1996

Estimates of the Natural Rate of Unemployment based on Married Males and Married Females

Pamela Bowers
Wright State University - Main Campus

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ESTIMATES OF THE NATURAL RATE OF UNEMPLOYMENT
BASED ON MARRIED MALES AND MARRIED FEMALES

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science

By

PAMELA BOWERS
B.S., Ohio State University, 1978

1996
Wright State University
I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY Pamela Bowers ENTITLED Estimates of the Natural Rate of Unemployment Based On Married Males and Married Females BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF Master of Science.

Rudy Fichtenbaum, Ph.D.
Faculty Supervisor

[Signature]

Roger Sylvester
Director of M.S. in Social and Applied Economics
ABSTRACT


The natural rate of unemployment is always estimated using rates of unemployment for married males, yet no substantiated criteria exists for this choice. This study compares estimates of the natural rate of unemployment based on the unemployment rates of married males and married females, which are used in estimating the Phillips curve. The results show that the two series exhibit similar trends over the study period, but the female-based series is lower. This implies that the natural rate is not independent of the demographic group chosen to estimate it. The basis for the study is a 1993 article by Stuart E. Weiner, where a natural rate series based on married males is replicated taking into account demographic and structural changes.
To Benjamin
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1. INTRODUCTION

The natural rate of unemployment hypothesis was first introduced by Milton Friedman to the American Economic Association in 1967. This is a relatively recent development in historical terms, but the concept stemmed from an earlier idea, namely, the original Phillips curve. The Phillips curve relationship, i.e., the empirical relationship between inflation and unemployment, was first shown by A.W. Phillips in 1958. From that time until the introduction of Friedman's natural rate hypothesis in 1967, the Phillips curve underwent several transformations and refinements which allowed it to become an important tool for guiding government policy.

At first, it was accepted that the level of inflation in wages could be explained by excess demand for labor, in which case the government pursued demand management strategies to fulfill the goal of full unemployment. But later, this relationship was reinterpreted to indicate that there was a trade-off between price stability and unemployment. To Keynesian policymakers who were the mainstay of the government at the time, this meant that the
goal of full unemployment could not be met without incurring the penalty of severe inflation.

When the combination of high inflation and high unemployment or "stagflation" appeared in the early 1970's, the Phillips curve relationship was regarded as seriously flawed and virtually useless in combating the new economic reality. This resulted in the entire Keynesian labor market model coming under fire as well, especially from adherents of neoclassical economics. The natural rate of unemployment hypothesis was then offered as a new explanatory scheme to navigate the uncharted economic waters.

The natural rate hypothesis explains economic conditions like stagflation by differentiating between a short-run Phillips curve and a long-run Phillips curve. In the short-run, the curve is a negatively sloping relationship between the rate of inflation and the unemployment rate where expectations of future inflation are constant. In the long-run, the Phillips curve becomes perfectly vertical at an unemployment rate that is known as the natural rate of unemployment. At this level of unemployment, the expected rate of inflation is equal to the actual rate and there is no trade-off between inflation and unemployment. The policy implication is that no amount of demand management by government can influence the unemployment rate, because in the long-run the unemployment
rate always returns to the natural rate.

Essentially, the natural rate of unemployment hypothesis represents a rejection of all established Keynesian policy that is based on the Phillips curve. The purpose of this research then, is to counter the natural rate hypothesis by showing that estimation of the Phillips curve is not independent of normative values. Specifically, the choice of married male unemployment rates in estimating the Phillips curve represents a biased standard. This research will show that the natural rate will differ when separately estimated based upon married male or married female rates of unemployment. The choice of married males is unsubstantiated and apparently arbitrary, as there is no definitive criteria from which to make the choice. Furthermore, implicit assumptions are made in choosing married males. A key variable in an important economic model cannot be based on implicit assumptions and arbitrary choices without running the risk of shedding serious doubt on the foundation of the natural rate hypothesis.

The subject will be approached first by providing the reader with a background in the development of the natural rate hypothesis. The backgroud chapter begins with a brief description of the two dominant labor market models; neoclassical and Keynesian. Following that is the history and significance of the Phillips curve, which then leads
into a detailed presentation of the natural rate hypothesis and its concomitant concept of adaptive expectations. The principle component of any discussion of labor economics invariably involves description of the types of unemployment, which a section of the paper is devoted. The chapter closes with a detailed discussion of the factors influencing the level of the natural rate.

After having been prepared with background information, the next chapter, which presents the research methods and results, will provide the reader with the core of this paper. It begins with a description of the significance of the research problem, which has already been alluded to briefly. Then, presentations of the theoretical model, the statistical model and the details concerning the data follow. Finally, the estimation and inference procedures are described and the results presented.

The paper concludes with a brief summary and implications of the findings. Finally, shortcomings within the research are noted and some suggestions for the direction of future research are provided.
2. BACKGROUND

A Short Macroeconomic History

Two Dominant Models: Classical and Keynesian

The history of labor market theory shows that two basic models, classical and Keynesian, have predominated. The classical era began when the discipline of economics was founded by Adam Smith in the late 18th century (Marshall 1967, 28). David Ricardo, Robert Malthus and John Stuart Mill continued to develop the discipline in the early 19th century. The Classical school of thought evolved into neoclassical economics in the mid to late 19th century mainly through the work of Marshall, Pigou, Pareto and others (Marshall 1967).

The Keynesian view was developed in the 1930's during the Great Depression by John Maynard Keynes. After World War II, it was refined into a neo-Keynesian view, which is also called the Neoclassical Synthesis, by Baumol, Modigliani, Samuelson, Solow, and Tobin to name only a few (Klammer 1983). Today, the theoretical basis for the two models continues to evolve among practicing economists and in academic circles. For example, Keynesian thought has been branched out by Post-Keynesians who reject the neoclassical synthesis (Klammer 1983, 6). Neoclassical
thought has been moved in new directions by the monetarists and the New Classical economists (Klamer 1983). Even taking into account these newer derivatives of the original theories, the essential debate in macroeconomics still basically remains between the classical and Keynesian models.

**The Neoclassical Model**

The neoclassical model describes a market system that is inherently stable and that tends towards an equilibrium. Conditions for equilibrium are based on the following assumptions: all workers have identical skills and all jobs have identical skill requirements; information held by all economic agents is perfect and obtained without cost; labor has perfect mobility to meet variations in labor demand; wages and prices are equal to the value of the marginal product of labor and since all workers and jobs are identical, wages are equal for all workers. In addition, wages and prices adjust instantaneously according to the forces of supply and demand and market equilibrium is achieved. Full employment results at the equilibrium point, which is where the amount of labor demanded equals the amount supplied. If unemployment exists at all it is because workers value their leisure time more and choose not to work, therefore making all unemployment in the neoclassical model purely voluntary. Unemployment is seen
as only a temporary situation, because complete and instantaneous wage and price flexibility allows the system to quickly return to equilibrium. The self-correcting market mechanism solves unemployment by allowing wages and prices to fall (Schettkat 1992, 8-10).

The assumptions of the neoclassical model describes a system that apparently works with the precision of a drill team, but what is not apparent is that the model cannot explain the occurrence of business cycles with its accompanying periods of prolonged high unemployment. Also, Keynes maintained that deflation would not occur in the neoclassical framework because of rigid nominal wages. The weakness of the model was revealed at the beginning of the Great Depression which was not supposed to occur according to adherents of neoclassical theory. Reality dictated otherwise and showed that unemployment can coexist with an equilibrium condition. This was ample evidence that the market could not be relied upon by the government to solve the problem of unemployment and so the neoclassical view was discredited. Neoclassical theorists have since responded to this inconsistency by citing wage rigidities as a "special case" of the theory, which provides a rationale for unemployment (Schettkat 1992, 11). In contrast, wage rigidities are an essential part of the Keynesian model as described in the following section.
The Neo-Keynesian Model

The refutation of a self-correcting market mechanism and the acknowledgment of market imperfections is the essence of the Keynesian view (Blaug 1985, 668). The market is viewed as an inherently unstable system that tends toward disequilibrium and where wages and prices adjust slowly. The assumptions of Keynes's model practically run counter to the neoclassical model in that workers and jobs are heterogeneous, competition is imperfect due to limited mobility of labor and information is not costless and perfect for all economic agents (Klamar 1983, 5). The model emphasizes the downward inflexibility of nominal wages that keeps the market from clearing (Blaug 1985, 665). Workers are unwilling to continue to supply their labor at reduced nominal wages, but at the same time, they are willing to supply their labor at lower real wages due to a general rise in prices.

The reasons for rigid nominal wages are unclear in Keynes's original theory, but Neo-Keynesians have cited the implicit contract model and the efficiency wage model as explanations for rigidity of real wages. Unemployment results from deficient aggregate demand and is considered involuntary. The following quotation is Richard Kahn's simplified interpretation of Keynes's more cumbersome definition of involuntary unemployment; "There is involuntary unemployment to the extent that, at the current
money wage and with the current price level, the number of desiring to work exceeds the number of men for whose labor there is a demand" (Schettkat 1992, 14).

If unemployment is the problem, then the remedy for the goal of attaining full employment is through applying government fiscal and monetary policy to stimulate aggregate demand. Neo-Keynesian theory and policy remained the accepted standard for government until the discovery of the Phillips curve (Schettkat 1992, 17).

The Phillips Curve

The empirical relationship between unemployment and inflation was first shown by A.W. Phillips in 1958 when he created a scatter plot of annual percentage rates of change of nominal wages and unemployment as a proportion of the labor force for British time-series data over the years 1861-1913 (Blaug 1985, 678). Phillips discovered an inverse nonlinear relationship between the variables representing unemployment and nominal wages. This discovery by itself is not particularly surprising as one would expect wages to rise when the labor market is tight and vice versa. What is significant about the Phillips curve is that it shows that wages begin to rise rapidly well before full employment is reached or in other words, wage inflation begins at around 5.5% unemployment (see figure 1).
Figure 1. The Phillips curve shows an inverse relationship between the rate of inflation and the rate of unemployment.

Ironically, Phillips was actually looking to establish the stability of the relationship not the negative correlation between the variables, but others found the latter to be the more intriguing result (Frisch 1983, 34).

The Phillips curve was mainly an empirical relationship, so in order for it to reach full legitimacy in economics it needed a solid theoretical basis. Robert G. Lipsey supplied the needed theory by deriving the Phillips curve for a single labor market using nominal wages instead of the wage inflation rate (Frisch 1983, 36). Lipsey
established a measurement of excess demand in the labor market as a link between the rate of change in nominal wages and the unemployment rate. From this, wage inflation could be explained by excess demand in the labor market and the rate of unemployment could be interpreted as an indicator of the level of excess demand (Frisch 1983, 31).

Practical application of the Phillips curve became evident in 1960 when Paul Samuelson and Robert Solow made modifications to Lipsey's model (Frisch 1983, 41). The curve was constructed to show an inverse relationship between the rate of inflation and the rate of unemployment. This new construct destroyed the Keynesian goal of full employment with no inflation as it revealed that there was a trade-off between price stability and full employment. Full employment could not be achieved without generating a corresponding high rate of inflation. For government policymakers this meant changing the goal of full employment to choosing an acceptable level of unemployment and accompanying level of inflation. Keynesian policy prescriptions based on the Phillips curve were maintained throughout the 1960's, but flaws in the Keynesian labor market model became exposed during the early 1970's when the phenomenon of stagflation appeared.

Stagflation described a condition of simultaneous high unemployment and high inflation which could not be adequately explained by the Keynesian model. Milton
Friedman called stagflation "an unlovely label", but pointed to it to raise doubts about the stability of the Phillips curve, which was assumed until this time (Friedman 1977, 455). As evidence of instability he cited that "the inflation rate that appeared to be consistent with a specified level of unemployment did not remain fixed: in the circumstances of the post-World War II period, when governments everywhere were seeking to promote 'full employment', it tended in any one country to rise over time and to vary among countries. Looked at the other way, rates of inflation that had earlier been associated with low levels of unemployment were experienced along with high levels of unemployment" (Friedman 1977, 455).

The Natural Rate of Unemployment Hypothesis

The phenomenon of stagflation and accumulating doubts about the stability of the Phillips curve led to the emergence of monetarism and the development of the natural rate of unemployment hypothesis. It was first introduced by Friedman in his Presidential address to the American Economic Association in 1967 (Blaug 1985, 681). Through it he demonstrated that there were several important elements left out of the Keynesian model; the distinction between the short run and the long run regarding the effects of changes in nominal aggregate demand and the role that inflationary
expectations play in unemployment. Also, the Keynesian view simply did not contain any explanation about how inflationary expectations are formed. Economists generally agreed that the elements missing from the neo-Keynesian model and included in the natural rate hypothesis was an improvement in macroeconomic theory.

Friedman and his ideological associates, known as monetarists, were the latest progeny in the evolution of the classical model who believed in the efficiency of a market system that tends towards an equilibrium. Central to the monetarist challenge of neo-Keynesian beliefs is the distinction between the long run and the short run (Klamer 1984, 7). Neo-Keynesians concentrated only on the short run and adhered to their founder's adage, "In the long run we are all dead", whereas monetarists believed that the classical position is upheld if the long-run effects of economic policy is taken into consideration (Klamer 1984, 7). Another classical position that monetarists upheld was the neutrality of money which says that "changes in the money supply affect the price level only and are neutral with respect to real output and employment" in the long run (Klamer 1984, 8). Encompassing the idea of the neutrality of money was the quantity theory of money that expressed the monetarist view that the inflation rate is determined by the rate of change in the supply of money or the "velocity" of money. Monetarists, like Keynesians, believe that inflation
reflects excess demand in the goods and labor markets, but monetarists also gave significance to the role of money as expressed in the quantity theory of money. Thus, the natural rate of unemployment hypothesis together with monetarism constituted a frontal attack on the Keynesian model. The absolute supremacy of Keynesian views, held for nearly forty years finally came to an end and a gradual reinstatement of the relevance of classical position had begun.

According to the natural rate of unemployment hypothesis there exists different Phillips curves for both the short and long run. The short-run Phillips curve is similar to the Solow-Samuelson curve in that it is a negatively sloped relationship between the rate of inflation and the rate of unemployment, but the difference is that expectations of inflation are constant. The long-run Phillips curve is a vertical line at some unemployment rate called the natural rate of unemployment. The natural rate of unemployment is the only level of unemployment at which the expected rate of inflation is equal to the actual rate of inflation, consequently, in the long run there is no stable trade-off between inflation and unemployment. In the short run, however, the curve is unstable and shifts over time as the expected rate of inflation changes.
Adaptive Expectations

The instability of the short-run Phillips curve is explained by Friedman's model of inflationary expectations that is known as adaptive expectations. In the model of adaptive expectations "people form expectations of future inflation by looking at past rates of inflation" (Blaug 1985, 684). It is hypothesized that people pay more attention to recent prices than to those in the past. From this information a model is constructed to give more weight to the most recent price and geometrically less weight to past prices as time recedes (Blaug 1985, 684).

The hypothetical situation that illustrates adaptive expectations begins when the government wants to reduce unemployment by exercising expansionary policies to achieve full employment. This results in an increase in aggregate demand and an unanticipated change in prices. Figure 2 illustrates this graphically.

The initial position of the economy is point A, where unemployment is at the natural rate of 6% and actual inflation equals expected inflation at 3%. Firms are motivated to hire more workers in response to increased aggregate demand. Increased hiring causes the unemployment rate to fall below the natural rate to 4% and the economy is now at point B. As demand for workers outstrips the supply competitive pressure bids wages higher but not high enough to keep up with inflation. Because firms want to remain
profitable the higher costs of labor are transferred to product prices, which increases actual inflation to 6%. Meanwhile, workers are temporarily fooled into thinking that the rise in nominal wages means their real wages are higher. This is what Friedman terms "money illusion". When workers realize that real wages have decreased, they react by demanding higher wages in accordance with inflation or else quit. Firms choose not to raise wages further, which results in quits and lay-offs of recently hired workers. The unemployment rate returns to 6%, the natural rate and the economy is at point C. The end result is that the
unemployment level returns to its original level, but now overall prices are higher. Thus, the only way to keep unemployment lower than the natural level is to increase inflation at an increasing rate.

For monetarists in particular and supporters of neoclassical economics in general, keeping inflation low is more important than reducing unemployment, because the inflation rate can be controlled by metering the growth of the money supply, whereas the unemployment rate is not controlled by any government measure in the short run and settles at the natural rate in the long run. From this one must conclude that a certain level of unemployment must be accepted as inevitable. If the acceptable level of unemployment is dictated by the natural rate, then it would be in keeping with the spirit of scientific inquiry to examine how the natural rate is determined and what it's relationship is to the actual rate of unemployment.

Unemployment, The Natural Rate and Inflation
Types of Unemployment

The short-run Phillips curve and the adaptive expectations model is essentially the neoclassical explanation of the business cycle, which was left out of the pre-Keynesian model. In the neoclassical model, the business cycle and the cyclical unemployment that results from it is seen only as a short-run phenomenon. The
structural and frictional portions of unemployment are seen as long-run phenomena and are represented by the natural rate of unemployment. Put another way, the natural rate is the level of unemployment that exists once all cyclical fluctuations are removed (Rissman 1986, 3). By comparison, the actual rate of unemployment is the composite of all three types of unemployment: cyclical, frictional and structural. Cyclical unemployment is caused by fluctuations in aggregate demand and the relative unresponsiveness of real wages to a decrease in demand for labor (Rissman 1986, 3-4). Frictional unemployment results from normal job turnover as workers and employers seek an optimal match of skills for pay. This kind of search activity results in the optimal use of resources and benefits the economy in terms of higher productivity (Weiner 1986, 21). "Structural unemployment is the result of shifts in the relative demand for different types of labor" (Rissman 1986, 4). Causes of structural unemployment are many, ranging from "changes in relative factor prices, technological innovations, changes in tastes and preferences or perhaps changes in institutional or other characteristics of the economy (Rissman 1986, 4). So, just as cyclical forces contribute to short-term changes in employment, structural and frictional forces contribute to long-term changes in employment and directly influences the level of the natural rate of unemployment.
Factors Influencing the Level of the Natural Rate of Unemployment

Structural change in the economy affects the level of the natural rate because, workers who are displaced adjust slowly, causing a long-term increase in the unemployment rate. "Structural change implies non-transient shifts of employment across industry and/or regional lines" (Leonard 1987, 155). Pools of labor are largely stationary and workers whose particular skills are no longer needed must invest in obtaining new skills. Geographic and skill mismatch are part of an extensive and descriptive classification system of structural unemployment presented by Standing (1983) and Hart (1990) which consists of seven causal categories. Weiner (1993) describes a simplified version as follows.

Weiner decomposes structural unemployment into three categories of "market imperfections": worker-job mismatch, institutional barriers and workers' preferences. Unemployment due to worker-job mismatch involves workers who lack required skills, are not in the needed geographic location or lack information about vacancies to obtain suitable employment. An example is "downsizing" which encompasses defense industry cutbacks and white-collar lay-offs. Downsizing is the result of institutional changes within organizations that seek to increase profitability by changing the organizational structure. The result of
downsizing is mismatch as the organization re-locates or changes it's skill requirements (Weiner 1993, 56). Institutional barriers include laws and social practices, such as minimum wage laws, overly restrictive regulation and discrimination which can contribute to increased unemployment. Workers' preferences include transfer payment disincentives and excessive wage demands. Examples of transfer payments are unemployment compensation and welfare payments which can provide a disincentive for finding and accepting employment. Excessive wage demands are demands for real wage increases in excess of productivity gains which may provide a disincentive for firms to maintain the labor force at its present size or location (Weiner 1993, 54). Thus, market imperfections of a structural nature contribute to higher actual and natural unemployment rates in the long run by permanently altering the relative demand for and supply of labor.

Demographic forces are another major influence on the level of the natural rate over the long run. The usual reasoning is that an increase in the labor force of certain groups, such as women and teenagers and more recently non-whites, groups who typically have higher unemployment rates, exert an combined effect of increasing the natural rate. Gordon (1982, 145) and Perry (1970) assert that the changing proportions of gender and age groups in the labor force are the primary demographic forces causing movement in the
natural rate. This is demonstrated in estimates of the Phillips curve by Perry where the age and gender composition of the labor force was controlled to show the effect of demographic changes on the natural rate (Perry 1970). However, Summers asserts that "the changing age-sex composition of the labor force can account for relatively little of the increase in unemployment in recent years [1965-1985]" (Summers 1992, 292).

Summers constructed a table of the unemployment rates of various demographic groups: age-sex, marital status, and education; which were weighted by share in the labor force for the period 1965 to 1985 (Summers 1992, 298). From it he was able to assess the relative effect of demographic changes on the unemployment rate over the period. One notable finding was a fifty percent increase in unemployment of married and formerly married men between 1978 and 1985 (Summers 1992, 295). By contrast, "for single men and women and for married women the data reveal only very minor increases in unemployment since 1974" (Summers 1992, 297). Also, "the increasing participation rates of women has not had a major impact on the unemployment rate" (Summers 1992, 294). Furthermore, unemployment for white prime-aged males (aged 35 to 44) has increased by 75% over the period (1965 - 85) (Summers 1990, 295). "Unemployment attributed to teenagers has declined in recent years" (Summers 1992, 297).

Rissman has also noted the changes in the composition of
the labor force in the 1970's and 1980's relative to the 1950's and 1960's. This change was marked by a significant increase in the proportion of people who traditionally have had high rates of unemployment, namely, non-whites, women and teenagers. Rissman cites that the proportion of youths in the labor force peaked in 1975 and of all the demographic factors, the changing age group composition of the labor force had the largest effect on the unemployment rate (Rissman 1986, 5-6). Also, Rissman states that the changing demographic composition of the labor force has contributed less than 1% to the increase in the actual unemployment rate. Rissman concludes that demographic forces have played only a minor role in explaining the upward movement of the unemployment rate and she suggests that the rise is mainly attributable to structural forces (Rissman 1986, 6).

What is revealed by these findings is that demographic forces are important in influencing the level of the natural rate, but the groups that are usually thought of as the unemployment-rate-increasing culprits are now vindicated by those same demographic forces. The reason may well be that the labor force of the nineties is not the same as that of the sixties and researchers must take the facts into account. To summarize then, structural and demographic factors are the primary influences that combine to change the natural and actual rates of unemployment over time.
When actual and natural rates of unemployment are plotted on a time-line it becomes especially clear that the natural rate is not a fixed number, but varies over time. Also, it is noteworthy that the natural rate has been trending upward (see figure 3).

![Graph showing actual and natural rates of unemployment.]

Figure 3. Actual and natural rates of unemployment. (Source of actual unemployment data, Bureau of Labor Statistics; source of natural rate data, Bowers, 1995).

Labor market imperfections of a structural nature are reflected in the upward trend of the natural rate throughout the period 1961 to 1994, in particular, the oil shocks of the 1970's and numerous and massive corporate downsizings in the late 1970's and 1980's. Another characteristic that is
observed in the chart is that the actual and natural rates rarely coincide. This lack of coincidence of the natural and actual rates reflects the activity of the business cycle. When the natural rate exceeds the actual rate the economy is booming and the labor market is tight, creating inflationary pressures. Conversely, when the natural rate is below the actual rate the economy is in a recessionary period and the labor market is slack, stalling inflationary pressures. The difference between the actual and natural rates of unemployment then, is a measure of slackness in the economy. Rissman demonstrates that there is a positive correlation between this difference with the inflation rate (Rissman 1986, 3). Furthermore, Weiner claims the difference "has been a reliable indicator of future increases in inflation" (Weiner 1994, 7).

The Importance of the Natural Rate in the Economy

The natural rate of unemployment is an important concept linking labor markets to the macroeconomy and is useful as a inflationary gauge in monetary policy. It represents the "critical mass" of the economy or how much more employment the economy can absorb before inflation is unleashed. However, the natural rate hypothesis, including the expectations-augmented Phillips curve, produces policy implications that run counter to Keynesian fiscal and
monetary policies that focus on managing aggregate demand. Proponents of the hypothesis claim the Keynesian policies ultimately fail, because of the absence of a long-run trade-off between inflation and unemployment. They recommend that governments should refrain from trying to manage aggregate demand to lower the unemployment rate, because the long-run tendency is toward the natural rate of unemployment, which is the lowest possible level of unemployment that can be sustained without incurring inflation. Another policy implication of the natural rate hypothesis is that the target rate of inflation should be zero. Finally, in order to achieve zero inflation a deflationary policy is required, which will force output to be low and unemployment to be high. It is acknowledged that the transition to zero inflation will be painful, but it is thought it will be short-lived as inflationary expectations are revised downwards.

The deflationary policy seems especially draconian and prudence demands that we would want to be sure that the hypothesis is correct before enacting such a measure. Is there really no trade-off between the rates of inflation and unemployment in the long run? How long is the long run or for that matter, the short run? A recent (1994) estimate by Weiner puts the natural rate at about 6.3%, which is high compared to the natural rates in the period previous to the oil shocks (Weiner 1994, 6). Should this level of
unemployment be accepted without question? Or instead should some level of inflation be tolerated? Human capital is at stake as well as financial capital. With so much hinging on a theoretical concept and a mathematical construct, the manner in which the value of the natural rate is derived and interpreted is imperative.

An early attempt to estimate the natural rate was done by Gordon (see Gordon 1982). He calculates the natural rate of unemployment and potential GNP that relies heavily on demographically adjusted unemployment rates. His estimates do not reflect the combined effect of demographic and structural changes in the economy as does Weiner's more recent attempt. Gordon's and Weiner's demographically adjusted NR for 1980 is 5.9% and 6.4% respectively. Gordon indicates that structural changes other than supply shocks are not taken into account. He says "much of the acceleration of inflation on the 1970's is attributed to changes in the relative prices of food and oil and in the exchange rates rather than to a shortfall of the actual unemployment rate below the natural rate" (Gordon 1982, 146). Clearly, Weiner's NR estimates include broader scope of structural change than does Gordon.

Estimation of the natural rate, particularly the Phillips curve, has not been independent of a normative value that says that the unemployment rate of married men represents the standard. Perhaps this convention was
established out of a notion of tradition that men have in the past been the principle and singular wage earners for their families. Perhaps it has been perpetuated out of bias against any other group that may pose a challenge to a coveted position of power and status. Whatever the reason, in the name of scientific inquiry, the unsubstantiated assumptions behind this selection must be revealed and corroborated assumptions must be established in its place.
3. RESEARCH

The Significance of the Problem

With the importance of the natural rate of unemployment established, the purpose of this research is to show that using a different demographic group for estimating the Phillips Curve changes the estimate of the NR, thus showing that the natural rate is not independent of the demographic group chosen. This would call into question the results of a recent study by Weiner of the Federal Reserve Bank of Kansas City, which presented estimates of the "natural rate" of unemployment (see Weiner, "New Estimates of the Natural Rate of Unemployment").

Weiner estimates two natural rate series, one is demographically adjusted and another is both demographically and structurally adjusted. He first estimates a Phillips curve where the unemployment rate of married men is used for the unemployment variable. Natural rates of married men are generated and used to calculate the natural rates of several race/gender/age groups over several time periods. These estimates form the basis of the demographically and fully adjusted natural rate series. Finally, to estimate the fully adjusted series each group is weighted by its share
in the labor force.

This research will estimate the Phillips curve and the natural rate series by following Weiner's methodology with the exception that the unemployment rate of married females will be substituted for the unemployment rate of married males. In this way, it will be shown that the natural rates estimates are different depending on whether married male or married female unemployment rates are used, thus demonstrating that the natural rate is dependent upon the demographic group upon which it is based.

The Theoretical Model

The inverse relationship between the percentage change in the inflation rate and the rate of unemployment is the well-known Phillips curve and forms the theoretical basis for estimating the natural rate of unemployment. The equation, as formulated by the natural rate hypothesis is stated as:

(3.1) \[ \pi_t = \pi_t^* - b(u_t - u^*) \]

where "the actual inflation rate \( \pi_t \) is explained by the expected inflation rate \( \pi_t^* \) and the deviation of the actual rate of unemployment \( u_t \) from the natural rate \( u^* \)" (Frisch 1983, 53).
When the equation is expressed in terms of observable variables it becomes:

\[ n_t = n_{t-1} - b\theta(u_t - u^*) - b(1 - \theta)(u_t - u_{t-1}) \]

where "the actual rate of inflation is now explained by the lagged rate of inflation, the level of excess demand as indicated by the deviation of \( u_t \) from \( u^* \), and the change in the level of excess demand as expressed by a change in the rate of unemployment \( (u_t - u_{t-1}) \)" (Frisch 1983, 56). The theoretical model assumes that inflationary expectations are formed according to the adaptive expectations model and that the long-run Phillips curve "is a vertical line on the abscissa at the position of the natural rate of unemployment" and represents "a steady-state situation in which inflation is fully anticipated and the rates of inflation and unemployment do not change" (Frisch 1983, 56).

The principle economic variables used in this study are the unemployment rate and the inflation rate. "Unemployment is the percentage of the labor force that is unemployed", as shown below:

\[ \text{(3.3)} \quad \text{Unemployment rate (UR) = } \frac{\text{unemployment (U) x 100}}{\text{labor force (LF)}} \]

(McConnell and Brue 1992, 547).
The labor force, then, is the total of all employed and unemployed persons:

(3.4) \[ \text{Labor force} = \text{employment} + \text{unemployment} \]

(McConnell and Brue 1992, 547). Unemployment is defined by the Department of Labor Statistics as follows: "People are considered officially unemployed if during the survey week [done by the Bureau of the Census] they were 16 years of age or older, were not institutionalized, and did not work, but were available for work and (1) had engaged in some specific job-seeking activity during the past 4 weeks, (2) were waiting to be called back to a job from which they had been temporarily laid off, (3) would have been looking for a job but were temporarily ill, or (4) were waiting to report to a new job within 30 days. Those officially employed include people who, during the survey week, were 16 years or older and either (1) were employed by a private firm or government unit, (2) were self-employed, or (3) had jobs but were not working because of illness, bad weather, labor disputes, or vacations (McConnell and Brue 1992, 546).

In trying to find a suitable definition of inflation, I quote Helmut Frisch, "there is no generally acceptable or satisfactory definition" (Frisch 1983, 9). What he means is that inflation is commonly defined by a condition, rather than by what it actually is and as such lacks a scientific
precision. A typical textbook definition states, "inflation is a rising general level of prices in the economy" (McConnell and Brue 1992, 581). So, if inflation is a general rise in price levels, then it is also a marked by a fall in the value of money. Frisch furthers qualifies the definition of inflation as a condition that is neither a one-time increase in the general price level or a reversible condition, i.e. it is continuous and irreversible over a considerable period of time.

If the definition of inflation is imprecise, then the measurement of it is equally imprecise because it cannot be measured directly, but only by means of indexing. Measuring inflation always involves the construction of price indexes. The most commonly used index is the CPI or the Consumer Price Index. Recently, the CPI has been faulted for overstating inflation and understating the steady improvements in productivity and standards of living (see Gordon 1981). Other indexes are used as measures of inflation, such as the Implicit Price Deflator (IPD) and the index of Personal Consumption Expenditure (PCE), of which the latter was chosen for this study. The PCE avoids the flaws cited against the CPI.
The Statistical Model

The first statistical relationship to be estimated is the Phillips curve, which takes the following form:

\[ p_t = a_0 + \sum_{i=1}^{8} b_i p_{t-1} + \sum_{i=0}^{4} c_i \ln u_{t-1} + e_t \]

where \( p_t \) represents the percentage change in inflation at time \( t \) and \( u_t \) represents unemployment at time \( t \) (Weiner 1993, 64). A linear-log model is specified by (3.5) and assumes the error term is normally distributed.

The natural rates of each race/gender/age group are estimated using the following log-log equation:

\[ \ln u_{j,t} = a_0 + \sum_{i=1}^{3} a_i QTR_i + b_1 \ln u_{mm,t} + e_t \]

where \( u_{j,t} \) represents the unemployment of group \( j \), \( u_{mm,t} \) represents the unemployment rate of married males and the \( QTR_i \) terms represent quarterly dummy variables (Weiner 1993, 64). The error term is assumed to be normally distributed.

Several other mathematical relationships were required to complete the study. First, an inverted form of the Phillips curve was necessary to find the natural rates for either married males or married females \( u_{mm/f}^N \) as shown below:
where $a_0$ and $c_i$ are coefficients derived from the Phillips curve equation. Another similar relationship is required to invert the group natural rate regression equation (3.6) to find the group natural rates and is given as follows:

\[
(3.8) \quad u_j^N = \exp a_0 + \frac{a_1 + a_2 + a_3}{4} + b_1 \ln u_{mm/f}^N.
\]

The coefficients derived from (3.6) are entered into (3.8) along with the natural log of the married male or female natural rates and in this way the group natural rates are found. Finally, the following relationship generates the overall natural rate series:

\[
(3.9) \quad u_t^N = \sum_{j=1}^{20} (u_j^N)(s_j, t)
\]

where the group natural rates from (3.8) are weighted by each group's share in the labor force $(s_j, t)$. 

\[
(3.7) \quad u_{mm/f}^N = \exp \left[ -\frac{a_0}{4} \sum_{i=0} \frac{c_i}{4} \right]
\]
The Data

In estimating the Phillips curve (equation 5), a statistic measuring inflation is required, as well as, an unemployment statistic. The fixed-weight index for Personal Consumption Expenditure (PCE) at seasonally adjusted annual rates was chosen as a measure of inflation. It is found in the tables for National Income and Product Accounts (Survey of Current Business). The Weiner study used the fixed-weight PCE deflator net of food and energy because, it avoids "accounting for food and energy price inflation which, over the short run, is little influenced by slack in the economy" (Weiner 1993, 68). Mr. Larry Moran, Chief Liaison at the Bureau of Economic Analysis asserted that the chain-weighted PCE would be the best measure of inflation, because instead of using one weight throughout the time period, the weights change over time, thus allowing less bias to creep in (Moran 1995). It would have been desirable to use either the PCE net of food and energy or the chain-weighted PCE had a complete series been readily available. Using the fixed-weight PCE as a measure of inflation then, the percentage change in the inflation rate was calculated in preparation for estimating the Phillips curve.

Regarding the unemployment rate used in the Phillips curve, the original Weiner study uses seasonally adjusted quarterly data for married males. This study uses quarterly seasonally unadjusted data for married males and for married
females. The source of this data is the same compact disk as mentioned below.

The remainder of the data used in this study contains labor force and unemployment rate statistics for the entire U.S. population over the period 1961 to 1992, as well as, the same statistics for the white population. The labor force data represents the size of the civilian labor force and are quarterly averages of household data. The unemployment rates are quarterly averages for the civilian noninstitutional population. Both are not seasonally adjusted. Labor force data and unemployment rates for the entire and white populations were collected for both genders and 5 age groups. These statistics were found on CD-ROM by the Office of Employment and Unemployment Statistics.

A comparable set of labor force and unemployment rate statistics was required for the non-white population and had to be generated from the above data set, since a complete series was unavailable. Non-white labor force statistics were easily generated by subtracting the total labor force \( LF_t \) from the white labor force \( LF_w \) for each age and gender group to yield the non-white labor force \( LF_n \);

\[
LF_n = LF_t - LF_w
\]

Obtaining non-white unemployment rates required several steps. First, solving (3.1) for \( U \) forms a general
equation for finding unemployment (3.11). Second, (3.8) is used to construct a relationship that finds the number of unemployed non-white persons \((U_N)\) using only available statistics (3.12), where \((U_{R_t})\) and \((L_{F_t})\) is the unemployment rate and size of the labor force of the U.S. population and \((U_{R_w})\) and \((L_{F_w})\) is the unemployment rate and labor force size of the white population. The calculations are performed on each age/gender group.

\[
(3.11) \quad U = \frac{UR \times LF}{100}
\]

\[
(3.12) \quad U_N = \frac{U_{R_t} \times L_{F_t}}{100} - \frac{U_{R_w} \times L_{F_w}}{100}
\]

Unemployment \((U_N)\) and labor force \((L_{F_N})\) values for each group can then be substituted into (3.1) which is re-written as (3.13), thus generating the unemployment rates for non-whites.

\[
(3.13) \quad U_{R_N} = \frac{U_N}{L_{F_N}} \times 100
\]

The average annual share of each group in the labor force was calculated by dividing the annual total number of each race/gender/age group in the labor force by the annual total labor force. This produced a series over the sample period for each group.
The Estimation and Inference Procedures

A four-part approach for estimating an overall natural rate series is followed and is similar to that described by Weiner (see Weiner 1993, 64-5). The first step is to estimate a statistical equation relating the percentage change in the rate of inflation to the unemployment rate of married males (3.5), which is essentially the Phillips curve. In estimating this equation, the inflation variable is lagged eight periods and the sum of the lagged coefficients is constrained to equal one. The constraint allows solution of a natural unemployment rate (either married males or married females) where inflation is kept constant. The Phillips curve is estimated over several sample periods in order to generate coefficients that will later form the basis for the demographically and fully adjusted natural rate series. The full sample period (1961.2 to 1992.4) is used for estimating the demographically adjusted series. Also, smaller time segments, referred to as the first (1961.2 to 1972.), second (1973.1 to 1979.4) and third (1980.1 to 1992.4) periods, are used for the fully adjusted series. The Chow test was used to determine structural breaks after first and second periods. The married male and married female unemployment rates were used in separate estimates of both the Phillips curve and the Chow test.
The Almon polynomial distributed lag approach is used to solve (3.5), where a second degree polynomial is chosen and the first lag on inflation effectively begins with \( t - 1 \). SAS is used for all regression procedures in this study and proc syslin in particular is used here, because it allows application of the constraint on the lagged variables in the Phillips curve equation.

The second step is to solve the Phillips curve equation for the unemployment rate for which inflation is constant. For this, we use (3.7) which, when the appropriate coefficients from the preceding step are substituted in, yields married male and married female natural rates for the three sample periods.

The third step is to calculate the natural rate of unemployment for the 20 different racial/gender/age groups based on regressions relating them to the married male or married female natural rate of unemployment. This step involves (3.6) and requires only the data for white and non-white population groups. Both the dependent and independent variables are logged and quarterly dummy variables are formed to take into account the seasonal variations in unemployment. Using OLS, regressions are run on each race/gender/age group to yield coefficients that are used in (3.8) to estimate group natural rates of unemployment. Also, a Chow test is performed on all groups to determine the consistency of structural breaks.
The fourth and final step is to weight the groups by the average annual share they hold in the labor force and then construct an overall natural rate series. First, annual averages are found for the labor force size for each group. The total average annual size of the labor force is also found. Then, the average annual share of each group is determined by dividing the relative size of each group by the total size of the labor force. Group shares are estimated over the full sample period. Finally, using 3.9 several natural rate series are estimated. The demographically adjusted series comes from the group natural rates generated over the full sample period. The fully adjusted series is estimated from group natural rates over the three smaller time periods. The overall natural rate series then becomes a composite of time segments (1961.2 to 1972.4, 1973.1 to 1979.4 and 1980.1 to 1992.4) taken from each fully adjusted series.

The Estimates

In this section, the estimates and their statistical significance are presented. A Chow test was performed on the Phillips curve equation (3.5) where the null hypothesis states that there is no difference between time periods. A tabulation of the results is shown in table 1. The male and female-based tests show that the null is rejected for periods one and two, but not rejected for periods two and
This finding allows for the collapse of periods two and three into one longer period, 1973 to 1992.

Table 1.--Chow Test Results on the Phillips Curve

<table>
<thead>
<tr>
<th></th>
<th>$F_{CRIT} .05%$</th>
<th>$F_{CALC}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Period 1+2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1961 to 1972</td>
</tr>
<tr>
<td>Male Based</td>
<td>2.17</td>
<td>2.41</td>
</tr>
<tr>
<td>Female Based</td>
<td>2.17</td>
<td>2.61</td>
</tr>
</tbody>
</table>

The Phillips curve estimates are shown in table 2. Following Weiner's estimation procedure, the sum of the coefficients on inflation is constrained to equal one, so there are no t-statistics given. The constraint was tested and proved to be valid. The t-statistics for the intercept (Int.) and unemployment (U) are shown in parentheses and the null hypothesis states that there is no significant relationship between the coefficients and inflation. In the male-based model, the null hypothesis is rejected for periods 0 and 2+3 for both coefficients. Also, in period 1 there appears to be no statistical relationship between inflation and unemployment, which agrees with Weiner's results. In the female-based model, only in period 2 is the null hypothesis rejected for both coefficients.
This result leads me to question the idea of a structural break between periods 2 and 3. I reason that in the Chow test for period 2+3 the null is narrowly rejected, producing a weak conclusion that no structural break exists. Furthermore, the t-test for period 2+3 shows that the relationship between U and P is insignificant, whereas it is
decidedly significant for period 2 alone. This is sufficient evidence in favor of no break between the periods. Therefore, equation (3.8) will use male-based NRUs for periods 0, 1 and 2+3 and female-based NRUs for periods 0, 1, 2 and 3.

The intercept and unemployment coefficients are used in (3.7) to generate the male and female-based natural rates (NRU). The married male natural rates that were generated using (3.7), come very close to that given by Weiner at 3.5, 3.0 and 3.9 respectively. The column labeled "s" is the standard error of the regression.

In the Chow tests for male and female-based groups (see tables 3 and 4 on the following pages), the null hypothesis states that there is no significant difference between the two periods, i.e., there is no difference either between period one and two or between period two and three. All of the test statistics reject the null hypothesis and it is concluded that the three periods are significantly different from one another at the five percent level. The p-values that are shown as "0", are values less than one percent.

The results of the group Chow tests show that there are structural breaks between the time periods which allows estimation of the fully adjusted group natural rates by applying equation (3.6) to each group in each of the three time periods.
Table 3.--Chow Test Statistics on Male-Based Groups

<table>
<thead>
<tr>
<th>Period 1+2</th>
<th>Period 2+3</th>
</tr>
</thead>
<tbody>
<tr>
<td>F&lt;sub&gt;CRIT .05%&lt;/sub&gt;</td>
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</tr>
<tr>
<td>F&lt;sub&gt;CALC&lt;/sub&gt;</td>
<td>P-value</td>
</tr>
<tr>
<td>White Males</td>
<td></td>
</tr>
<tr>
<td>16-19</td>
<td>7.47</td>
</tr>
<tr>
<td>20-24</td>
<td>9.02</td>
</tr>
<tr>
<td>25-54</td>
<td>45.09</td>
</tr>
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<td>55-64</td>
<td>26.27</td>
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<tr>
<td>65+</td>
<td>57.91</td>
</tr>
<tr>
<td>White Females</td>
<td></td>
</tr>
<tr>
<td>16-19</td>
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</tr>
<tr>
<td>20-24</td>
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<tr>
<td>25-54</td>
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<tr>
<td>Non-White Males</td>
<td></td>
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<tr>
<td>16-19</td>
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</tr>
<tr>
<td>20-24</td>
<td>15.29</td>
</tr>
<tr>
<td>25-54</td>
<td>5.05</td>
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<td>7.56</td>
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<td>Non-White Females</td>
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<td>16-19</td>
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<td>25-54</td>
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<td>55-64</td>
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<tr>
<td></td>
<td>Period 1+2</td>
</tr>
<tr>
<td>------------------</td>
<td>------------</td>
</tr>
<tr>
<td><strong>F&lt;sub&gt;CRIT&lt;/sub&gt; .05%</strong></td>
<td>2.36</td>
</tr>
<tr>
<td><strong>F&lt;sub&gt;CALC&lt;/sub&gt;</strong></td>
<td><strong>P-value</strong></td>
</tr>
<tr>
<td><strong>White Males</strong></td>
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<tr>
<td>16-19</td>
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<td><strong>White Females</strong></td>
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<tr>
<td>16-19</td>
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<tr>
<td>20-24</td>
<td>31.82</td>
</tr>
<tr>
<td>25-54</td>
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</tr>
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<td><strong>Non-White Males</strong></td>
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</tr>
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<tr>
<td><strong>Non-White Females</strong></td>
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</tr>
<tr>
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<td>7.37</td>
</tr>
<tr>
<td>65+</td>
<td>7.48</td>
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Table 5.—Estimates of Natural Rates of Unemployment of Selected Population Groups

<table>
<thead>
<tr>
<th>Demographically Adj.</th>
<th>Fully Adjusted Third</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male NR</td>
<td>Female NR</td>
</tr>
<tr>
<td>White Males</td>
<td></td>
</tr>
<tr>
<td>16-19</td>
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<td>20-24</td>
<td>8.31</td>
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<tr>
<td>25-54</td>
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<tr>
<td>55-64</td>
<td>3.17</td>
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<tr>
<td>65+</td>
<td>2.54</td>
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<tr>
<td>White Females</td>
<td></td>
</tr>
<tr>
<td>16-19</td>
<td>18.33</td>
</tr>
<tr>
<td>20-24</td>
<td>9.77</td>
</tr>
<tr>
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<td>5.53</td>
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<tr>
<td>55-64</td>
<td>3.76</td>
</tr>
<tr>
<td>65+</td>
<td>3.23</td>
</tr>
<tr>
<td>Non-White Males</td>
<td></td>
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<tr>
<td>16-19</td>
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</tr>
<tr>
<td>20-24</td>
<td>16.96</td>
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<tr>
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<td>55-64</td>
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<tr>
<td>Non-White Females</td>
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<td>4.26</td>
</tr>
<tr>
<td>65+</td>
<td>3.33</td>
</tr>
</tbody>
</table>
Equation (3.6) is also estimated for the entire sample period to obtain the demographically adjusted group natural rates. A total of 160 regressions were run on the groups, which includes four time periods, twenty groups and two genders (see appendix for detailed results).

Table 5 provides demographically adjusted and fully adjusted third period group natural rate estimates. Overall, the female-based rates were lower than the male-based rates for the all groups, except white males.

Table 6.—Gender-Based Fully Adjusted Natural Rate Series

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961</td>
<td>5.60</td>
<td>4.82</td>
<td>1977</td>
<td>7.91</td>
<td>6.85</td>
</tr>
<tr>
<td>1962</td>
<td>5.56</td>
<td>4.78</td>
<td>1978</td>
<td>7.96</td>
<td>6.89</td>
</tr>
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<td>1963</td>
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<td>4.82</td>
<td>1979</td>
<td>7.95</td>
<td>6.87</td>
</tr>
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The fully adjusted natural rate series is shown in Table 6. There are sharp changes in values after 1972 and 1979 for both the male-based and female-based series which are consistent with the periods of structural change. In both the male and female-based series the natural rates have been trending downward, but remain at higher levels than those previous to the first oil shock in 1973.

The demographically and fully adjusted natural rate is also shown graphically (see figure 4). The demographically

![Graph of Fully Adjusted and Demographically Adjusted Natural Rates of Unemployment.](image-url)

Figure 4. Fully Adjusted and Demographically Adjusted Natural Rates of Unemployment.
adjusted natural rate series does not take into account structural changes in the economy, only the demographic factors of race, gender and age over the sample period. The fully adjusted series however, takes both demographic and structural factors into account. In Figure 4, both the male and female-based demographic series peak at the same time; around 1975 to 1978. There is on average a difference of about .45 of a percent between the male and female-based demographically adjusted series. In the fully adjusted series it is notable that the curves of both genders appear to follow the same trends. The structural breaks of the 1970's are clearly delineated in both. The principle difference between the two is the female-based graph is lower than the male-based graph by about .88 of a percent on average. Another notable characteristic of the female-based fully adjusted graph is that it very close and parallel to the demographically adjusted graph around 1980 and thereafter.
4. CONCLUSION

Summary

The results as presented, show that the natural rate of unemployment is not independent of the demographic group chosen for the unemployment variable used in estimating the Phillips curve. Over the study period 1961 to 1992, estimates of the male-based and female-based natural rates produce significantly different estimates. The two principle characteristics of the results are 1) both gender-based natural rate series exhibit the same trends over time and 2) the female-based fully and demographically adjusted natural rate series are consistently lower than the corresponding male-based series. It can be concluded, therefore, that the difference between male-based and female-based fully adjusted and demographically adjusted natural rate series can mainly be attributed to gender.

The resulting female-based natural rate series (see Table 6 and Figure 4) are in accord with the demographic studies of Summers and others.
Implications

The results of this study strongly suggest that the estimation of the natural rate is dependent on the demographic group upon which it is based. Specifically, the natural rate depends upon the gender of married persons chosen for the unemployment data used in estimating the Phillips curve. The entire basis for natural rate estimation lacks definitive and substantiated criteria for selection of data, particularly for the unemployment rate used in estimating the Phillips curve. For example, Weiner specifies that the unemployment rates of married men be used because, "the overall unemployment rate is not consistent--it is too sensitive to changes in the composition of the labor force" (Weiner 1993, 57). This construes a bias in favor of using the unemployment rates of married men by Weiner with only a vague allusion to some undefined criterion of "consistency". It can be postulated that if other researchers who have estimated the natural rate are also exhibiting this same bias, then all such estimates are based on unstated and incomplete assumptions, which therefore calls into question the validity of all estimates thus derived. This suggests that the natural rate is at least highly questionable and at most unreliable for use in high-level policy formation.
Presently, policy prescriptions concerning unemployment and inflation in the United States depend heavily on the validity of the natural rate hypothesis. If it could be shown that there is no "true" natural rate, then there would be no basis for the monetarist belief that there is no trade-off between unemployment and inflation in the long run and that unemployment cannot be lowered in the short run by any policy means. As the natural rate is the "yardstick" to which all rates of unemployment are measured, then invalidating that yardstick would remove the rationale for the laissez faire approach to dealing with actual levels of unemployment that are deemed to be too high. As it stands, the male-based natural rates estimated both by this study and by Weiner show that the 1992 level (which is the most recent estimate) has yet to become as low as it was during the 1960's. By most accounts, the natural rate is high, meaning, higher than levels previous to the oil-shock years. Without a natural rate hypothesis to obstruct government intervention towards lowering unemployment, there would no compelling economic reason not to proceed.

Shortcomings

The natural rate series presented in this paper runs about six tenths of a percentage point higher on average
from 1961 to 1979 as compared to Weiner's estimates and about three tenths of a percentage point lower on average than his after 1979. The difference may be attributed to the accumulation of differences in data and estimation techniques used to reach the results. For example, the inflation data used here was a fixed-weight PCE, but Weiner uses a fixed-weight PCE net of food and energy. Also, Weiner uses seasonally adjusted data for married males in the Phillips curve, but the unemployment rate data used here is seasonally unadjusted for married male and married females.

There is some question as to why the male-based coefficients produced by the Phillips curve in this study and by Weiner differ. Perhaps the answer lies in the estimation procedure. Weiner claims he uses ordinary least squares to estimate the Phillips curve which has a restriction on the sum of the coefficients of inflation. I would like to know how he accomplished that, because that was not possible using SAS. Nevertheless, reasonable estimates were produced in this study.

The low t-statistics of Phillips curve coefficients for certain periods indicate that the relationship between those coefficients and inflation is not significant. If another estimation procedure could be found (Weiner's OLS method,
for example) it would be worth running the model again to see if these same results are still obtained.

**Suggestions**

Correction of the shortcomings mentioned above as part of some future study is desirable in order to discover and completely resolve the differences between these results and Weiner's, so that a more complete comparison can be made. This study only explored the difference in natural rate estimation between genders, but a more thorough exploration could be made by comparing the natural rates based on other demographic characteristics such as marital status and race.

It is suggested that further research be conducted to define and test the validity of the assumptions behind using one demographic group over another in estimating the natural rate. The outcome of this should be the formation of validated criteria for group selection. Selection criteria should be made explicit and exact and should not be left up to tradition or bias. This no doubt will help to standardize natural rate estimation and possibly through questions raised in the process, challenge the notion of the natural rate itself.
APPENDIX

The following pages contain the tabulated results of the group regressions. Table 7 contains the coefficients, t-statistics and adjusted r-squares for the female-based models and table 8 contains the same information for the male-based models. The first of the two letters in the group designation indicate race (w for white and m for minority) and the second letter is gender (m for male and f for female). The numbers indicate the age group. For example, 1619 means sixteen to nineteen years old and 2024 means twenty to twenty-four years old and so on.
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  - a3: 0.0315
  - b1: 0.4892

- **wm 5564**
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  - a1: 0.0062
  - a2: 0.017
  - a3: 0.0481
  - b1: 0.9817

- **wm 2554**
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  - a1: -0.0094
  - a2: -0.0111
  - a3: -0.0212
  - b1: 0.9975

- **mm 65**
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  - a1: 0.0257
  - a2: -0.0301
  - a3: 0.0727
  - b1: 0.6487

- **mm 5564**
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  - a1: 0.2591
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  - b1: 0.2034

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  - a1: 0.1095
  - a2: 0.2358
  - a3: 0.1863
  - b1: 1.2542

- **mm 5564**
  - a0: 0.5704
  - a1: 0.1111
  - a2: 0.03
  - a3: 0.0985
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- **mm 65**
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  - a1: 0.3322
  - a2: 0.149
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  - a1: 0.0557
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  - a3: 0.0792
  - b1: 0.0001

- **mm 2554**
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  - a1: 0.0557
  - a2: 0.0007
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