The Empirical Evidence of Mean Diversion in the U.S. Labor Market 1970-2009

John Silvia, Chief Economist
Wells Fargo Securities, LLC
One Wachovia Center, 301 South College Street, NC0602
Charlotte, NC 28288-0602, USA
Tel: 704-374-703 Fax: 704-383-3102 E-mail: john.silvia@wellsfargo.com

Azhar Iqbal (Corresponding Author)
Vice President and Econometrician
Wells Fargo Securities, LLC, One Wachovia Center, 301 South College Street, NC0602
Charlotte, NC 28288-0602, USA
Tel: 704-383-6805 Fax: 704-383-3102 E-mail: azhar.iqbal@wellsfargo.com

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Abstract

Policy makers love to speak about restoring the economy and the associated "good" jobs as voters imagine they were in the past. But is such economic nostalgia reasonable in a dynamic global economy? Our work here suggests that the labor market has been constantly evolving since 1970 and that there is no tendency to return to "normal" if such a normal were to be defined as it was in the good old days.

Since 1970 the mean and standard deviation of employment growth had actually been decreasing for each decade up until the 1990-99. For the most recent (2000-09) period, the standard deviation shows an uptick and a significant reduction in the mean. We find that the trend coefficient is statistically significant and has a negative sign. That implies the employment growth rate has a decreasing pattern over time.

Our results suggest, the level of the employment growth rates is mean-diverting and subject to a structural break. Second, in the presence of the ARCH effect, OLS standard errors can be misleading, with a spurious regression possibility. Finally, the ARCH effect and unit root problem have serious consequences for forecasting and the forecast band could be narrower than the actual.

Keywords: Employment, Structural Change, ARCH, Mean Diversion

JEL Classification: C10; J21; J30

Introduction

Policy makers love to speak about restoring the economy and the associated "good" jobs as voters imagine they were in the past. But is such economic nostalgia reasonable in a dynamic global economy? Moreover, has it actually been true that the economy, and particularly the labor market, were ever as stable as we imagine? This paper seeks to characterize the behavior of the U.S. employment growth rate over the economic cycle. We raise three fundamental questions which are; first, does the employment growth over time exhibit a mean-reverting behavior? That is, does the growth in employment exhibit a tendency to return to some average value? Second, how volatile are employment and does this volatility obscure the message of employment growth? Finally, do employment growth rates vary between decades/ sub-samples?

In this paper we divide the U.S. employment growth rate into decades since 1970. We test if all the data share the same statistical moments—average and standard deviation. We also estimate an instability ratio, the standard deviation as a percent of mean, where the higher value of the instability ratio is an indication of higher volatility. In addition, we test whether there is any change in the character (linear vs. non-linear) of the trend in employment growth over time. The next issue would be to test whether employment growth is mean-reverting or not. We employ unit root methodology on the series and test whether employment growth contains a unit root or not. If a series does not contain a unit root we call it stationary and, otherwise, non-stationary. Moreover, a stationary series fluctuates around a constant long-run mean that implies the series, employment growth in this case, has a finite variance which does not depend on time, hence mean reversion. On the other hand, if a series is non-stationary (contains a unit root) that implies the series has no tendency to return to the long run mean and the variance of the series is time dependent. Therefore, the best way to test whether the employment growth series is mean reverting would be to test whether employment growth contains a unit root (not mean reversion) or not (mean reversion).

Dickey and Fuller (1979, 1981) introduced the eminent and first standard process for unit root testing and their test is known as ADF (Augmented Dickey-Fuller) unit root test. However, there are some others unit root tests, other than the ADF test, available in the literature. For instance, Phillips and Perron (1988) proposed an alternative to the ADF test, called the PP test, and Kwiatkowski, Phillips, Schmidt, and Shin (1992) introduced KPSS test. Due to the serious issues related with the traditional unit root tests, which are the ADF, PP, and KPSS, recent literature proposed to employ the most efficient tests of unit root developed by Elliot, Rothenberg, and Stock (1996) (hence after ERS) as well as Ng and Perron (2001) (after here NP).

However, there is another potential issue which is very important and that is the presence of a structural break in the time series. Perron (1989) found that the standard ADF tests are biased towards the null hypothesis in the presence of a structural break in the time series. In other words, the ADF tests failed to reject the null of a unit root even though the time series is stationary and that happened because of a structural break in the time series. Perron (1989) suggested that it is not necessary that most macroeconomic time series are characterized by a unit root process—not mean reversion, but rather that persistence arises only from large and infrequent shocks and many macroeconomic time series return to their long run mean after small and frequent shocks. Banerjee et al. (1992), Christiano (1992) and Zivot and Andrews (1992) criticize Perron's idea of an exogenous structural break and they suggested that the structural break would be endogenous. Zivot and Andrews (1992) suggested a unit root test with endogenous break.

The above mentioned tests assumed that there is a break-point and determined the break date either exogenously or endogenously. But the important question is; if there is no break point and we enter a break point into the regression then what happened to the unit root tests results? Nunes et al. (1997) and Bai (1998) provided the answer to the question and the answer is "spurious break". More explicitly, when the disturbances of a regression model follow an $I(1)$ process, order of integration one, there is a tendency to estimate a break point in the middle of the sample, even though a break point does not actually exist. Therefore, unit root tests are not reliable in these cases; (1) when a break point exists and did not include in the test regression, (2) if a break point does not exist and did include in the test regression, and (3) the use of incorrect break date in the test regression.

Recently, Kim and Perron (2009) proposed a unit root test with structural break that address these issues and provide a more efficient testing procedure. Kim-Perron (2009) unit root test allows a break at unknown time under both the null and alternative hypotheses. The test also tackles the issue of "spurious break" and proposed a pre-test for a break that is valid whether the noise component is integrated or stationary (see Kim-Perron, 2009 for more detail).

We employ a comprehensive unit root methodology and use ADF, PP, KPSS, ERS, NP, Perron, Zivot-Andrews and Kim-Perron tests on the U.S. employment growth rate series and test whether the employment series is mean reverting.

Once we determine the econometric set-up for mean reversion then we would explore the volatility of the employment growth. We address the volatility issue in two different ways. First, we calculate the mean, standard deviation, and the instability ratio for each decade. This would provide a picture for each decade and, based on standard deviation and instability ratios, we can evaluate which decade has higher employment volatility, higher standard deviation and instability ratio. Second, we employ an Autoregressive Conditional Heteroscedasticity (ARCH) approach on the employment growth and the benefits of the ARCH are numerous. For instance, if we find the ARCH effect in a time series that indicates the series has volatility clustering—the deviation from the mean is not constant over time and that the deviation is smaller for some periods than others, and vice versa. Recently, Hamilton (2008) proposed the use of ARCH in macroeconomics and suggested that even if our primary interest is in the estimation of the conditional mean (mean reversion or not), correctly modeling the conditional variance (volatility of the series) can still be quite important for two reasons. First, due to the correction for outliers and high-variance episodes estimated parameters would be more accurate. Second, if we don't make the correction then the result would be a spurious regression (see Hamilton (2008) for more detail).

Our efforts suggest that since 1970 the mean and standard deviation of employment growth had actually been decreasing up until the 1990-99. For the most recent (2000-09) period, we see an uptick in the standard deviation and a significant reduction in the mean. Moreover, when we evaluate the entire period as a whole, 1970-2009, we find that the trend coefficient is statistically significant and has a negative sign. That implies the employment growth rate has a decreasing pattern over time. In addition, the standard deviation (1.79%) is higher than the mean (1.73%); this is evidence of high volatility in the employments series. Indeed, the growth of employment is volatile over time.

Summing up, our empirical analysis suggests that the level of the employment growth rates is mean-diverting and subject to a structural break. In addition, the ARCH effect in the employment growth series implies the employment series has a volatility cluster—the deviation from the mean is not constant over time and that the deviation is smaller for some periods than others, and vice versa. Finally, the ARCH effect and unit root problem have serious consequences for forecasting and the forecast band could be narrower than the actual.

The rest of the paper is organized as follows. In section 2 we discuss theory and data for the employment growth. Section 3 introduces the econometric set-up of the study and section 4 explains the results. The concluding remarks of the paper are discussing in section 5.

Dynamic Economy: Dynamic Labor Market

"They're closing down the textile mill across the railroad track

Foreman says these jobs are going boys and they ain't coming back to your hometown."

My Hometown, Bruce Springsteen from Born in the U.S.A., 1984

The old jobs are gone and are not coming back. Moreover, jobs seldom stay in the same place forever and are not likely to pay the same real wage and benefits over time. These are the cold hard facts that political rhetoric constantly attempts to shield from the public. As economists our job is very different today than it was thirty years ago and certainly is not in the same location many of us grew up. Moreover, the textile and shoe jobs of New England are gone and so was the relative standard of living associated with those jobs. In addition, many of the tobacco, textile, furniture and apparel jobs of the South are also gone. The hegemony of Detroit's auto industry is gone. Yet in their place are many health, education, information technology and business services jobs that did not exist at the end of World War II. Therefore, it seems that there is no mean reversion in the jobs data and there is no going back to the old economy.

Exhibit I provides dramatic visual evidence of the evolution of the American labor market since just 1970. Over that period job growth has been generally positive with the expected declines in employment during recessions. What is surprising to some extent is the decline in the pace of job growth over that same time period. Job growth since 1970 has steadily declined in the U.S.A of Bruce Springsteen.

It is true that the share of jobs going to manufacturing has declined while the share going into services has risen since 1970. (Note 1) Retail and wholesale service sector employment has risen but the largest percentage increase has been in government employment which has quadrupled over time. Some would describe this pattern as the arrival of the post-industrial state. In Exhibit II, the returns to education for workers are readily apparent. Just over the last six years we have witnessed the income disparity between workers of different education not only persist but actually increase over this period. With shift, on a percentage basis, from consumer demand for goods to services and the application of technology in the production of both goods and services there have been increased demands upon workers themselves to acquire new skills and work in new jobs that were unknown before the 1970s. Jobs for less-skilled workers have declined while workers in information-processing, communications and managerial areas have increased. (Note 2) Therefore, the employment growth may be mean-diverting and subject to a structural change.

It is worthwhile to mention that we are not the first who is going to apply unit root tests on the employment data. Several researchers have had employed unit root test on the employment series and there is mixed evidence whether employment is mean-reverting or not. Nelson and Plosser (1982) applied ADF test on the 14 U.S. macroeconomic series including employment. They used annual dataset for 1909-1970 time period and concluded that employment series is mean-diverting. Since then many researcher have used Nelson-Plosser dataset and have different conclusions for the employment. For instance, Perron (1989) include a structural break for the 1929 crash and concluded that employment is mean-reverting and subject to a structural break. Zivot and Andrews (1992) concluded that employment is mean-diverting. Lee and Strazicich (2003) included two breaks and based on the LM test concluded that employment is mean-diverting. (Note 3) But in this paper we are not going to use the Nelson-Plosser dataset for the following reasons; First, many researchers in the past, introduced or modified unit root test and compared their test's performance with the existing unit root tests and Nelson-Plosser dataset is good for comparison but objective of our study is not to introduce a new unit root test. In addition, we are interested to analyze the behavior of the employment growth and for that purpose latest employment data is more appropriate. Second, we are examining the employment behavior by decades since 1970. Third, we also concentrate on the volatility of the employment growth and apply ARCH approach. Finally, we apply a comprehensive unit root methodology on the employment growth.

We use the U.S. nonfarm payrolls, year-over-year percent change, and source of data series is Bureau of Labor Statistics (BLS). Our employment growth analysis begins with 1970:Q1 (quarterly data series). We do not extend back to the end of the World-War-II (WWII) because the U.S. economy could not function properly by mid or late 1960s. For instance, the U.S. economy slipped five times into recession between the end of the WWII and 1965. Therefore, the start date for our analysis is 1970:Q1. We divide the data series into four decades (1970-79, 1980-89, 1990-99 and 2000-09:Q3); the fourth is not a complete decade. Other possible choices could have been to divide the data into business cycles, from trough to peak, etc. Although, data division according to the business cycle is a good choice, it does not fit into our analysis. For instance, each business cycle does not equal in duration and the duration varies from 4 quarters to 30 quarters. Moreover, our analysis is based on regression analysis, i.e., estimation of the trend as well as application of the ARCH approach. For estimation purposes, more observations with bigger time span are always better than the fewer observations. Therefore, we divide the data into decades and each decade has at least one recession and that implies that each decade contains business cycle properties, e.g., peak and trough.

Econometrics of Mean Reversion

Unit Root Testing: Introduction

Dickey and Fuller (1979, 1981) introduced the idea of a unit root and proposed a standard unit root testing procedure which is known as ADF (Augmented Dickey-Fuller) test of unit root. But unit root testing became popular in economics, especially among macro-economists, after the publication of the seminal paper by Nelson and Plosser (1982). Nelson and Plosser employed unit root methodology on 14 U.S. macroeconomic time series and they could reject the null hypothesis of a unit root for only one time series, which was the unemployment rate. In addition, Nelson and Plosser concluded that many macroeconomic series are non-stationary. That implies many macroeconomic series exhibit trending behavior or a non-stationary mean—put simply, not mean-reverting. Therefore, unit root tests can be used to characterize a time series. There are many other unit root tests, other than ADF test, available in the literature. For instance; Phillips-Perron (1988) (PP), and Kwiatkowski-Phillips-Schmidt-Shin (1992) (KPSS) tests of unit root (also known as traditional unit root tests); tests introduced by Elliot-Rothenberg-Stock (1996) (ERS) and Ng-Perron (2001) (also known as efficient unit root tests). We employ all these tests on the U.S. employment series and test whether the employment series is mean reverting. (Note 4)

Unit root Tests and Structural Breaks

Perron (1989) challenged Nelson-Plosser's conclusion, that is, most macroeconomic time series contain a unit root. Perron argued that in the presence of a structural break, the standard ADF tests are biased towards the non-rejection of the null hypothesis. He concluded that most macroeconomic time series are not characterized by a unit root but rather that persistence arises only from large and infrequent shocks. In addition, Perron used the Nelson-Plosser dataset and incorporated an exogenous structural break for the 1929 Crash. He reversed the Nelson-Plosser's conclusion for 10 of the 13 macroeconomic time series.

However, Perron's assumption of 'known break date' (also known as exogenous break) was criticized, most notably by Christiano (1992) as "data mining". Christiano argued that the data based procedures are typically used to determine the most likely location of the break and this approach invalidates the distribution theory underlying conventional testing. Since then, there are two major views about the break date, which are (a) known or exogenous break date and (b) unknown or endogenous break date. Perron (1989) proposed an exogenous (known) structural break unit root test. Several other studies have developed using different methodologies for endogenously determining the break date, including Zivot and Andrews(1992), Banerjee et al. (1992), Perron and Vogelsand (1992), Lumsdaine and Papell(1997) and many others(see Byrne and Perman, 2006 for survey). (Note 5)

The above mentioned tests assumed that there is a break-point and determined the break date either exogenously or endogenously. But the important question is; if there is no break point and we enter a break point into the regression then what happened to the unit root tests results? Nunes et al. (1997) and Bai (1998) provided the answer to the question and the answer is "spurious break". More explicitly, when the disturbances of a regression model follow an $I(1)$ process, order of integration one, there is a tendency to estimate a break point in the middle of the sample, even though a break point does not actually exist. Therefore, unit root tests results are not reliable in these cases; (1) when a break point exists and did not include in the test regression, (2) if a break point does not exist and did include in the test regression, and (3) the use of incorrect break date in the test regression. The good thing of the Perron (1989) type's tests is that they are invariant to the break parameters and thus their performance does not depend on the magnitude of the break.

Recently, Kim-Perron (2009) proposed a unit root test with structural break that address these issues and provide a more efficient testing procedure. For instance, Perron (1989) test allows for a break under the null and alternative hypotheses but assume exogenous break and, on the other hand, Zivot-Andrews (1992) test assume endogenous break but did not allow break under the null hypothesis. In addition, both tests did not talk about the "spurious break". Kim-Perron (2009) unit root test allows a break at unknown time under both the null and alternative hypotheses. The test also tackles the issue of "spurious break" and proposed a pre-test for a break that is valid whether the noise component is integrated or stationary (see Kim-Perron; 2009).

Unit Root tests with Exogenous Break: Perron tests

Perron (1989) introduced the first standard unit root tests with structural break and all others tests are extension or modification of the Perron's test and thereby we start with the Perron test. Perron suggested three models. The models take into account the existence of three kinds of structural breaks: a 'crash' model (Model A), which allows for a break in the level (or intercept) of the series; a 'changing growth' model (Model B), which permits for a break in the slope (or rate of growth); and lastly one that includes both effects to occur simultaneously (Model C), i.e. one time change in both the level and the slope of the series.

$$\text{Model (A)} \quad \Delta y_t = \gamma + \gamma_1 DU_t + d(DTB)_t + \alpha y_{t-1} + \beta time + \sum_{j=1}^{p} \phi_j \Delta y_{t-j} + \varepsilon_t \tag{1}$$

Model (B) $$\Delta y_t = \gamma + \gamma_1 DT_t^* + \alpha y_{t-1} + \beta time + \sum_{j=1}^{p} \phi_j \Delta y_{t-j} + \varepsilon_t \quad (2)$$

Model (C) $$\Delta y_t = \gamma + \gamma_1 DU_t + d(DTB)_t + \gamma_2 DT_t + \alpha y_{t-1} + \beta time + \sum_{j=1}^{p} \phi_j \Delta y_{t-j} + \varepsilon_t \quad (3)$$

Where y_t is dependent variable and employment growth in our case. *Time* is a time variable or time dummy. The intercept dummy DU_t represents a change in the level;

$$DU_t = \begin{cases} 1 & if \quad t > TB \\ 0 & otherwise \end{cases} \quad (4)$$

The slope dummy DT_t (also DT_t^*) represents a change in the slope of the trend function;

$$D^*T_t = \begin{cases} t & if \quad t > TB \\ 0 & otherwise \end{cases} \quad (5)$$

The crash dummy model;

$$DTB = \begin{cases} 1 & if \quad t = TB + 1 \\ 0 & otherwise \end{cases} \quad (6)$$

TB is the break date. It is worth mentioning that each of the three models has a unit root with a break under the null hypothesis, as the dummy variables are incorporated in the regression under the null. The alternative hypothesis is a broken trend stationary process.

Unit Root tests with Endogenous Break: Zivot-Andrews Tests

The endogenous structural break test of Zivot and Andrews (1992) is a sequential test which utilizes the full sample and uses a different dummy variable for each possible break date. The selection criterion for the break date is based on the t-statistic from an ADF test and a minimum (i.e. most negative) value of t-statistic will be the indication of the break date. Consequently, a break date will be chosen where evidence is least favorable for the unit root null hypothesis. The Zivot-Andrews minimum t-statistic test has its own asymptotic theory and critical values. The latter are more negative than those provided by the Perron (1989) and may be suggest greater difficulty in rejecting the unit root null hypothesis. Zivot-Andrews test evaluates the joint null hypothesis of a unit root with no break in the series. As a consequence, accepting the null hypothesis in the context of Zivot-Andrews test does not imply unit root but rather unit root without a break. The critical values for Zivot-Andrews tests are derived under the assumption of no structural breaks under the null hypothesis.

Efficient Unit Root tests with Break: Kim-Perron Tests

Kim and Perron (2009) test allows break under both the null and alternative hypotheses and , when a break is present, the limit distribution of the test is the same as in the case of a known break date, thereby allowing increased power while maintaining the correct size. If there is no break in the trend then we can apply the standard ADF or any unit root test with no break dummies. Hence, we need a pre-test to assess whether a break is present or not. Kim and Perron (2009) proposed the procedure that has the correct size and powerful whether the noise is stationary or integrated. (Note 6) The testing procedure is based on a quasi-GLS approach using an autoregression of order one for the noise component, which a truncation to 1 when α is in some neighborhood of 1, and a bias correct. For a given break date, one constructs the F-test for the null hypothesis of no structural change in the deterministic components. Kim and Perron (2009) labeled the test as Exp-W_{FS}. The test has the same asymptotic size whether the noise is stationary or integrated (see Kim-Perron; 2009 for more detail). We apply Perron (1989), Zivot-Andrews (1992) and Kim-Perron (2009) tests on the employment growth and test whether the employment series is mean-reverting as well as subject to a structural change.

Macroeconomics and ARCH: Hamilton (2008)

Once we settled the issue of the mean-reversion then the natural question would be does employment series has a volatility cluster? Moreover, we would like to know the behavior of the variance of the employment series. To answer all these questions we employ the Autoregressive Conditional Heteroscedasticity (ARCH) approach on the employment and the benefits of the ARCH are numerous. For instance, if we find the ARCH effect in a time series, employment growth in this case, then that indicates the series has volatility clustering, i.e., some periods are more volatile than others. In other words, the deviation from the mean is smaller for some periods than others, and vice versa.

Recently, Hamilton (2008) proposed use of the ARCH in macroeconomics and suggested that even if our primary objective is the estimation of the conditional mean (mean reversion or not) having a correct description of the conditional variance (volatility of the series) can still be quite important for two reasons. First, OLS standard errors can be misleading, with a spurious regression possibility in which a true null hypothesis is asymptotically rejected

with probability one. Second, the inference about the conditional mean can be inappropriately influenced by outliers and high-variance episodes. Consequently, if we incorporate the conditional variance directly into the estimation of the mean then the estimates of the mean would be more efficient (see Hamilton (2008) for more detail). Therefore, we utilize the ARCH approach.

Results

Simple Statistics: The Mean, Standard deviation, Instability Ratio, and Trend

We broke up the employment growth data since 1970 into decades which roughly approximates four distinct periods of economic performance and political policy orientations. We estimate a mean, standard deviation and instability ratio for each decade. The instability ratio, standard deviation as percent of mean, represents the volatility of the employment series in each decade where the higher value of the instability ratio is an indication of higher volatility. One vital benefit of the instability ratio is that it identifies the magnitude of the volatility of employment growth by decade. Without an instability ratio, it is hard to specify employment volatility by decades for researchers. For instance, if we set the standard deviation as the volatility criterion, then the 1970s has highest standard deviation. If we stick with this criterion, then the 1970s is most volatile. But the problem with this criterion is that the 1970s also has the highest mean. Therefore, standard deviation alone is not the best measure of volatility especially when we compare different decades. Indeed, we need to consider both mean and standard deviation to determine volatility in the employment growth by decades. The instability ratio includes both mean and standard deviation and gives us information about which decade has a higher standard deviation relative to the mean for employment growth. Based on the instability ratio we conclude that 2000-09 is most volatile and 1990s is most stable decade for employment growth.

For the 1970s period, see Table 1 for results, employment growth contains a trend, in that, the coefficients of the time variable (time dummy) are statistically significant and that the trend is linear and upward, since coefficient of the time variable is positive. In addition, 1970s contain highest mean (2.49%) and standard deviation (2.15%) and we estimate an instability ratio 86.35 (standard deviation is 86.35 percent of the mean). There are several reasons behind the high standard deviation of the 1970s. For instance, oil prices quadrupled following the Arab Oil Embargo in late 1973; there was a financial crisis/stock market collapse and a substantial slowdown in the global economy. These factors may account for the volatility of the employment growth during the 1970s. As we continue testing over subsequent decades we find that the results of the 1970s are not repeated during the 1980s—a decade of apparent prosperity and stock market gains relative to the 1970s. During the 1980s, the standard deviation of employment growth appears large relative to its average value; standard deviation (1.91%) is higher than the mean (1.87%). We find a non-linear trend for the 1980s, a U-shaped trend. In addition, the instability ratio (102.14) is higher than during 1970s. The 1980s also had an oil shock and global economic activity turned down. There was a financial crisis/stock market crash and nonfarm employment tumbled 3.1 percent during the 1981-82 recession.

The 1990s also follows a non-linear trend, U-shaped trend, and a decline in the mean (1.8%) as well as in standard deviation (1.26%). But the decline in the standard deviation is much more than the decline in the mean. Consequently, the instability ratio (70) is smallest in the 1990s thereby this decade is most stable for the employment growth. The major factors behind this instability are that the "great moderation" and the Information Technology (IT) boom. During the 1990s U.S. economy experienced a boost in the productivity and that is known as the great moderation and during that period output per-worker increased. (Note 7) The IT boom bring in many new jobs, however, the out-sourcing job process also got more attention. Overall, the 1990s is most stable decade for the employment growth. For the most recent period (2000-09), employment growth does not follow the decreasing pattern of the last three decades and that is reduction in the mean and standard deviation. Instead, the current period shows a significant decline in the mean and an uptick in the standard deviation. The instability ratio (191.2) is highest in all decades and thereby most volatile decade for employment growth. In addition, there is no evidence of a trend that is the coefficient of the time variable is statistically insignificant. There are some major reasons for this high volatility as well as the reduction in the mean, (1) bust of the IT bubble, (2) more job out-source during 1st half of 2000s , (3) 2001 recession had a job-less recovery and (4) 2007-09 recession has the highest job loss since post WW-II. (Note 8)

Our efforts suggest that since 1970 the mean and standard deviation of employment growth had actually been decreasing up until the most recent (2000-09) period. The most recent period shows a significant decline in the mean and an uptick in the standard deviation. When we evaluate the entire period as a whole, 1970-2009, we find that the trend coefficient is statistically significant and has a negative sign. That implies the employment growth rate has a decreasing pattern over time. In addition, the standard deviation (1.79%) is higher than the mean (1.73%), this is evidence of high volatility in the employment series. Indeed, the growth of employment is volatile over time as pictured by Exhibit I. Overall; this pattern suggests that the character of employment growth changes over time due to changing underlying economic forces and/or policy changes.

Unit Root Tests without Structural Break

Table 2 shows results based on unit root tests and these tests do not consider a structural break in the test regression as well as in the null and the alternative hypotheses. We start with the ADF test's results. First case we consider

within the ADF test is the zero-mean case (no intercept and trend in the test regression). (Note 9) We reject the null hypothesis that the employment series has a unit root (not mean-reversion) in favor of the alternative hypothesis that the employment series is stationary (mean-reversion). In second case, we incorporated a constant (also known as drift parameter) in the test regression but results did not show any change and the employment series is still mean-reverting (stationary). The third case which includes a constant and a linear trend in the test regression and the result is as rejection of the null hypothesis of a unit root. Therefore, based on the ADF test results, the employment growth series is mean reverting.

The next unit root test we applied on the employment growth series is the PP test. The PP test has the null hypothesis of a unit root and the alternative is stationary (mean-reversion). We ran three different regression equations which are (i) equation with no intercept and trend, (ii) regression equation with constant and (iii) test equation with a constant and a linear trend. The results based on the PP test indicate strong evidence of mean-reversion. In other words, in all three cases we reject the null hypothesis of a unit root and conclude that the employments series is mean-reverting. We also applied the KPSS test on the employment growth series. The null hypothesis of the KPSS test is that the underline series is stationary (in our case, the employment series is stationary) and the alternative hypothesis is non-stationary. The KPSS test only considers two cases, which are (a) test regression with a constant and (b) regression equation with a constant and a linear trend. We failed to reject the Ho: the employments series is stationary in both cases thereby the KPSS test results indicate that the U.S. employment growth series is mean-reverting.

Interesting, all three unit root tests have the same conclusion, that is, the level of the employment growth series is mean-reverting. However, as we mentioned earlier, the ADF, PP and the KPSS tests have some limitations and may lead to a misleading conclusion. Therefore, we employ more efficient and reliable unit root tests which are ERS (DF-GLS and Point-optimal) and Ng-Perron tests. The results based on ERS and Ng-Perron tests are also available in Table 2. The DF-GLS test has the null hypothesis of a unit root and the alternative is stationary. We failed to reject the null hypothesis of a unit root in both cases; (i) a constant in the test regression and (ii) a constant and a linear trend in the regression. Therefore, the DF-GLS test results contradict the ADF, PP and KPSS tests' results. Moreover, the DF-GLS test indicates that the level of the employment growth series is not mean-reverting. However, the first difference of the employment growth series is stationary. (Note 10)

The next unit root test we applied on the employment series is the ERS Point-optimal unit root test which has the null hypothesis of a unit root and the alternative hypothesis is stationary (mean-reversion). When we include a constant in the test regression then we reject the null hypothesis that the employment series has a unit root at 10% level of significance. That implies the employment growth series is mean reverting. However, when we include a constant and a linear trend in the test regression then the result rejects the idea of the mean-reversion, the level of the employment series has a unit root. But the first difference of the employment growth series is stationary. Although the ERS point-optimal unit root test has a confusing conclusion, if we set the level of significance as 5% then we fail to reject the null hypothesis of a unit root. Now we proceed to the most efficient test of unit root and that is Ng-Perron tests. The results based on the Ng-Perron tests indicate that the employment growth series contains a unit root. In other words, the employments series is not mean reverting.

In sum, based on the unit root tests without structural break, we conclude that the level of the U.S. employment growth rates is not mean-reverting. Although, the ADF, PP, and the KPSS tests' results are in favor of the mean-reversion, these tests have lower power than the ERS and Ng-Perron tests. Therefore, we give more importance to those results which are based on the ERS and Ng-Perron tests. (Note 11)

Unit Root Tests with Structural Break

In this section of the study we discuss the results based on the unit root tests which incorporate a structural break (see Table 3 for results). We utilized the Perron (1989) test and consider 1973:Q4 as a break date. (Note 12) We failed to reject the null hypothesis of a unit root with a structural break. That implies, the employments series is not only mean diverting but also has a structural break and the break date is 1973:Q4. The next test we applied on the employment growth series is the Zivot-Andrews test. We test different options for a break date. For instance, 1973:Q4-1975:Q1 (time duration of the 1973-75 recession) and 1981:Q3-1982:Q4 (time duration of the 1981-82 recession). We try one by one each quarter of the above mentioned time period. We end up 1975:Q1 as a break date. The null hypothesis of the Zivot-Andrews test is a unit root with no structural break. The results based on the Zivot-Andrews test fail to reject the null hypothesis and conclude that the employment growth series is mean diverting. The Zivot-Andrews test's results are not in favor of a structural break but the Perron test supports the idea of a structural break in the employment growth series. The Zivot-Andrews test does not assume a structural break under the null hypothesis but the Perron test allows for a break under the null and alternative hypotheses. Nunes et al. (1997) suggested that there may be some size distortion for Zivot-Andrews test.

The first step of the Kim-Perron procedure is a pre-test for the break date. We apply the EXP-W_{FS} test and found that employment growth series has a structural break and that is 1973:Q4. Next step would be to follow the Kim-Perron unit root test and determine whether employment growth contains a unit root. Based on the Kim-Perron test results, we fail to reject the null hypothesis that employment growth contains a unit root as well as subject to a

structural break for all three models. The Kim-Perron unit root test is the most efficient test and thereby, based on the Kim-Peron test, we conclude that employment growth series contains a unit root and subject to a structural break in our sample period.

ARCH Results

We have found that the level of the employment growth series is non-stationary, mean-diverting, that implies that the mean and/or variance of the employments series are not constant over time and may be time dependent. But it is still important to analyze the behavior of the employments series' variance and test whether the variance is volatile over time; it is also known as the ARCH effect. The ARCH effect has very serious consequences for modeling and forecasting. For instance, in the presence of the ARCH effect OLS standard errors can be misleading, with a spurious regression possibility (see Hamilton (2008) for more detail). Another issue could be that the forecast band could be narrower than the actual. Therefore, we employ the ARCH approach which overcomes the constant variance problem. We divided the sample period into decades and applied an ARCH Approach on each decade's data as well as the complete sample that is 1970:Q1-2009:Q3, see Table 1 for results. We found an ARCH effect for each decade as well as for the complete sample period. (Note 13) The implication of the ARCH effects is that the employment growth series has a volatility cluster—some periods are more volatile than others. In other words, the variance of the employment growth is not constant over time and has episodes of high variance for some periods than others. That also implies, the forecast band, upper and lower band of the forecast, will not be constant and may be smaller for some time period than others, and vice versa.

If we sum-up our empirical analysis, then the level of the employment series is mean diverting and subject to a structural break. The ARCH effect tells us the employment growth series has a volatility cluster—some periods are more volatile than others.

Conclusion: Key findings of the Study

Policy makers love to speak about restoring the economy and the associated "good" jobs as voters imagine they were in the past. But is such economic nostalgia reasonable in a dynamic global economy? Moreover, has it actually been true that the economy, and particularly the labor market, were ever as stable as we imagine? Our work here suggests that the labor market has been constantly evolving since 1970 and that there is no tendency to return to "normal" if such a normal were to be defined as it was in the good old days. Moreover, labor market policies built on such nostalgia in an attempt to return to the past are misplaced at best and likely to hurt workers more by providing false hopes and also lead to a misallocation of economic resources than if forward looking policies were adopted to adapt workers for the future of the labor market.

Our efforts suggest that since 1970 the mean and standard deviation of employment growth had actually been decreasing up until the most recent (2000-09) period. The most recent period (2000-09) shows a significant decline in the mean and an uptick in the standard deviation. When we evaluate the entire period as a whole, 1970-2009, we find that the trend coefficient is statistically significant and has a negative sign. That implies the employment growth rate has a decreasing pattern over time. In addition, the standard deviation (1.79%) is higher than the mean (1.73%); this is evidence of high volatility in the employments series.

Summing-up, our empirical analysis suggests that the level of the employment growth rates is mean-diverting and subject to a structural break. Therefore, the level of the employment series is not appropriate for the modeling and forecasting purpose because of a unit root problem. Second, due to the presence of a structural break in the employment series it would be better to employ only those techniques which are assuming a structural break in the data e.g., cointegration tests with a structural break. Third, in the presence of the ARCH effect, OLS standard errors can be misleading, with a spurious regression possibility. Finally, the ARCH effect and unit root problem have serious consequences for forecasting and the forecast band could be narrower than the actual.

References

Bai, J. (1998). A Note on Spurious Break. *Econometric Theory,* vol. 14(05), pp 663-669.

Banerjee, A., Lumsdaine, R. and Stock, J. (1992). Recursive and sequential tests of unit-root and the trend break hypotheses: theory and international evidence. *Journal of Business Economics and Statistics*, 10, 271-287.

Bhargava, Alok. (1986). On the Theory of Testing for Unit Roots in Observed Time Series. *Review of Economic Studies*, vol. 53(3), pp 369-84.

Byrne J. and Perman, R. (2006). Unit Roots and Structural Breaks: A Survey of the Literature. *Working paper* # 2006_10. Department of Economics, University of Glasgow, UK.

Caner, M. and Kilian, L. (2001). Size distortions of tests of the null hypothesis of stationarity: evidence and implications for the PPP debate. *Journal of International Money and Finance*, vol. 20(5), pp 639-657

Christiano, L. (1992). Searching for a break in GNP. *Journal of Business Economics and Statistics,* 10, 237-250.

Clemente, J., Montanes, A., and Reyes, M. (1998). Testing for a unit root in variables with a double change in the mean. *Economics Letters,* 59(2), pages 175-182.

Dickey, D. and Fuller, W. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74, pp 427-431.

Dickey, D. and Fuller, W. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root, *Econometrica*, 49, 1057-1072.

Diebold, F. X. (2007*). Elements of Forecasting*. 4th ed., Thomson South-Western.

Elliott, G., Rothenberg, T. & Stock, J (1996). Efficient Tests for an Autoregressive Unit Root. *Econometrica* 64, 813—836.

Fuller, W. A. (1976). *Introduction to Statistical Time Series*. New York: John Wiley.

Gordon, R. (2005).”What caused the decline in US Business cycle volatility?” *NBER working paper 11777.*

Hamilton J. (2008). Macroeconomics and ARCH, *Forthcoming in Festschrift in Honor of Robert F. Engle.*

Kim, D. & Perron, P. (2009). Unit root tests allowing for a break in the trend function at an unknown time under both the null and alternative hypotheses. *Journal of Econometrics*,148, pp1–13.

Kwiatkowski, D., Phillips, P., Schmidt, P. & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of Econometrics* 54(1-3):159-178.

Lee, J. and Strazicich, M. (2003). Minimum Lagrange Multiplier Unit Root Test with Two Structural Breaks. *The Review of Economics and Statistics*, vol 85(4), pp 1082-1089.

Lumsdaine, R.L. and Papell, D.H. (1997). Multiple trend breaks and the unit root hypothesis. *Review of Economics and Statistics*, 79, 212-218.

Maddala, G. and Kim, I (2003). *Unit Root, Cointegration, and Structural Changes*. Cambridge University Press.

Nelson, C. R. and Plosser, C. I. (1982). Trends and random walks in macroeconomics time series: some evidence and implications. *Journal of Monetary Economics* 10, 139–162.

Ng, S. and Perron, P. (2001). Lag length selection and the construction of unit root tests with good size and power. *Econometrica* 69, 1519–1554.

Nunes, L.C., C-M. Kuan and P. Newbold (1997). Spurious regression*. Econometric Theory*, 11, pp 736-49.

Papell, D. H. and Prodan, R. (2003). Restricted Structural Change and the Unit Root Hypothesis. *Working paper, University of Houston*

Perron P. (1988). Trends and Random Walks in Macroeconomic Time Series: Further Evidence from a New Approach. *Journal of Economic Dynamics and Control*, 12, 297-332.

Perron, P. (1989). The great crash, the oil price shock and the unit root hypothesis. *Econometrica*, 57, pp 1361-1401.

Perron, P. (1997). Further evidence on breaking trend functions in macroeconomic variables. *Journal of Econometrics*, 80, 355-385.

Perron, P. (2005). Dealing with Structural Breaks. Mimeo forthcoming in the *Handbook of Econometrics.*

Perron, P & Vogelsang, T.(1992). Testing for unit root in a time series with a changing mean: correction and extension. *Journal of Business and Economic Statistics,* 10, 467-470.

Perron, P & Yabu, T. (2009). Testing for shifts in the trend with an integrated or stationary noise component. *Journal of Business and Economic Statistics* (in press).

Phillips, P. & Perron, P. (1988). Testing for a unit root in time series. *Biometrika*, 75, pp1361-1401.

Schwert, W. (1989). Test for Unit Roots: A Monte Carlo Investigation. *Journal of Business and economic Statistics*, 7, pp 147-159.

Silvia, John (2006).Domestic Implications of a Global Labor Market. *Business Economics*, July 2006.

Silvia, John. & Iqbal, Azhar. (2009). Mean Diversion: When Getting Back to the Old Economy Isn’t Possible. Southern Economic Association, 79th Annual Meetings, November 2009, TX, USA.

Zivot, E. and Andrews, D.W.K. (1992). Further evidence on the great crash, the oil price shock and the unit root hypothesis*. Journal of Business and Economic Statistics*, 10, 251-270.

Notes

Note 1. For some microeconomic fundamentals behind these patterns please see Silvia (2006).

Note 2. U.S. Bureau of the Census, Statistical Abstract of the United States (Washington, D.C., U.S. Government Printing Office, various issues.

Note 3. See Byrne and Perman (2006) for a survey

Note 4. Here we are not explaining these tests in detail because of space limit. See Silvia and Iqbal (2009) for more detail.

Note 5. It is worth mentioning that many researchers are considering multiple structural breaks. The argument for incorporating more than one break is that only considering one break is insufficient and leads to a loss of information when actually more than one break exits. Lumsdaine and Papell (1997), Clemente et al. (1998), and Pappel and Prodan (2003) considered multiple breaks. But we are not using multiple breaks test in this study because our analysis starts, sample start date, from 1970 and it is relatively a short history. Therefore, we only employ single break tests, both exogenous and endogenous breaks test.

Note 6. It is worthwhile to mention that this procedure originally introduced by Perron and Yabu (2009).

Note 7. During the great moderation U.S. productivity increased and the volatility associated with the productivity reduced. However, the causes and the consequences of the great moderation are debatable, see Gordon (2005) for more detail.

Note 8. The 2007-09 recession is not officially ended at the timing of this writing.

Note 9. Ng and Perron (2001) suggested that the Modified Akaike Information Criterion (MAIC) is a better choice for the lag order selection thereby we select lag length based on MAIC, see Ng and Perron (2001) for more detail.

Note 10. We only report the results for the level of the employment growth series because we are interested in the mean reverting properties of the employment growth series. However, we also estimate the results for the first difference. All results and data are available upon request from authors.

Note 11. Although, ERS point-optimal test is rejecting Ho: the employment series has a unit root, at 10% level of significance but the standard level of significance is 5% and at 5% ERS failed to reject the null hypothesis of a unit root.

Note 12. We are considering 1973:Q4 as break date because this date is the beginning of the 1973-75 recession. This recession is famous for the initial Post World-War-II oil shock and, due to the oil shock, energy input prices rose sharply, production technologies were rendered obsolete and hence the employment growth rates become volatile.

Note 13. It is worth mentioning that we used the level and 1st difference of the employment growth series and found ARCH effect in both cases.

Table 1. Employment Growth, Nonfarm Payrolls, Year-to-Year percent Change

Period	Mean	S.D*	Instability Ratio**	Skewness	Kurtosis	Trend	ARCH
1970-79	2.49	2.15	86.35	-0.76	-0.37	Linear(positive)	ARCH effect
1980-89	1.87	1.91	102.14	-0.67	-0.06	Non-linear(U-shape)	ARCH effect
1990-99	1.8	1.26	70	-1.21	0.62	Non-linear(U-shape)	ARCH effect
2000-09	0.68	1.3	191.2	-0.46	-0.83	No Trend	ARCH effect
1970-2009	1.73	1.79	103.47	-0.32	-0.39	Linear(negative sign)	ARCH effect

*S.D. = Standard Deviation

** Instability Ratio = (S.D./Mean)*100

Table 2. Unit Root Tests; Without Structural Break

	Test Option		
Test Name	**Constant**	**Constant & Trend**	**None**
ADF	No	No	No
PP	No	No	No
KPSS	No	No	N/A
DF-GLS	Yes	Yes	N/A
ERS	No	Yes	N/A
Ng-Perron	Yes	Yes	N/A

Table 3. Unit Root Tests; With Structural Break

	Test Option		
Test Name	**Model A**	**Model B**	**Model C**
Perron*	Yes	Yes	Yes
Zivot-Andrews**	Yes	Yes	Yes
Kim-Perron***	Yes	Yes	Yes

No = No unit root --- Mean-reversion; Yes = Unit root ---- Not Mean-reversion; * Break Date= 1973:4Q; ** Break Date= 1975:Q1

*** Break Date= 1973:Q4

Exhibit I

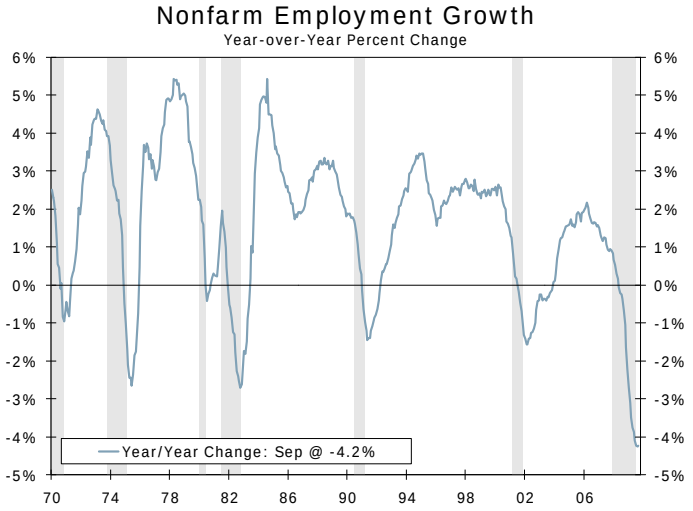

Exhibit II