for afterward periods at the same critical levels. This can be interpreted as monetary non-neutrality in the short period.

The prices-unemployment cross-correlations also revealed similar results except for the insignificancy of their cross-relationship for both contemporanous and afterward periods.

Finally, I believe that, despite the price countercyclicality revealed by the empirical results of this paper and many other papers as well, one still have to be cautious about judging the validity of macroeconomic theories from observed signs of price-output level correlation.

Endnotes

1. This terminology was later introduced later on by Milton Friedman who adapted it from Wicksell.

2. The rates of labour force growth $\dot{N} = \{dN/dt)/N)$, and of average labour-productivity growth, $y \dot{/} N = \{d(y/N)/dt)(y/N)$, both are fairly steady.

3. Cagan (1956) and Friedman (1956) introduced the following adaptive expectations hypothesis:

$$\overset{e}{P}_{t+1} - P_t = \gamma(P_t - P_{t-1}), \quad \gamma<1$$

where $\overset{e}{P}_{t+1}$ is the expected inflation for time t+1 formed at time t, So the public expect inflation next period to be the current rate of inflation, $P_t - P_{t-1}$, multiplied by the constant γ.
To obtain the fixed distributed lag we rearrange the above equation by recursive substitution which will be

$$\overset{e}{P}_{t+1} = \gamma\overset{e}{P}_t + (1-\gamma)\,{}_t\overset{e}{P}_{t+1}$$

$$= \gamma\overset{e}{P}_t + (1-\gamma)\,[{}_t\overset{e}{P}_{t-1} + (1-\gamma)\ {}_{t-1}\overset{e}{P}_{t-2}]$$

$$= \gamma \sum_{j=0}^{\infty}(1-\gamma)^J\, \overset{e}{P}_{t-j}$$

which says that expected inflation is nothing more than weighted average of past inflations.

4. They have pointed out a number of mechanisms through which recessions might leave permanent scars on the economy by altering the natural rate of unemployment. for example workers may lose valuable job skills when unemployed, and thus lowering his chances of finding job after recession. Or long period of unemployment may change the individual preference of work.

5. As described in Lucas (1973), the Lucas hypothesis can be expressed by

$$H = \frac{\tau^2\gamma}{(1 - H)^2\sigma_x^2 + \tau^2(1 + \gamma)}$$

where (H) depends on the ratio between the variance of the relative price level in each specific market (τ^2),and the variance of the aggregate exogenous shock ($\sigma^2{}_x$). Agents in each market respond to the difference between the observed price and the expected economy-wide price level. Expectations are formed rationally and use all the available information. Therefore, the mean of the distribution of the expected price level depends on the variances of both the prior distribution of past prices (σ^2) and that of the data collected in each specific market (τ^2). The variance of the price level (σ^2) is in turn proportional to the variance of the exogenous shocks (σ^2_x) because DX_t (differenced nominal income) changes affect both the level of real income (in an amount HDX_t), and the inflation rate (by $[1-H]DX_t$). Hence, aggregate supply is a function of the price elasticity of real income (γ) and of a parameter that reflects the fact that expectations are formed rationally.

6. There are many contributors to this school, but some recent contributions are due to Stanley Fischer (1977), Edmund Phelps and John Taylor (1977), N.G. Mankiw (1985), and Robert J. Gordon (1990).

7. Suppose that price setting is staggered: half the firms set prices on the first of each month and half on the fifteenth. If the money supply rises on June 10, then half the firms can raise their prices on June 15. But these firms will probably not raise their prices very much. Because half of the firms will not be changing their prices on the fifteenth. If the June 15 price-setters make little adjustment in their prices, then the other firms will make little adjustment when their turn comes on July 1, and so on. The price level rises slowly as a result of small price increases on the first and fifteenth of each month.

8. Akaike information criterion (AIC) and Schwarz criterion (SC) are commonly used selection criterion to aid in model specification, particulary for determining things like the number of lags to include.

9. In general it may be preferable to use seasonally unadjusted data.Ghysels, and Hall (1990) claim that seasonal-adjustment filters have at least three adverse effects on the power of unit root tests. First, the power of unit root tests may be reduced due to the smoothing effects of the filters. Second, the long leads and lags used in the filters may produce distant autocorrelations in the adjusted series. The third and final problem is induced by the nonlinear properties of seasonal-adjustment filters.

10. Up to four lags and leads have been used and produced similar results to what have been presented here.

Appendix #1: Linear and Differenced Filters Results

Cross-Correlations Of Linear Filter Detrended Output and Prices(1947Q1-1994Q2).

Variable	Coefficient	SE	t-Ratio
Equation(1):			
CPI	-0.069417	0.02634	-2.64
Constant	-0.00322	0.004951	-0.65
R^2 = 0.97	DW = 1.988		
Equation(2):			
CPI	0.027087	0.05745	0.47
CPI_{-1}	-0.10116	0.058	-1.74
Constant	0.000034	0.00039	0.09
R^2 = 0.89	DW =1.10		
Equation(3):			
CPI_{+1}	0.17492	0.0616	2.84
CPI	-0.13274	0.0794	-1.67
CPI_{-1}	-0.12167	0.07056	-1.72
Constant	-0.00022	0.00039	-0.57
R^2 = 0.89	DW = 1.24		
Equation(4):			
RGDP	-2.8232	0.416	-6.78
Const.	0.00402	0.003	1.35
R^2 = 0.92	DW = 0.55		
Equation (5):			
RGDP	-2.9388	0.3429	-8.57
RGDP-1	-2.4402	0.3467	-7.04
Const.	0.00934	0.00289	3.23
R^2 = 0.93	DW = 0.62		
Equation (6):			
RGDP+1	-1.1484	0.2029	-4.06
RGDP	-3.4001	0.2672	-16.76
RGDP-1	-1.7188	0.2826	-6.43
Const.	0.00728	0.00237	3.08
R^2 =0.95	DW =0.32		

Cross-Correlations of Linear Filter Detrended Output And Prices (1947Q1-1971Q4).

Variable	Coefficient	SE	t-Ratio
Equation(1):			
CPI	0.039112	0.02842	-1.38
Constant	0.000122	0.00075	0.16
R^2 = 0.68	DW = 2.01		
Equation(2):			
CPI	0.014531	0.0721	0.20
CPI_{-1}	-0.047565	0.06588	-0.72
Constant	0.000031	0.00076	0.04
R^2 = 0.68	DW = 2.00		
Equation(3):			
CPI_{+1}	0.067675	0.05527	1.23
CPI	-0.04786	0.08218	-0.58
CPI_{-1}	0.0073269	0.06602	0.11
Constant	-0.000078	0.000598	-0.13
R^2 =0.70	DW = 2.01		
Equation(4):			
RGDP	-0.029956	0.1255	-0.24
Const.	-0.0038961	0.005034	-0.77
R^2 =0.98	DW = 1.43		
Equation (5):			
RGDP	-0.06575	0.1443	-0.47
RGDP-1	-0.0037675	0.1441	-0.03
Const.	-0.0016728	0.003895	-0.43
R^2 =0.98	DW = 1.34		
Equation (6):			
RGDP+1	-0.0060746	0.1570	-0.0387
RGDP	-0.12515	0.1803	-0.69
RGDP-1	-0.038303	0.152	-0.25
Const.	-0.0047209	0.007488	-0.63
R^2 =0.98	DW = 1.81		

Cross-Correlations Of Linear Filter Detrended Output And Prices (1972Q1-1994Q2).

Variable	Coefficient	SE	t-Ratio
Equation(1):			
CPI	-0.085573	0.05153	-1.66
Constant	-0.0045151	0.004412	-1.02
R^2 =0.95	DW = 1.83		
Equation(2):			
CPI	-0.017275	0.05292	-0.33
CPI_{-1}	0.064327	0.05384	1.20
Constant	-0.00026236	0.0009194	-0.29
R^2 =0.95	DW = 1.66		
Equation(3):			
CPI_{+1}	0.017054	0.01614	1.06
CPI	-0.019667	0.05614	-0.35
CPI_{-1}	0.051279	0.05635	0.91
Constant	-0.0005728	0.001154	-0.50
R^2 =0.95	DW = 1.94		
Equation(4):			
RGDP	-0.35949	0.1581	-2.27
Const.	-0.01484	0.01642	-0.90
R^2 = 0.99	DW =1.19		
Equation (5):			
RGDP	-0.25111	0.1665	-1.51
RGDP-1	0.047746	0.1609	0.30
Const.	-0.021828	0.02305	-0.95
R^2 = 0.99	DW = 1.61		
Equation (6):			
RGDP+1	-0.097805	0.1554	-0.63
RGDP	-0.26914	0.1764	-1.53
RGDP-1	0.010344	0.1719	0.06
Const.	-0.020671	0.02209	-0.94
R^2 =0.99	DW = 0.36		

Cross-Correlations Of Differenced Filter Detrended Output And Prices (1947Q1-1994Q2).

Variable	Coefficient	SE	t-Ratio
Equation(1):			
CPI	-0.060881	0.02947	-2.07
Constant	0.00098715	0.0001221	8.08
R^2 =0.04	DW = 1.99		
Equation(2):			
CPI	-0.032087	0.04982	-0.64
CPI_{-1}	-0.017771	0.04912	-0.36
Constant	0.00097036	0.000124	7.83
R^2 = 0.07	DW = 1.93		
Equation(3):			
CPI_{+1}	0.092462	0.05322	1.74
CPI	-0.14538	0.06229	-2.33
CPI_{-1}	0.000072945	0.04939	0.01
Constant	0.00097075	0.0001339	7.25
R^2 = 0.7	DW = 1.92		
Equation(4):			
RGDP	-0.069662	0.08500	-0.82
Const.	0.0027647	0.000604	4.58
R^2 = 0.73	DW = 2.12		
Equation (5):			
RGDP	-0.056519	0.09913	-0.57
RGDP-1	0.041354	0.09822	0.42
Const.	0.0027339	0.0006475	4.22
R^2 = 0.71	DW = 1.94		
Equation (6):			
RGDP+1	0.053061	0.09875	0.54
RGDP	-0.13141	0.1106	-1.19
RGDP-1	0.070891	0.09596	0.74
Const.	0.0025862	0.0005095	5.08
R^2 = 0.75	DW = 1.99		

Cross-Correlations Of Differenced Filter Detrended Output And Prices (1947Q1-1971Q4)

Variable	Coefficient	SE	t-Ratio
Equation(1):			
CPI	-0.062183	0.03827	-1.63
Constant	0.0011433	0.0001517	7.53
R^2 = 0.03	DW =1.96		
Equation(2):			
CPI	-0.00054406	0.07013	-0.008
CPI_{-1}	-0.042816	0.06756	-0.63
Constant	0.0011287	0.00015	7.53
R^2 =0.09	DW = 1.92		
Equation(3):			
CPI_{+1}	0.084467	0.07909	1.07
CPI	-0.12174	0.09823	-1.24
CPI_{-1}	-0.0063824	0.06981	-0.91
Constant	0.0011226	0.0001659	6.77
R^2 = 0.05	DW = 1.96		
Equation(4):			
RGDP	-0.0046971	0.1114	-0.04
Const.	0.0020951	0.0008289	2.53
R^2 = 0.72	DW = 2.01		
Equation (5):			
RGDP	0.015693	0.1346	0.12
RGDP-1	0.044014	0.1333	0.33
Const.	0.0020325	0.0008903	2.28
R^2 = 0.68	DW =1.78		
Equation (6):			
RGDP+1	0.10009	0.1291	0.78
RGDP	-0.0552257	0.1463	-0.36
RGDP-1	0.099887	0.1257	0.79
Const.	0.0017075	0.0006499	2.63
R^2 = 0.76	DW = 1.86		

Cross-Correlations Of Differenced Filter Detrended Output And Prices (1972Q1-1994Q2).

Variable	Coefficient	SE	t-Ratio
Equation(1):			
CPI	-0.05464	0.04845	-1.13
Constant	0.00078036	0.0002199	3.55
R^2 = 0.24	DW = 1.98		
Equation(2):			
CPI	-0.062722	0.05854	-1.07
CPI_{-1}	0.028907	0.05836	0.50
Constant	0.00072134	0.00025	2.89
R^2 = 0.22	DW = 1.90		
Equation(3):			
CPI_{+1}	0.026414	0.06305	0.74
CPI	-0.060557	0.06119	-0.99
CPI_{-1}	-0.018134	0.06277	-0.29
Constant	0.00068547	0.0002492	2.75
R^2 =0.28	DW = 2.04		
Equation(4):			
RGDP	-0.35184	0.1602	-2.2
Const.	0.0036981	0.001014	3.65
R^2 = 0.76	DW = 2.35		
Equation (5):			
RGDP	-0.25283	0.1686	-1.50
RGDP-1	0.039768	0.1639	0.24
Const.	0.0033375	0.001098	3.04
R^2 = 0.77	DW = 2.44		
Equation (6):			
RGDP+1	-0.16719	0.1831	-0.91
RGDP	-0.30561	0.1854	-1.65
RGDP-1	-0.018328	0.1770	-0.10
Const.	0.0034587	0.001148	3.01
R^2 = 0.77	DW = 2.42		

Appendix #2: Tables

Table #1

Summary Statistics For Full and Split Samples.

Series	Sample	# of Obser.	Mean	Standard error
RGDP				
	1947Q1-1994Q2	190	12.48	0.58706
	1947Q1-1971Q4	100	11.99	0.34911
	1972Q1-1994Q2	90	13.01	0.19684
	1947Q1-1959Q4	52	11.71	0.18954
	1960Q1-1972Q4	52	12.32	0.19723
	1973Q1-1981Q4	36	12.86	0.10070
	1982Q1-1994Q2	50	13.16	0.10261
CPI				
	1947Q1-1994Q2	190	3.72	0.66539
	1947Q1-1971Q4	100	3.17	0.17040
	1972Q1-1994Q2	90	4.34	0.42887
	1947Q1-1959Q4	52	3.05	0.11336
	1960Q1-1972Q4	52	3.33	0.11485
	1973Q1-1981Q4	36	3.96	0.22537
	1982Q1-1994Q2	50	4.68	0.14886
Unemployment				
	1966Q1-1994Q2	114	2.00	0.34184
	1966Q1-1972Q4	28	1.56	0.23662
	1973Q1-1994Q2	86	2.15	0.22952
	1973Q1-1981Q4	36	1.95	0.15202
	1982Q1-1994Q2	50	2.29	0.16006

Table #2

Augmented Dickey-Fuller Unit-Root test for the(log)level of the series.

Series	Sample	T	No.of lags	Type of Test	Test Statistics	Asy. Critical Value at 5%
RGDP						
	1947Q1-1994Q2	190	1	Z-test	3.3128**	-21.3
				T-test	-.16375**	-3.43
				*F-test	2.2940**	6.34
CPI						
	1947Q1-1994Q2	190	1	Z-test	4.3708**	-21.3
				T-test	-1.7501**	-3.43
				*F-test	1.9603**	6.34
Unemployment						
	1966Q1-1994Q2	114	2	Z-test	18.3018**	-13.7
				T-test	-2.1178**	-2.89
				*F-test	2.8681**	4.71

Note: The following statements are valid throughout these tables:

1- Z-test is ρ-test which is = $T(\hat{\rho}-1)$.
2- * non-zero drift.
4- ** Null hypothesis have been accepted.
5- * Null hypothesis have been rejected

Table #3

Phillip-Perron Unit-Root test for the (log)level of the series.

Series	Sample	T	No.of lags	Type of Test	Test Statistics	Asy. Critical Value at 5%
RGDP						
	1947Q1-1994Q2	190	1	Z-test	0.04718**	-21.3
				T-test	0.017654**	-3.43
				*F-test	2.3410**	6.34
CPI						
	1947Q1-1994Q2	190	1	Z-test	-2.3122**	-21.3
				T-test	-1.1184**	-3.43
				*F-test	.88535**	6.34
Unemployment						
	1966Q1-1994Q2	114	2	Z-test	-4.1192**	-13.7
				T-test	-2.029**	-2.89
				*F-test	3.438**	4.71

Table #4:

Cross-Correlations of Detrended Output and Prices (1947Q1-1994Q2)

Variable	Coefficient	SE	t-Ratio
Equation(1):			
CPI	-0.1091	0.030	-3.61
Constant	0.00003	0.000	0.112
R^2 = 0.61	DW = 2.008		
Equation(2):			
CPI	-0.09129	0.054	-1.68
CPI_{-1}	-0.01127	0.054	-0.21
Constant	0.00004	0.0003	0.16
R^2 = 0.62	DW = 2.06		
Equation(3):			
CPI_{+1}	0.086883	0.041	1.71
CPI	-0.12418	0.059	-2.10
CPI_{-1}	-0.021974	0.048	-0.46
Constant	-0.000046998	0.0002	-0.20
R^2 = 0.62	DW = 2.02		
Equation(4):			
RGDP	-0.15474	0.087	-1.78
Const.	-0.00029	0.001	-0.40
R^2 = 0.92	DW = 2.29		
Equation (5):			
RGDP	-0.16419	0.102	-1.62
RGDP-1	-0.01773	0.098	-0.18
Const.	-0.00029	0.001	-0.39
R^2 = 0.92	DW = 2.29		
Equation (6):			
RGDP+1	-0.003352	0.106	-0.03
RGDP	-0.16647	0.123	-1.36
RGDP-1	-0.01891	0.104	-0.18
Const.	-0.00029	0.001	-0.39
R^2 = 0.92	DW = 2.29		

Table #5:

Cross-Correlations Between the Detrended Output and Prices (1947Q1-1971Q4).

Variable	Coefficient	SE	t-Ratio
Equation (1):			
CPI	-0.096245	0.040	-2.42
Const.	0.0000586	0.0004	0.16
R^2 = 0.52	DW = 1.99		
Equation (2):			
CPI	-0.058399	0.086	-0.68
CPI-1	-0.006452	0.084	-0.08
Const.	0.000049	0.0004	0.12
R^2 = 0.52	DW = 2.06		
Equation (3):			
CPI+1	0.083467	0.076	1.10
CPI	-0.09224	0.094	-0.98
CPI-1	-0.01331	0.069	-0.19
Const.	-0.00008	0.0003	-0.25
R^2 = 0.51	DW = 2.02		
Equation (4):			
RGDP	-0.079888	0.112	-0.72
Const.	-0.000119	0.001	-0.13
R^2 = 0.91	DW = 2.31		
Equation (5):			
RGDP	-0.077759	0.136	-0.57
RGDP-1	0.003627	0.130	0.03
Const.	-0.000119	0.001	-0.13
R^2 = 0.91	DW = 2.31		
Equation (6):			
RGDP+1	0.10314	0.144	0.72
RGDP	-0.00033	0.170	-0.02
RGDP-1	0.042778	0.139	0.31
Const.	-0.000106	0.001	-0.12
R^2 = 0.91	DW = 2.31		

Table #6:

Cross-Correlations Between the Detrended Output and Prices (1972Q1-1994Q2)

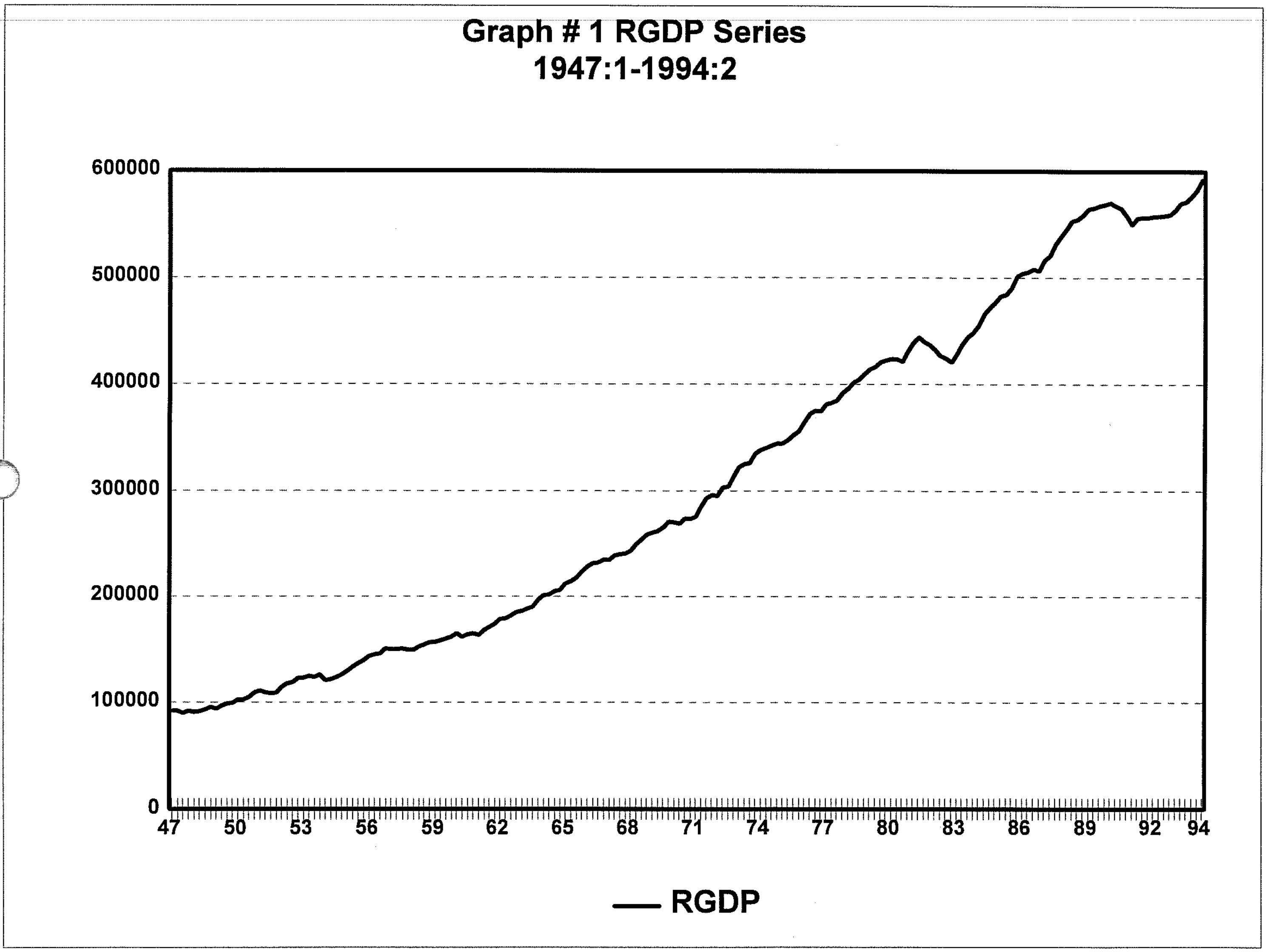
Variable	Coefficient	SE	t-Ratio
Equation(1):			
CPI	-0.22722	0.046	-4.96
Constant	0.000003	0.0002	0.02
R^2 = 0.82	DW = 2.00		
Equation (2):			
CPI	-0.13262	0.054	-2.47
CPI_{-1}	-0.12838	0.054	-2.37
Constant	0.00008	0.0002	0.39
R^2 = 0.86	DW = 2.06		
Equation (3):			
CPI_{+1}	0.03822	0.048	0.79
CPI	-0.14442	0.056	-2.58
CPI_{-1}	-0.13790	0.055	-2.49
Constant	-0.00006	0.0002	-0.30
R^2 = 0.86	DW = 2.06		
Equation(4):			
RGDP	-0.37722	0.186	-2.03
Const.	-0.00064	0.001	-0.48
R^2 = 0.93	DW = 2.22		
Equation (5):			
RGDP	-0.39769	0.188	-2.12
RGDP-1	-0.10257	0.190	-0.54
Const.	-0.00059	0.001	-0.45
R^2 = 0.93	DW = 2.21		
Equation (6):			
RGDP+1	-0.26818	0.173	-1.55
RGDP	-0.45184	0.189	-2.40
RGDP-1	-0.13992	0.190	-0.74
Const.	-0.00051	0.001	-0.44
R^2 = 0.93	DW = 2.14		

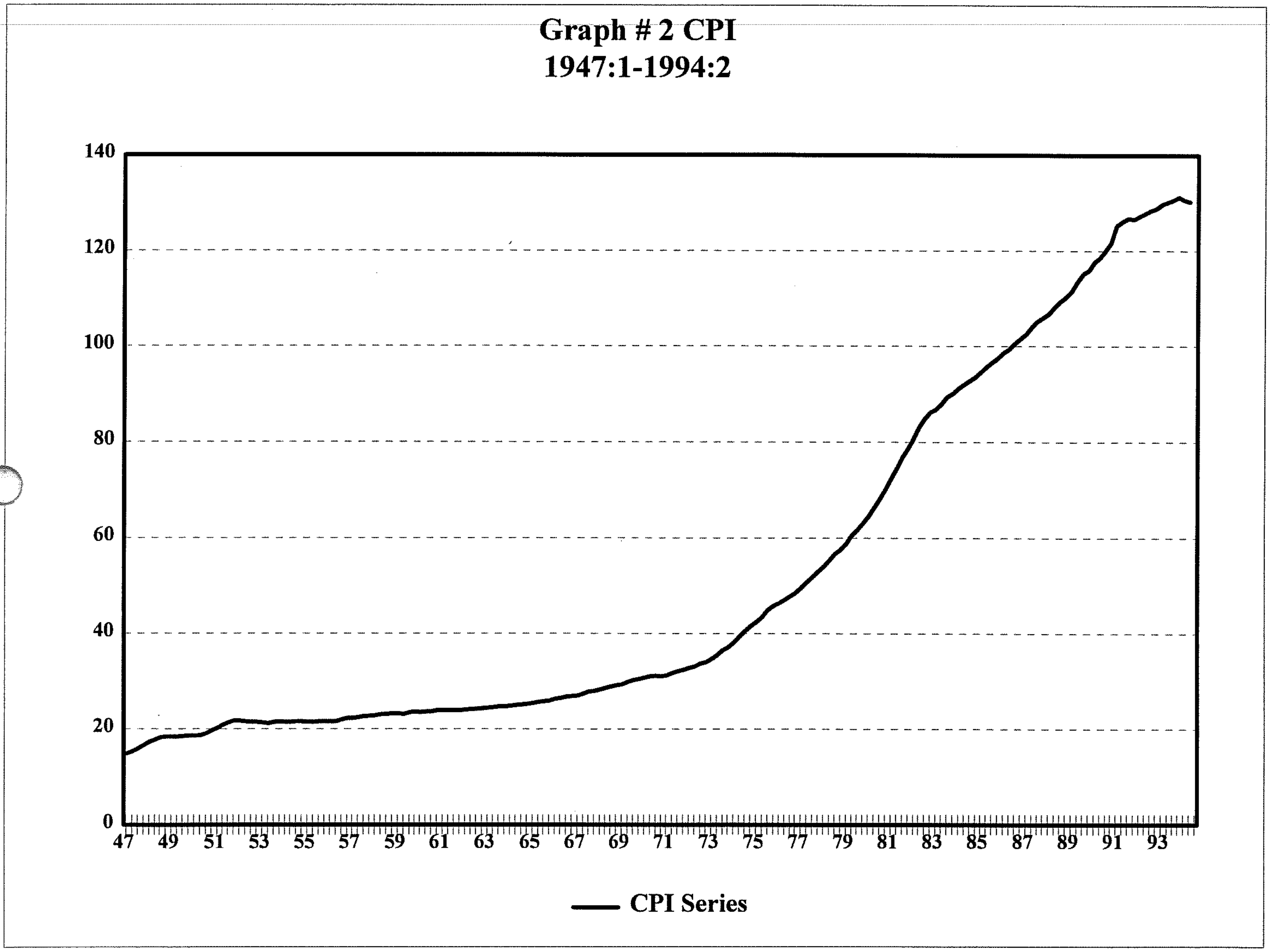
Table #7:

Cross-Correlations Between the Detrended Unemployment and Prices (1966Q1-1994Q2)

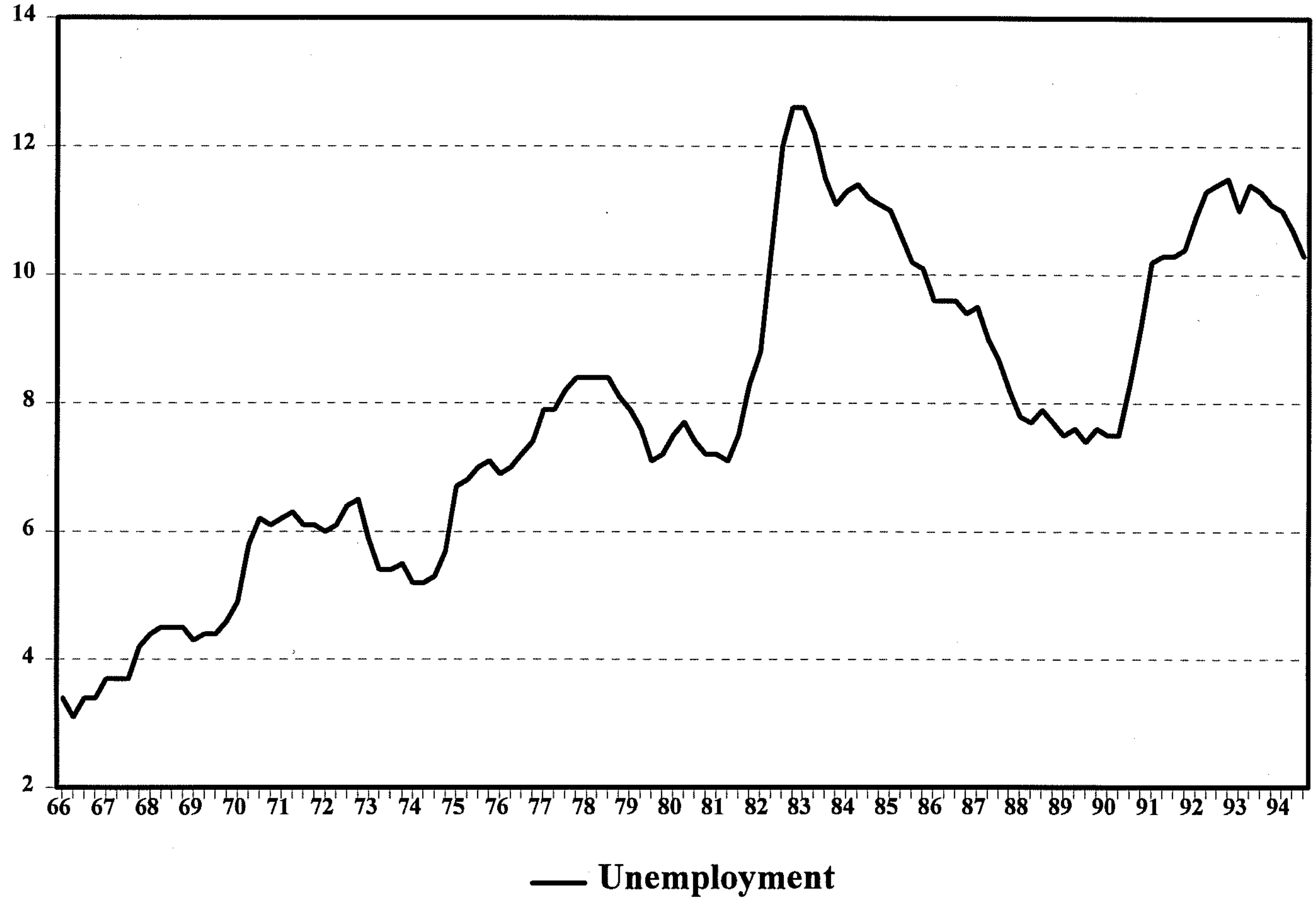
Variable	Coefficient	SE	t-ratio
Equation (1):			
CPI	-1.4698	1.86	-0.79
Const.	-0.0013587	0.01	-0.12
R^2 =0.81	**DW** =2.02		
Equation (2):			
CPI	-1.9052	1.90	-1.003
CPI-1	1.8708	1.90	0.99
Const.	-0.0011777	0.01	-0.11
R^2 =0.82	**DW** =2.02		
Equation (3):			
CPI+1	-1.1706	1.889	-0.62
CPI	-1.6992	1.938	-0.88
CPI-1	2.3034	1.978	1.16
Const.	-0.0011	0.010	-0.11
R^2 =0.82	**DW** =2.02		
Equation(4):			
PUN	-0.0043849	0.004	-1.033
Const.	-0.0001113	0.001	-0.093
R^2 =0.93	**DW** =2.27		
Equation (5):			
PUN	-0.0047766	0.004	-1.10
PUN-1	-0.0018205	0.004	-0.43
Const.	-0.00012818	0.001	-0.11
R^2 =0.93	**DW** =2.27		
Equation (6):			
PUN+1	-0.002173	0.004	-0.50
PUN	-0.0043423	0.004	-0.97
PUN-1	-0.0015629	0.004	-0.37
Const.	-0.0001218	0.001	-0.10
R^2 = 0.93	**DW** = 2.27		

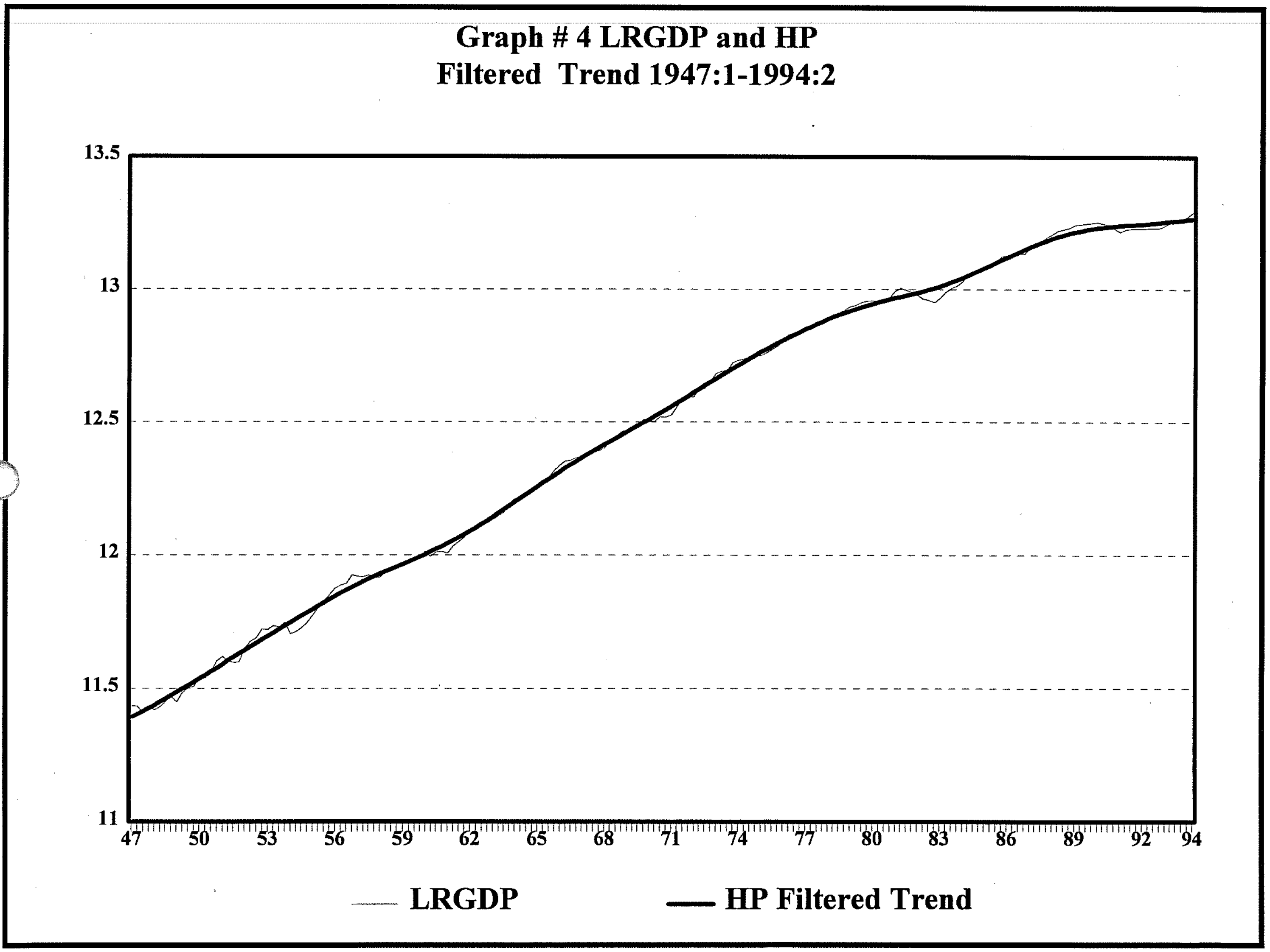
Appendix # 3 Graphics

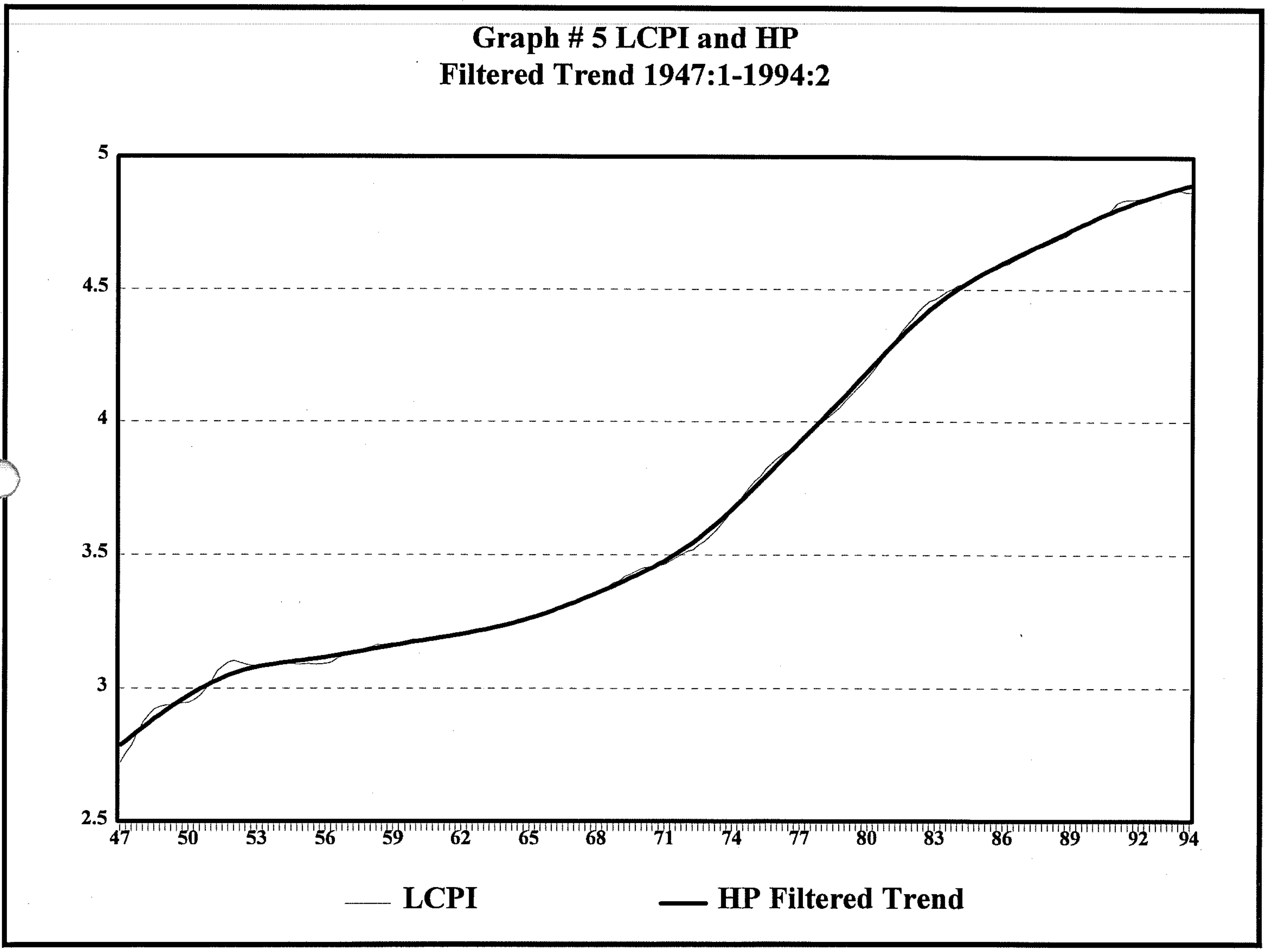


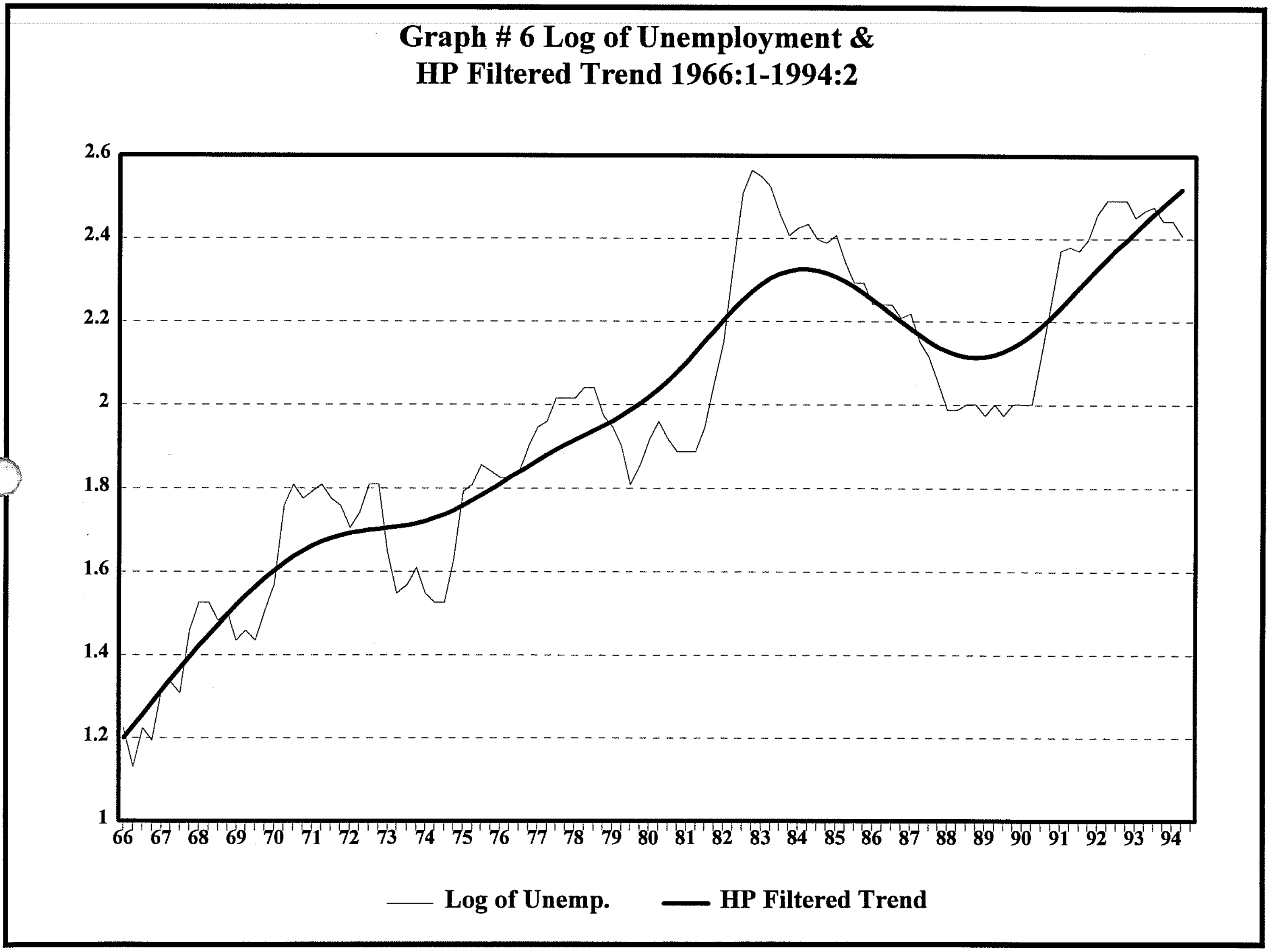

Graph # 2 CPI
1947:1-1994:2
140
120
100
80
60
40
20
0
47
49
51
53
55
57
59
61
63
65
67
69
71
73
75
77
79
81
83
85
87
89
91
93
CPI Series

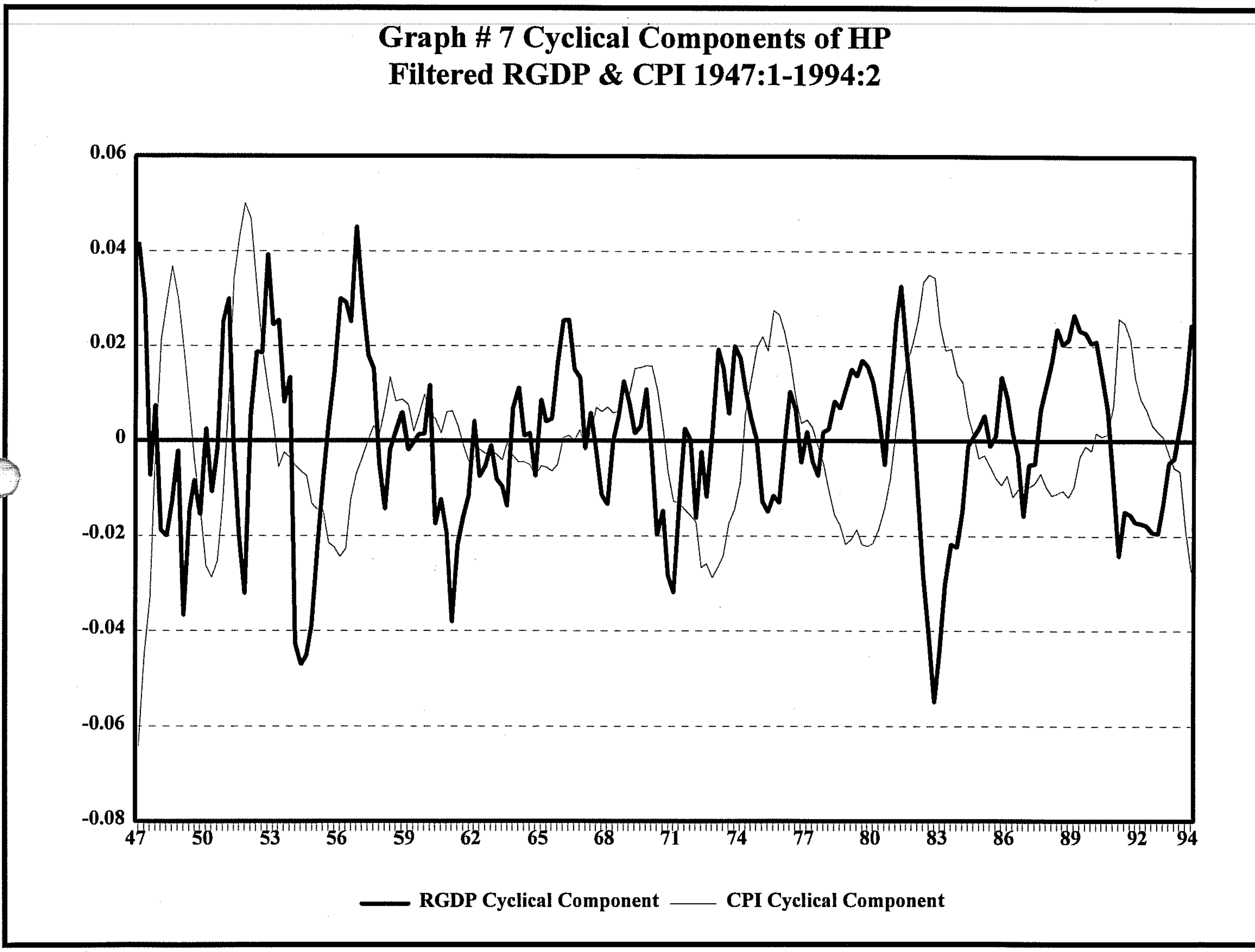
Graph # 3 Unemployment Series
1966:1-1994:2



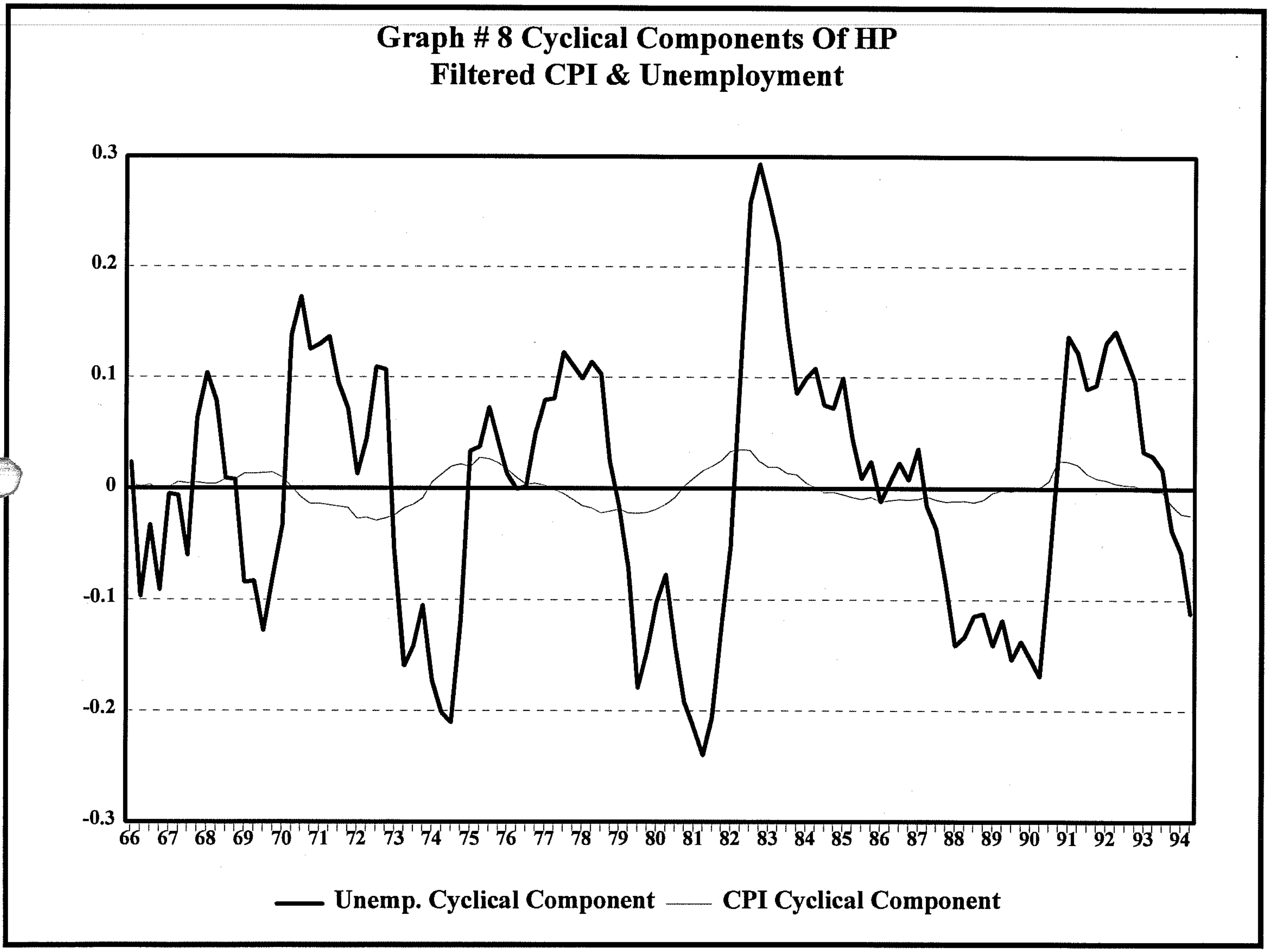

Graph # 4 LRGDP and HP
Filtered Trend 1947:1-1994:2
13.5
13
12.5
12
11.5
11
47
50
53
56
59
62
65
68
71
74
77
80
83
86
89
92
94
LRGDP
HP Filtered Trend

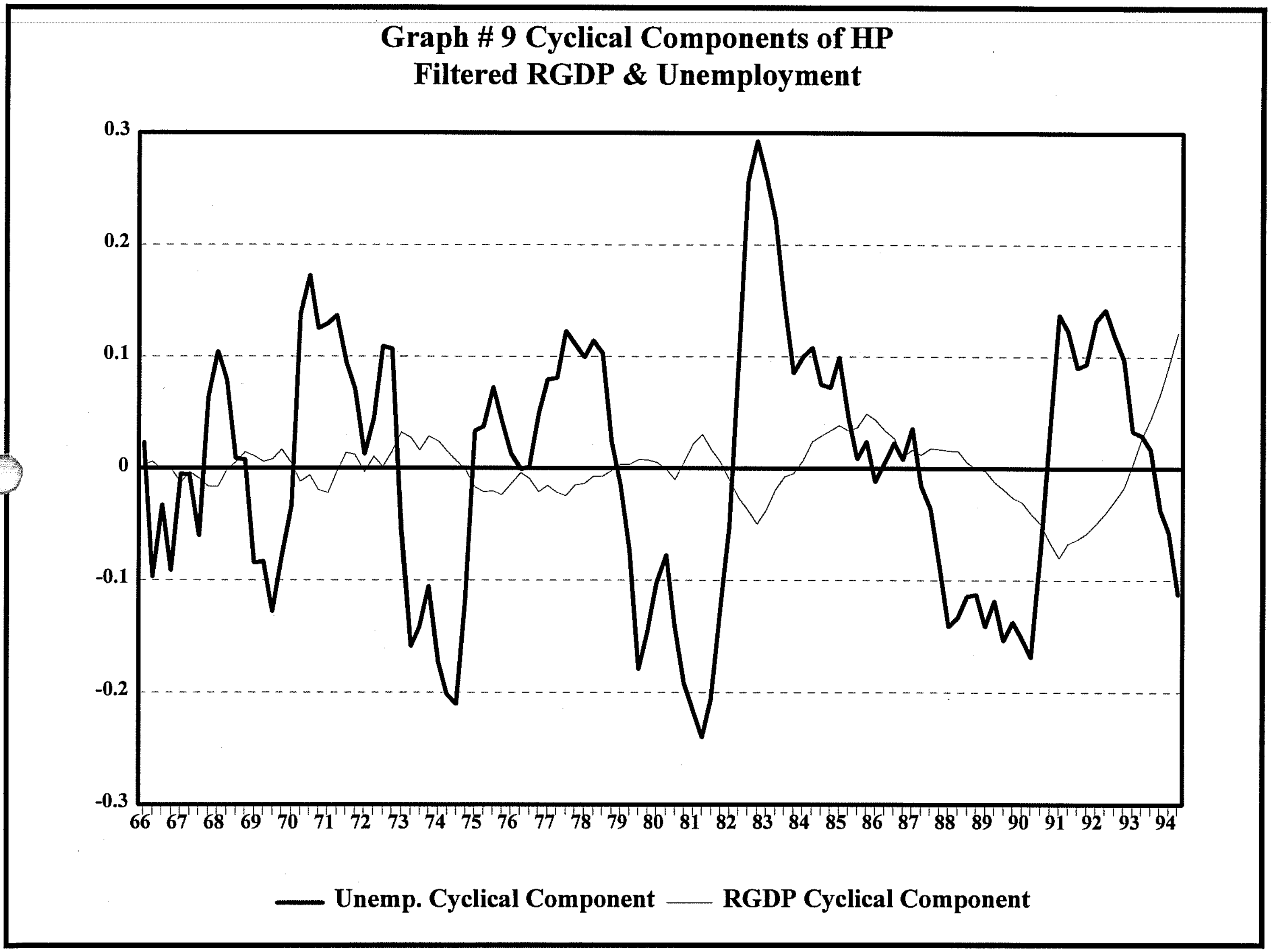

Graph # 5 LCPI and HP
Filtered Trend 1947:1-1994:2
5
4.5
4
3.5
3
2.5
47
50
53
56
59
62
65
68
71
74
77
80
83
86
89
92
94
LCPI
HP Filtered Trend


Graph # 6 Log of Unemployment &
HP Filtered Trend 1966:1-1994:2
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
Log of Unemp.
HP Filtered Trend

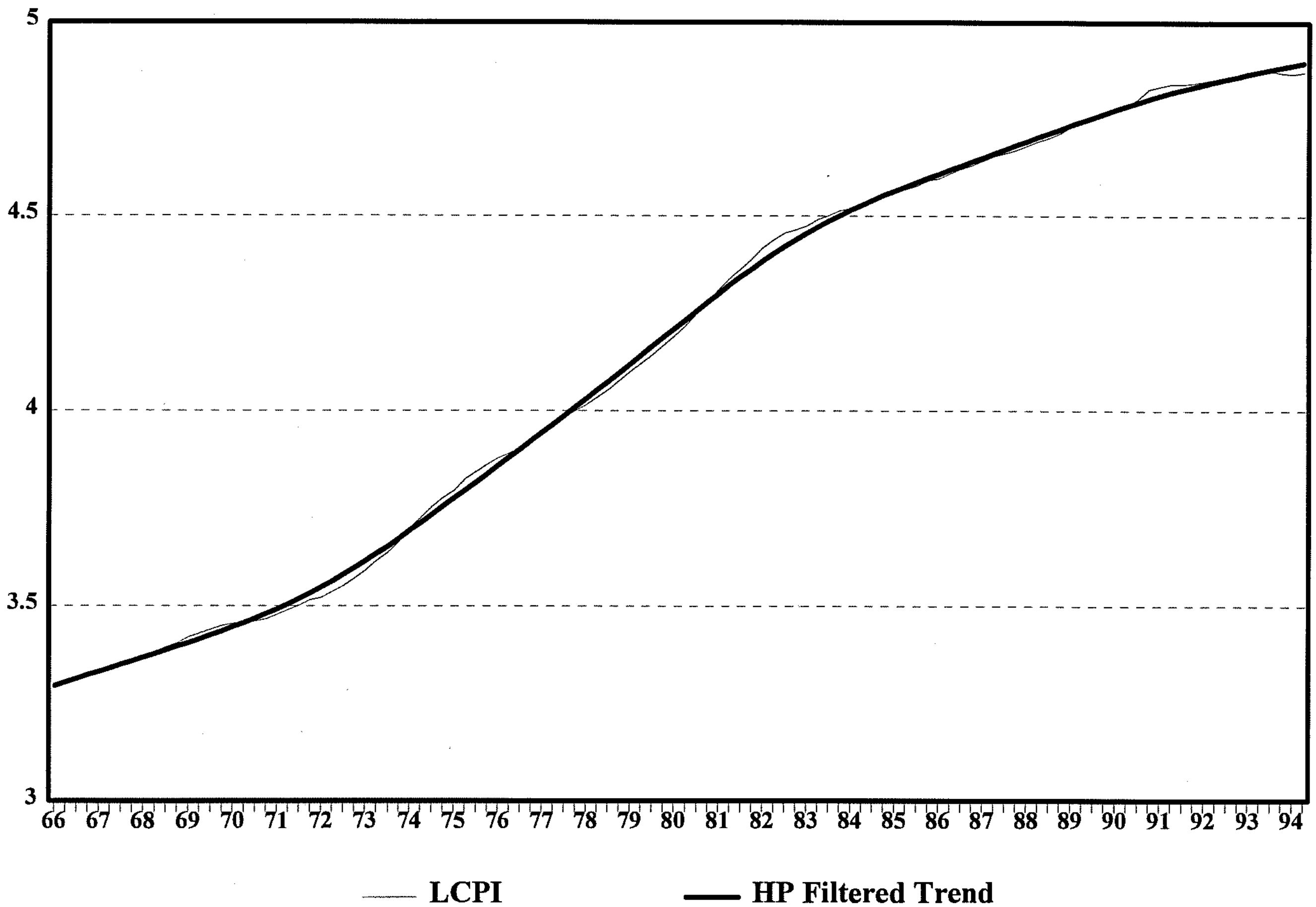


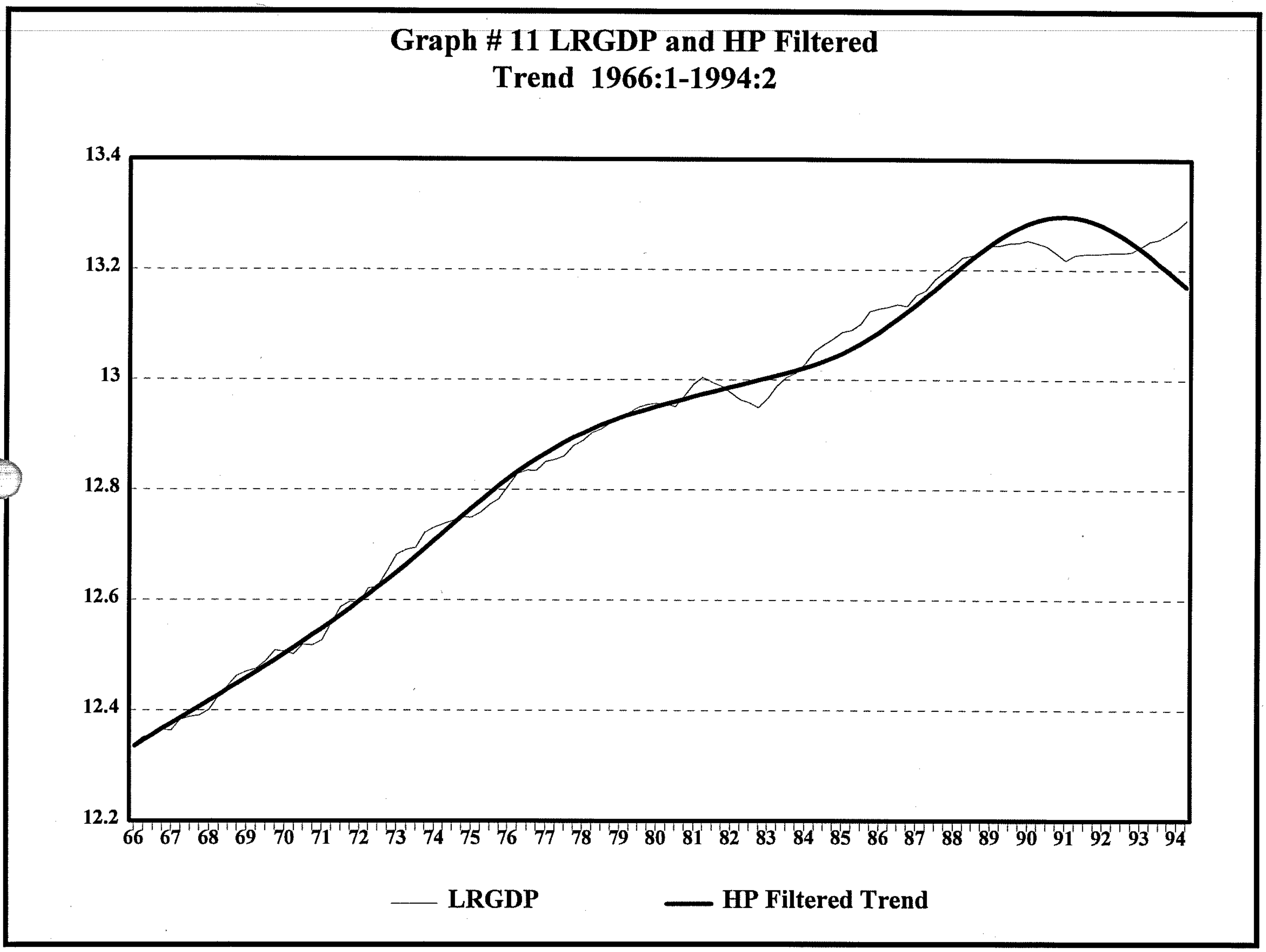
Graph # 7 Cyclical Components of HP
Filtered RGDP & CPI 1947:1-1994:2
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
47
50
53
56
59
62
65
68
71
74
77
80
83
86
89
92
94
RGDP Cyclical Component
CPI Cyclical Component


Graph # 8 Cyclical Components Of HP
Filtered CPI & Unemployment
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Unemp. Cyclical Component
CPI Cyclical Component


Graph # 9 Cyclical Components of HP
Filtered RGDP & Unemployment
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
Unemp. Cyclical Component
RGDP Cyclical Component

Graph # 10 LCPI and HP Filtered Trend 1966:1-1994:2




Graph # 11 LRGDP and HP Filtered
Trend 1966:1-1994:2
13.4
13.2
13
12.8
12.6
12.4
12.2
66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
LRGDP
HP Filtered Trend

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