Employment growth: Cyclical movements or structural change?

Although the economy is showing tentative signs of improvement, the employment picture is not expected to recover for some time. Understanding the factors influencing employment growth is important for assessing the performance of the labor market and, more generally, the overall economic picture. The popular press has looked to the Great Depression as a yardstick by which to measure the most recent downturn in economic activity. But, more recently, references to the stagflation of the late seventies and early eighties have captured the attention of the business media. Stagflation refers to a period of both high inflation and high unemployment. With the Federal Reserve's balance sheet expanding to historically high levels, the specter of stagflation looms once again, particularly if the Fed is not quick to take liquidity out of the system.

Yet, knowing just when to reverse course is a complicated undertaking. The Fed must carefully weigh incoming data and evaluate likely future outcomes before determining how best to obtain the Fed's twin goals of employment growing at potential and price stability. It is tempting to regard high or rising unemployment as a sign of a weak economy. And, normally, a weak economy is one with little inflationary pressures and therefore room for expansionary monetary policy to stimulate growth. But unemployment is influenced by more than simply aggregate conditions. In a dynamic economy that responds to changing opportunities, some industries are shrinking while others grow. Labor must flow from declining industries to expanding ones. This adjustment takes time. It takes time for employees in declining sectors to learn about new opportunities in other industries, acquire necessary skills, apply for job openings, and potentially relocate. And during this period of adjustment, the unemployment rate rises as waning industries lay off workers. Thus, the unemployment rate may increase or decrease even though the aggregate state of the economy remains stable, simply because the labor market adjusts to shifting patterns of production.

For a policy-maker, deciphering what portion of a rising unemployment rate is due to a cyclical slowdown, as opposed to a realignment in production, is essential. The two factors ideally should lead to different policy responses. If unemployment is rising because of a weak economy, the textbook response is for the Fed to ease monetary policy. If, instead, the unemployment rate is rising because of underlying compositional shifts in employment, an easing of monetary policy may impede the adjustment process and may also encourage inflation as employers across a broad spectrum of industries compete for scarce labor resources. Thus, understanding movements in the unemployment rate is more than just a theoretical exercise: It has practical implications for monetary policy.

As a first step towards evaluating the role of structural change, it is necessary to develop a measure of sectoral reallocation. In an earlier work, Lilien (1982) suggests a dispersion measure that is a weighted average of squared deviations of industry employment growth rates from aggregate employment growth. Abraham and Katz (1986) argue that Lilien's measure does not properly account for cyclical shifts in employment across industries. Economists have long characterized economic conditions by weighing data from a wide variety of sources. Burns and Mitchell (1946) characterized the business cycle as consisting of "expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals." Today, the National Bureau of Economic Research's (NBER) Business Cycle Dating Committee sifts through a number of different data sources to divine economic activity. In their announcement dating the start of the most recent recession to be December 2007, the committee states that "a recession is a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in production, employment, real income, and other indicators."[i] According to Abraham and Katz, Lilien's measure of sectoral reallocation conflates structural change with cyclical movements in employment. For example, the typical pattern during a period of economic weakness observed over the post- World War II era is for goods-producing industries to lay off relatively more workers than service-producing sectors. These relatively more cyclical industries also have lower average employment growth. Abraham and Katz show that under these conditions, Lilien's measure rises in the normal course of a recession, independently of structural reallocation.

Making matters even more complicated, structural realignment may be concurrent with economic downturns. Businesses on the brink of downsizing or disappearing altogether may find that they are tipped over the edge during a recession. To the extent that whole industries are affected, the downturn will then occur at the same time as sectoral reallocation. Recessions are followed by expansions, whereas sectoral reallocation is more permanent. Therefore, shifts in production that are cyclical in nature tend to be transitory, but those that are the result of structural shifts are more long lasting.

Others, including Loungani, Rush, and Tave (19XX), Rissman (19XX), and Groshen and Potter (20XXD), have employed a variety of techniques to distinguish between sectoral shifts that are driven by structural change and those that are driven by cyclical swings. Loungani et al, for example, suggests that stock market prices efficiently reflect the future stream of business profits. He employs measures based on stock prices to create a dispersion measure that reflects structural shifts rather than short-term cyclical fluctuations. Rissman notes that structural change is long-lasting, whereas cyclical shifts are of shorter duration. She uses this observation to distinguish between compositional shifts in employment that are due to short term cyclical fluctuations and those are that due to long term structural reallocation. Rissman's measure cannot be produced in real time because current changes in employment patterns may be either temporary or permanent. Thus, her measure offers little guidance for policy-makers who need to make decisions based on current information. The same criticism can be levied against Loungani's measure as well, although if the stock market is forward looking, this issue is less acute.[ii]

This problem of optimally inferring the current state has been widely studied in economics and in related statistical literature. Stock and Watson (1989) employ the Kalman filter to create an index of coincident economic indicators. They formally operationalize the idea that the business cycle "refers to co-movements in different forms of economic activity, not just fluctuations in GNP."[iii] A similar framework is applied here to the problem of disentangling comovements in industry employment growth that are cyclical from those that are structural. This framework has the added benefit of creating a measure of the business cycle that focuses only on the industry cross-section of employment growth. This is particularly relevant since it is widely thought that the labor market typically lags the business cycle. Thus, a measure of the business cycle based only on cross-sectional employment growth helps clarify the relationship between more traditional measures of the cycle, such as real GDP growth, and employment growth. This measure of the cycle may help shed light on the phenomenon of the jobless recoveries that we have experienced in the two most recent expansions. Furthermore, the model is based upon quarterly data, giving policy-makers a more timely tool for evaluating the relative importance of cyclical and structural factors on the labor market than other measures. There is little reason why the model cannot be estimated on a monthly basis as well. Finally, the model provides some insight into the sources of structural change in the economy.

The remaining article is divided into four sections. Employment growth for nine industries comprising most of total nonfarm employment is examined in Section I. The estimation framework is introduced in Section II and estimation results are presented in Section III. A measure of sectoral reallocation is developed in Section IV. Conclusions and suggestions for future research are found in Section IV.

Section I: Industry employment growth

The U.S. Bureau of Labor Statistics collects detailed industry employment data for workers on nonfarm payrolls. Over the years the industry classification system has changed to reflect the changing industrial composition of the economy. Because of this, it is difficult to compare earlier industry data, which were collected using the Standard Industrial Classification System (SICS), with more recent industry data that were collected using the North American Industry Classification System (NAICS). For example, nine new Service sectors and 250 new Service industries are recognized in the NAICS data, but not for the SICS data. The problem of comparability over time is less of an issue with the broadest industry aggregates.

Figure 1 shows annualized quarter to quarter employment growth from 1950 to the present for the following sectors: Construction; Durable Manufacturing; Nondurable Manufacturing; Transportation and Utilities; Wholesale Trade; Retail Trade; Finance, Insurance and Real Estate; Services; and Government.[iv] Business cycle recessions as determined by the NBER have been shaded for reference. The average annual industry employment growth rate over the time period is also shown. With the focus on the housing market as the source of some of our economic problems, employment in the Construction sector is interesting to examine. Employment growth in construction is highly volatile and, not surprisingly, quite cyclical as well. Construction employment appears to decline in advance of business cycle peaks and reaches its bottom at or just past the trough of a recession. Although employment growth in Construction was above average during the most recent expansion, the strong employment growth does not appear abnormally large in comparison to earlier recoveries.

Nonetheless, the most recent quarters show a very strong drop in construction employment, surpassing even the large declines of the mid seventies.

The Finance, Insurance, and Real Estate (FIRE) sectors tell a somewhat different story. As in most industries, recessions are marked by declining employment growth. Yet in FIRE, while employment growth dipped below average during recessions, employment in this sector very rarely declined. The steep drop in employment in the early nineties seems to be the harbinger of a structural change in employment growth in this sector with average employment growth fallinf below the +3 percent growth of earlier decades. Furthermore, the steep job losses of the past few quarters are unprecedented in the past 60 years.

The Services sector is also interesting to examine. At one time Services was thought to be the engine of growth of employment, as can be seen by the high average employment growth rates over the time period. Yet, more recently, employment growth here as well has been weak. And the steep declines in employment growth over the past quarter are the lowest we've seen since the late fifties.

Taken as a whole, these graphs suggest that part if not most of the recent declines in employment growth are cyclical. If this is true, then employment growth should rebound and return to normal as the economy moves into the expansionary phase of the business cycle. However, a portion of the recent declines in employment growth may be the result of structural realignment in the economy. If this is indeed the case, then it may indicate that some industries will likely experience significantly lower employment growth than they did on average over the past half century. Clearly, an accurate assessment of whether employment data is driven by the cycle or structural change is important for formulating policy and for projecting the future.

Table 1 shows this same employment growth data for the entire sample in the first column and divided into 10-year increments in the subsequent columns. Construction employment has averaged

2.1 percent quarterly annualized growth over the entire sample period. However, over the past decade the average quarterly growth in Construction employment has been only 0.5 percent. Durable and Nondurable Manufacturing have experienced large declines in employment over the past decade with job losses or stagnant growth since the late seventies. Employment growth in Transportation and Utilities has been weak for the past decade, as has been employment in Wholesale and Retail Trades. In fact, all sectors exhibited weaker average employment growth over the past decade than they had averaged over the last 60 years.[v]

Section II: A model of industry employment growth

The discussion of the previous section suggests that industry employment growth, in addition to having a long term trend, has two additional components: A cyclical component and a structural one. Let

$$g_{it} = a_i + C_{it} + X_{it} \tag{1.1}$$

where g_{it} is employment growth in sector i at time t, $i = 1, \ldots, I$ and $t = 1, \ldots, T$. a_i is trend employment growth in the industry. C_{it} is the cyclical portion of sector employment growth and it varies across time and industry. X_{it} is the structural part of industry employment growth. It also varies across time and industry. This construction is similar to the problem analyzed by Stock and Watson (19XX) in which they noted that individual aggregate time series depend upon a common cyclical component and an idiosyncratic component.

In order to move towards the goal of estimating the two components for each of the sectors, for each period t, more structure needs to be put on the equations. I assume that the cycle is a common component affecting all industries. However, the cycle may have a differential impact across sectors. Specifically,

$$C_{it} = b_i^1 C_t + b_i^2 C_{t-1} \quad (1.2)$$

where b_i^1 and b_i^2 are parameters indicating the sensitivity of the ith sector to current and lagged values of the business cycle. Furthermore, it is assumed that the cycle itself follows a second order autoregressive process with:

$$C_t = \phi_1 C_{t-1} + \phi_2 C_{t-2} + u_t. \quad (1.3)$$

u_t is i.i.d. normally distributed with unit variance.[vi] ϕ_1 and ϕ_2 are unknown autoregressive parameters that are to be estimated.

The idiosyncratic component of industry employment growth X_{it} is assumed to follow an AR(1) process. Specifically,

$$X_{it} = \gamma_i X_{it-1} + \varepsilon_{it} \quad (1.4)$$

where γ_i is a sector-specific parameter that indicates the degree of persistence of sectoral shocks. It is assumed that the ε_{it}'s are uncorrelated over time and across industries. $E(\varepsilon_{it}) = 0$ and $E(\varepsilon_{it}^2) = \sigma_i^2$ for all i,t. Furthermore, the ε_{it}'s are assumed to be uncorrelated with the cyclical shock u_t. This specification allows for a common unobserved cycle that has a differential impact across industries. It also permits structural change to occur through the idiosyncratic component X_{it}. Thus, changes in an industry's employment growth are due to either cyclical factors, or factors that are specific to that particular industry.

Estimation is accomplished using the Kalman filter, details of which are discussed below. The state vector $\underline{z}_t$ is given by $\underline{z}_t = [C_t, C_{t-1}, C_{t-2}, X_{1t}, X_{2t}, \ldots, X_{It}]'$. The Kalman filter algorithm enables estimates of the state vector $\underline{z}_t$ and the underlying parameters to be estimated. These parameters include the a_i's, b_i's, γ_i's, σ_i's, and ϕ_1 and ϕ_2. The shocks u_t and ε_{it} can also be obtained for $i = 1, \ldots, I$ and $t = 1, \ldots, T$. The Kalman filter is a way of optimally updating the underlying state vector as new information becomes available each quarter. A Kalman smoothing algorithm is used to optimally backcast for final estimates of the state vector.

Box 1: The Kalman filter

The Kalman filter is a statistical technique that is useful in estimating the parameters of the model specified above in equations (1.1) to (1.4). In addition, the Kalman filter enables the estimation of the processes u_t and and ε_{it} and the construction of the unobserved cyclical variable C_t and the structural components X_{it}. The Kalman filter consists of a state equation and a measurement equation. The state equation describes the evolution of the possibly unobserved variable(s) of interest, $\underline{z}_t$, while the measurement equation relates observables $\underline{g}_t$ to the state. The vector $\underline{g}_t$ is related to the *m × 1* state vector, $\underline{z}_t$, via the measurement equation:

$$\underline{g}_t = B\underline{z}_t + D\underline{\eta}_t + H\underline{w}_t \tag{1.5}$$

Where $t = 1, \cdots, T$; B is an $N\text{x}m$ matrix; $\underline{\eta}_t$ is an $N\text{x}1$ vector of serially uncorrelated disturbances with mean zero and covariance matrix I_N; and $\underline{w}_t$ is a vector of exogenous, possibly predetermined variables with H and D being conformable matrices.

In general, the elements of $\underline{z}_t$ are not observable. In fact, it is this very attribute that makes the Kalman filter so useful to economists. Although the $\underline{z}_t$ elements are unknown, they are assumed to be generated by a first-order Markov process as follows:

$$\underline{z}_t = A\underline{z}_{t-1} + F\underline{u}_t + G\underline{w}_t \tag{1.6}$$

For $t = 1, \cdots, T$, where A is an $m\text{x}m$ matrix, F is an $m\text{x}g$ matrix, and $\underline{u}_t$ is a $g\text{x}1$ vector of serially uncorrelated disturbances with mean zero and covariance matrix I_g. This equation is referred to as the transition equation.

The definition of the state vector $\underline{z}_t$ for any particular model is determined by construction. In fact, the same model can have more than one state space representation. The elements of the state vector may or may not have a substantive interpretation. Technically, the aim of the state space formulation is to set up a vector $\underline{z}_t$ in such a way that it contains all the relevant information about the system at time *t* and that it does do by having as small a number of elements as possible. Furthermore, the state vector should be defined so as to have zero correlation between the disturbances of the measurement and transition equations, $\underline{u}_t$ and $\underline{\eta}_t$.

The Kalman filter refers to a two-step recursive algorithm for optimally forecasting the state vector $\underline{z}_t$ given information available through time $t-1$, conditional on known matrices $B, D, H, A,$ F, G. The first step is the prediction step and involves forecasting $\underline{z}_t$ on the basis of $\underline{z}_{t-1}$. The second step is the updating step and involves updating the estimate of the unobserved state vector $\underline{z}_t$ on the basis of new information that becomes available in period *t*. The results from the Kalman filtering algorithm can then be used to obtain estimates of the parameters and the state vector $\underline{z}_t$ employing traditional maximum likelihood techniques.[vii]

The model of employment growth proposed above can be put into state space form, defining the state vector $\underline{z}_t = [C_t, C_{t-1}, C_{t-2}, X_{1t}, X_{2t}, \ldots, X_{It}]'$. The Kalman filter technique is a way to optimally infer information about the parameters of interest and, in particular, the state vector $\underline{z}_t$, which in this case is simply the unobserved cycle, C_t, and its two lags and the unobserved structural components X_{it}. The cycle, as constructed here, represents that portion of industry employment growth that is common across the industries, while allowing the cycle to differ in its impact on industry employment growth in terms of timing and magnitude through the parameters b_i^1 and b_i^2. The model is very much in the spirit of Burns and Mitchell's (1946) idea of cycles entailing comovement but the estimation technique permits the data to determine which movements are common and which are idiosyncratic.[viii]

Section III: Estimation Results

The estimate of the cycle $\hat{C}_t$ obtained from the Kalman filter exercise is shown in Chart 2 below.[ix] The values of the estimated cycle during NBER-dated recessions are shown in red. 2x standard error bands are also shown. These standard error bands give an indication as to whether the estimate is significantly different from zero. Estimates of the cycle that are less than zero are associated with recessions. The estimated cycle indicates that we are currently in the midst of a deep recession. The cyclical point estimate in 2009Q1 measures the recession to be the most severe since 1950. However, because of parameter uncertainty, this point estimate is not significantly worse than earlier recessions in a statistical sense.

Table 2 provides a comparison of the NBER recession dates and duration to those calculated here using a different criterion. An NBER recession is the period of time between the business cycle peak and the business cycle trough. Focusing on C_t, an alternative definition of a recession is naturally given as the period of time during which the measure of the cycle $\hat{C}_t$ is more than two standard deviations below zero.[x]

While $\hat{C}_t$ typically exhibits a turning point at the same time as the NBER-dated trough, the last two recessions were notably different. According to the NBER, the 1990-1991 recession lasted 3 quarters and the 2001 recession lasted for 4 quarters. As computed here, the employment-based measure of the cycle lasted 7 and 11 quarters respectively—significantly longer than the NBER's measure. This slow return of the labor market to normal growth gave rise to the term "jobless recovery." Using the methodology introduced here, the labor market experienced a delayed recovery relative to other measures of economic activity. At the time of the last recovery, Groshen and Potter (20XX) suggested that the abnormally slow recovery in 2001 was the result of sectoral reallocation and not due to cyclical factors. The evidence provided here suggests that sectoral reallocation was not the issue, but rather that the low growth in employment was likely attributable to cyclical activity. [xi] There is another notable discrepancy when comparing the NBER business cycle recession dates to those estimated here. The two NBER recessions in the early and mid-seventies were longer by 2 and 3 quarters respectively than those proposed here. Instead, the employment-based measure of the cycle shows a labor market that was quick to return to more normal activity during those times.

Table 3 provides parameter estimates with associated standard errors. All sectors of the economy are affected by cyclical variation, as constructed here. However, the degree of cyclical sensitivity varies across industries, with durable manufacturing employment being the most contemporaneously cyclically sensitive, followed by construction. The intercept term a_i is not significantly different from zero in construction, durable manufacturing , nondurable manufacturing, and transportation and utilities. The degree of persistence of the structural component is given by γ_i . There is a great deal of variation in the persistence of structural shocks ε_i . The most persistent sector is finance, insurance, and real estate. Shocks to services and transportation and utilities are not statistically persistent.

Table 4 presents estimates of the portion of the variance in employment growth attributable to variation in the structural shocks ε_i and to the cycle C . Some industries exhibit much more variation in employment growth than others. [xii] Construction and durable manufacturing are the two most volatile sectors of the economy, exhibiting large swings in employment growth. By comparison, the variance of employment growth in nondurable manufacturing and transportation and utilities is about 1/5th that of the most volatile industries and the least volatile sectors have about 1/10th the variation. The model attributes this volatility to either cyclical variation or structural shifts. It is straightforward to calculate the relative importance of these two components to an industry's employment variation. Details of the calculations are found below. Within construction, for example, about half the total variance in employment growth stems from the structural component and half is the result of cyclical variation. The cyclical component accounts for most of the variation in employment growth in durable manufacturing, nondurable manufacturing, transportation and utilities, wholesale trade, retail trade, and services. In contrast, the structural component carries the most weight in finance, insurance, and real estate and in the government sectors.

In addition to examining the estimated cycle, the idiosyncratic portion of employment growth is also useful to consider. Charts 3.a-3.i below show the idiosyncratic component X_{it} for each of the nine industries from 1950:1 through 2009:1. Positive values suggest that employment growth is stronger in these industries than explained by either normal cyclical variation or by long term trends. Note that the scale differs from one industry to the next, with both construction and durable manufacturing having wider variation than the other industries. Upon closer inspection of construction, the estimates suggest that employment growth in this industry was higher than could be explained from the business cycle or sectoral trends over most of the nineties through the first half of 2006, when the trend reversed, reflecting the unfolding crisis in the housing market. Finance, insurance, and real estate shows a marked decline in recent years, suggesting it is in the midst of a restructuring that is unexplained by either the cycle or long term trends.

Section IV: Sectoral Reallocation

In his original paper, Lilien (19XX) presented a dispersion measure as a way to quantify the degree of secoral reallocation occurring in the economy at any given time. His measure is given by:

$$\sigma_{Lt} \equiv \left[\sum_i s_{it} (g_{it} - g_t)^2 \right]^{1/2} \qquad (1.7)$$

where s_{it} is industry i's employment share at time t; g_{it} is employment growth in i at time t; and g_t is total employment growth at time *t.* Abraham and Katz (1986) demonstrate that this dispersion measure will increase even if no sectoral reallocation is present simply because some industries are more cyclically sensitive than others.

An alternative measure that does not suffer from the same drawback as Lilien's original is given by:

$$\tilde{\sigma}_t \equiv \left[\sum_i \tilde{s}_{it} (\tilde{g}_{it} - \tilde{g}_t)^2 \right]^{1/2} \qquad (1.8)$$

where $\tilde{x}$ indicates that the variable x is purged of the cycle. The framework and results of the previous sections provide a straightforward way to accomplish this. First, let $\tilde{g}_{it} = X_{it}$. Then, assuming that the cycle was zero in some reference year, taken to be 1964, it is simple to calculate $\tilde{e}_{it}$, $\tilde{e}_t$, $\tilde{s}_{it}$, and $\tilde{g}_t$ where $\tilde{e}_{it}$ is non-cyclical employment in industry i at time t and $\tilde{e}_t$ is total non-cyclical employment at time t. Chart 4 shows the results of these calculations. The blue line is Lilien's measure as given in equation (1.7) and the black line is calculated as in (1.8). The non-cyclical measure of dispersion is far less volatile than the original measure. Nonetheless, there has been a modest uptick in this measure of structural realignment over the past couple quarters. Chart 5 shows the noncyclical measure and another measure that is based only on the shocks ε_{it}. In this figure you can see the uptick more clearly. The measure shown in the bottom panel suggests that structural reallocation may be on the rise, being at levels not seen since the early eighties. However, while suggesting a potential role for industrial realignment in explaining recent increases in unemployment, this is a simple summary measure that may not be too informative in explaining recent changes in the unemployment rate.

In order to determine if the structural component of employment growth plays a role in unemployment dynamics, regressions of the following form were run:

$$\Delta ur_t = \alpha(L)\Delta ur_{t-1} + \delta(L)Cycle_t + \lambda(L)\Sigma_t + cW_t + \upsilon_t \tag{1.9}$$

where $\alpha(L)$, $\delta(L)$, and $\lambda(L)$ are polynomials in the lag operator L; Δur_t is the change in the unemployment rate; $Cycle_t$ is a measure of the cycle at time *t;* Σ_t is a measure of sectoral reallocation at time *t;* and W_t are other variables that potentially influence changes in the unemployment rate. υ_t is a random shock assumed iid normal. Two different measures of the cycle were examined, including deviations of real GDP growth from average, and $\hat{C}_t$. Several different measures of Σ_t were considered, including the two non-cyclical measures discussed above as well as the X_{it}'s and the ε_{it}'s individually. Of the two cyclical variables examined, the measure of the employment cycle $\hat{C}_t$ performed better than deviations of real GDP growth from its long term average in that those regressions had higher $\overline{R}^2$ values. Generally, the two dispersion measures of structural reallocation did poorly in explaining changes to the unemployment rate. However, individual X_{it}'s were statistically significant. These sectors include construction, durable manufacturing, and transportation and utilities. Structural change that favored these industries were associated with decreases in the unemployment rate. Some results of the calculations are found in Table XX.

Section V: Conclusions and suggestions for further research

The labor market appears to have a cycle that is well-described by comovements in employment growth. The estimate of the employment cycle that results seems to agree with anecdotal evidence about jobless recoveries. It also does a good job of capturing turning points in the business cycle, suggesting that it may be a useful tool for understanding labor market dynamics and may help in predicting future unemployment. The structural component that the methodology yields may also provide some additional insight into the impact of structural reallocation on changes in the unemployment rate. Since structural change favoring construction, durable manufacturing, and transportation and utilities seemed to be associated with decreasing unemployment, this fact suggests that there may be some impediments to displaced workers in these sectors finding jobs in other industries.

Employment Growth: Selected Industries

1950:1 TO 2009:1

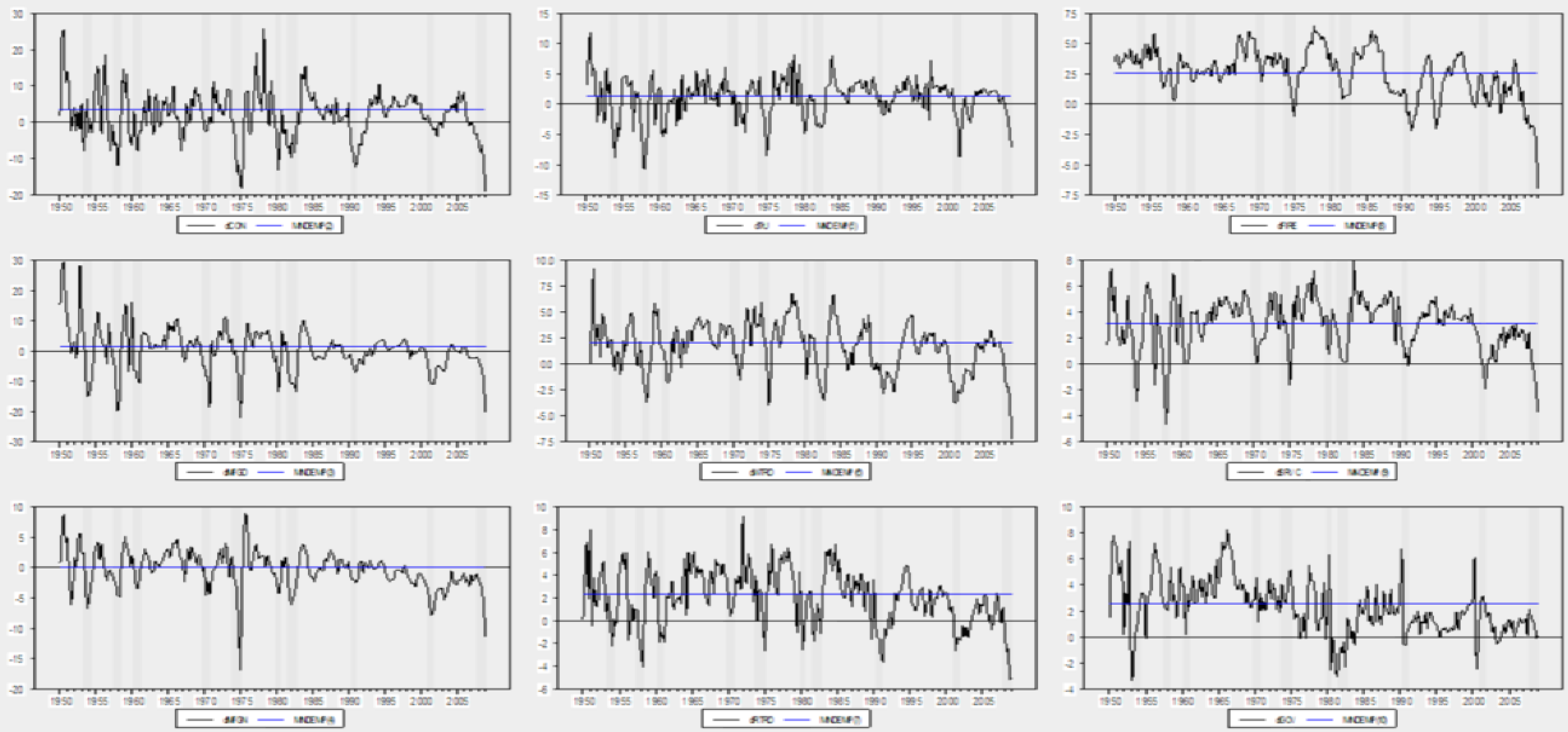


Table 1: Average annualzed quarterly employment growth, total and by decade

	Construction %	Durable Mfg	Nondurable Mfg	Transportation and Utilities	Wholesale Trade	Retail Trade	Finance, Insurance, Real Estate	Services	Government
Total	2.10	0.19	-0.42	0.88	1.64	2.02	2.56	2.92	2.33
2000s	0.01	-3.42	-3.31	-0.10	-0.26	-0.11	0.34	1.26	1.04
1990s	2.42	-0.04	-0.78	1.76	1.20	1.44	1.56	3.24	1.28
1980s	1.63	-0.90	-0.25	1.32	1.57	2.52	2.97	3.72	1.13
1970s	2.64	0.98	0.09	1.30	2.97	3.33	3.59	3.62	2.65
1960s	2.08	2.50	1.23	1.30	2.42	3.03	3.38	3.70	4.15
1950s	3.54	3.31	0.58	0.52	1.93	2.08	3.37	2.45	3.41

Table 2: Parameter estimates with associated standard errors*

	$\hat{a}_i$	$\hat{b}_i^1$	$\hat{b}_i^2$	$\hat{\gamma}_i$	$\hat{\sigma}_i$
Construction	1.8340 (1.1892)	1.9434*** (0.3424)	0.9832** (0.4027)	0.4218*** (0.0743)	20.3618 (1.8088)
Durable Mfg	0.2833 (1.4511)	3.8262*** (0.3516)	-	0.6138*** (0.0521)	9.6839 (1.0064)
Nondurable Mfg	-0.4921 (0.6067)	1.5414*** (0.1515)	0.0982 (0.1480)	0.6482*** (0.0508)	1.9360 (0.2327)
Transportation and Utilities	0.9000 (0.5763)	1.2617*** (0.2282)	0.4513* (0.2005)	0.0970 (0.0895)	3.8259 (0.4707)
Wholesale Trade	1.5475*** (0.4397)	0.7990*** (0.1098)	0.4600*** (0.1138)	0.5407*** (0.0689)	1.2138 (0.1082)
Retail Trade	1.9818*** (0.4187)	1.2144*** (0.1620)	0.0603 (0.1423)	0.1604* (0.0810)	1.8094 (0.2030)
Finance, Insurance, Real Estate	2.3328*** (0.6037)	0.2106* (0.0934)	0.1881* (0.0828)	0.8954*** (0.0364)	0.7552 (0.0783)
Services	2.9285*** (0.3877)	1.0762*** (0.0975)	0.1119 (0.1053)	0.1769 (0.1114)	0.4953 (0.0800)
Government	2.2656*** (0.3531)	0.0971 (0.1288)	0.1131 (0.0980)	0.5737*** (0.0638)	2.9276 (0.2525)

*Note: Estimation was based on data from 1950:1 through 2009:1. *** indicates parameter significance at the 1% level; ** indicates parameter significance at the 2% level;* indicates parameter significance at the 5% level.

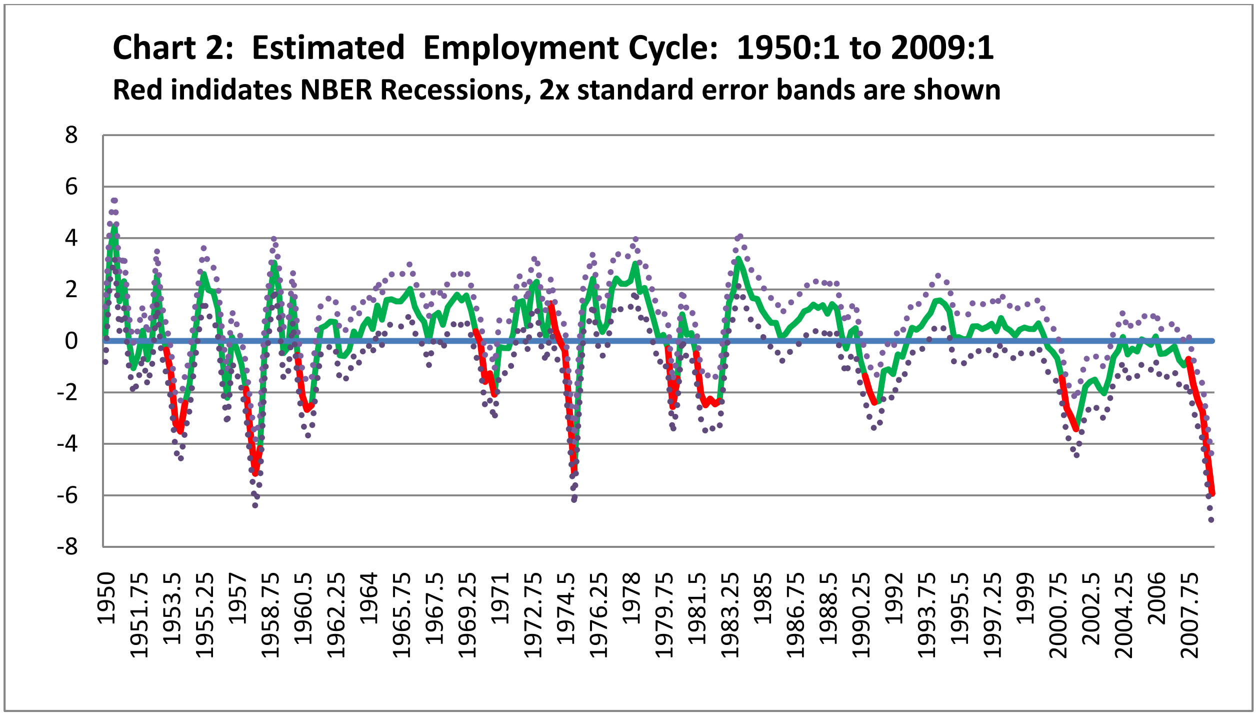


Chart 2: Estimated Employment Cycle: 1950:1 to 2009:1
Red indidates NBER Recessions, 2x standard error bands are shown
8
6
4
2
0
-2
-4
-6
-8
1950
1951.75
1953.5
1955.25
1957
1958.75
1960.5
1962.25
1964
1965.75
1967.5
1969.25
1971
1972.75
1974.5
1976.25
1978
1979.75
1981.5
1983.25
1985
1986.75
1988.5
1990.25
1992
1993.75
1995.5
1997.25
1999
2000.75
2002.5
2004.25
2006
2007.75

Table 2: Comparison of NBER and Employment Cycle dates

NBER			Employment		
Peak	Trough	Length in Quarters	Start	End	Length in Quarters
1953Q2	1954Q2	5	1953Q3	1954Q3	5
1957Q3	1958Q2	4	1957Q3	1958Q2	4
1960Q2	1961Q1	4	1960Q3	1961Q1	3
1969Q4	1970Q4	5	1970Q2	1970Q4	3
1973Q4	1975Q1	6	1974Q4	1975Q2	3
1980Q1	1980Q3	3	1980Q2	1980Q3	2
1981Q3	1982Q4	6	1981Q4	1982Q4	5
1990Q3	1991Q1	3	1990Q3	1992Q1	7
2001Q1	2001Q4	4	2001Q1	2003Q3	11
2007Q4		6+	2008Q1		5+

Table 3: Parameter estimates with associated standard errors*

	$\hat{a}_i$	$\hat{b}_i^1$	$\hat{b}_i^2$	$\hat{\gamma}_i$	$\hat{\sigma}_i$
Construction	1.8340 (1.1892)	1.9434*** (0.3424)	0.9832** (0.4027)	0.4218*** (0.0743)	20.3618 (1.8088)
Durable Mfg	0.2833 (1.4511)	3.8262*** (0.3516)	-	0.6138*** (0.0521)	9.6839 (1.0064)
Nondurable Mfg	-0.4921 (0.6067)	1.5414*** (0.1515)	0.0982 (0.1480)	0.6482*** (0.0508)	1.9360 (0.2327)
Transportation and Utilities	0.9000 (0.5763)	1.2617*** (0.2282)	0.4513* (0.2005)	0.0970 (0.0895)	3.8259 (0.4707)
Wholesale Trade	1.5475*** (0.4397)	0.7990*** (0.1098)	0.4600*** (0.1138)	0.5407*** (0.0689)	1.2138 (0.1082)
Retail Trade	1.9818*** (0.4187)	1.2144*** (0.1620)	0.0603 (0.1423)	0.1604* (0.0810)	1.8094 (0.2030)
Finance, Insurance, Real Estate	2.3328*** (0.6037)	0.2106* (0.0934)	0.1881* (0.0828)	0.8954*** (0.0364)	0.7552 (0.0783)
Services	2.9285*** (0.3877)	1.0762*** (0.0975)	0.1119 (0.1053)	0.1769 (0.1114)	0.4953 (0.0800)
Government	2.2656*** (0.3531)	0.0971 (0.1288)	0.1131 (0.0980)	0.5737*** (0.0638)	2.9276 (0.2525)

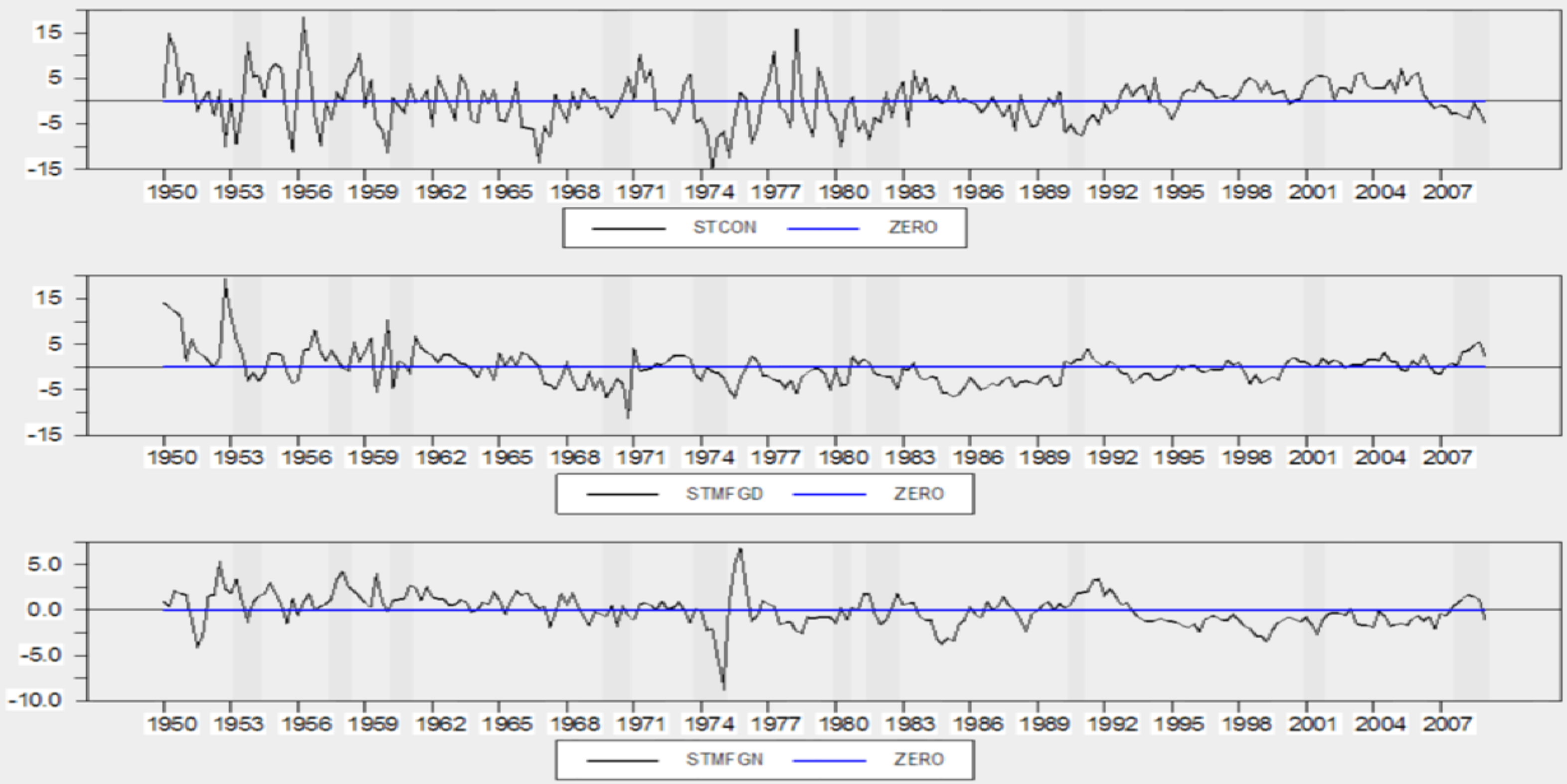
*Note: Estimation was based on data from 1950:1 through 2009:1. *** indicates parameter significance at the 1% level; ** indicates parameter significance at the 2% level;* indicates parameter significance at the 5% level.

Table 4: Effect of cyclical and structural components on variation

	Total Variance	Fraction of total variance due to C	Fraction of total variance due to X_i
Construction	47.3634	0.4770	0.5230
Durable Mfg	58.0776	0.7325	0.2675
Nondurable Mfg	10.9682	0.6956	0.3044
Transportation and Utilities	11.7053	0.6700	0.3300
Wholesale Trade	5.8806	0.7083	0.2917
Retail Trade	6.4909	0.7139	0.2861
Finance, Insurance, Real Estate	4.2221	0.0982	0.9018
Services	4.4683	0.8856	0.1144
Government	4.4794	0.0257	0.9743

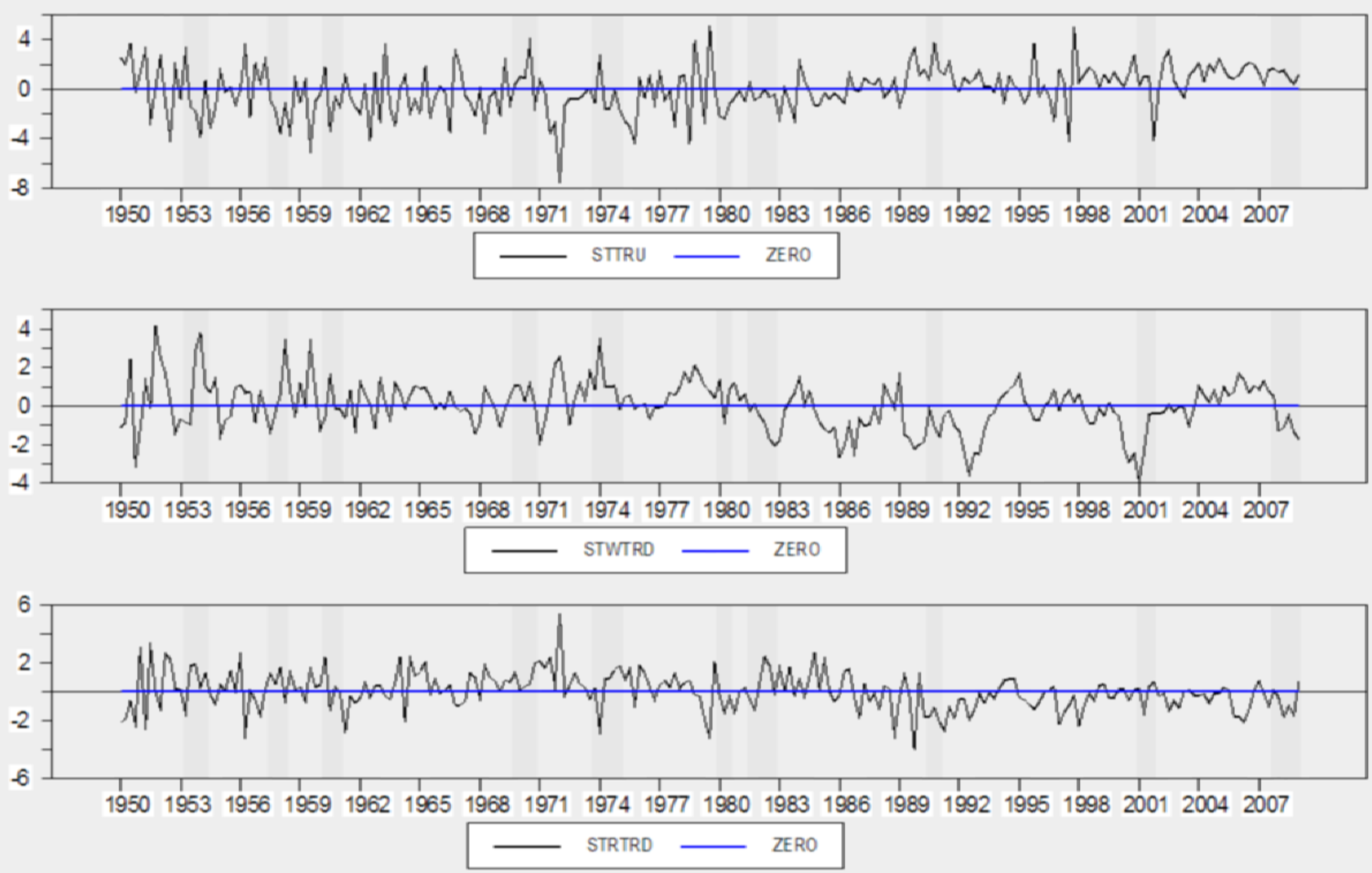
Sector Specific Changes in Employment Growth

1950:1 to 2009:1



Sector Specific Changes in Employment Growth

1950:1 to 2009:1



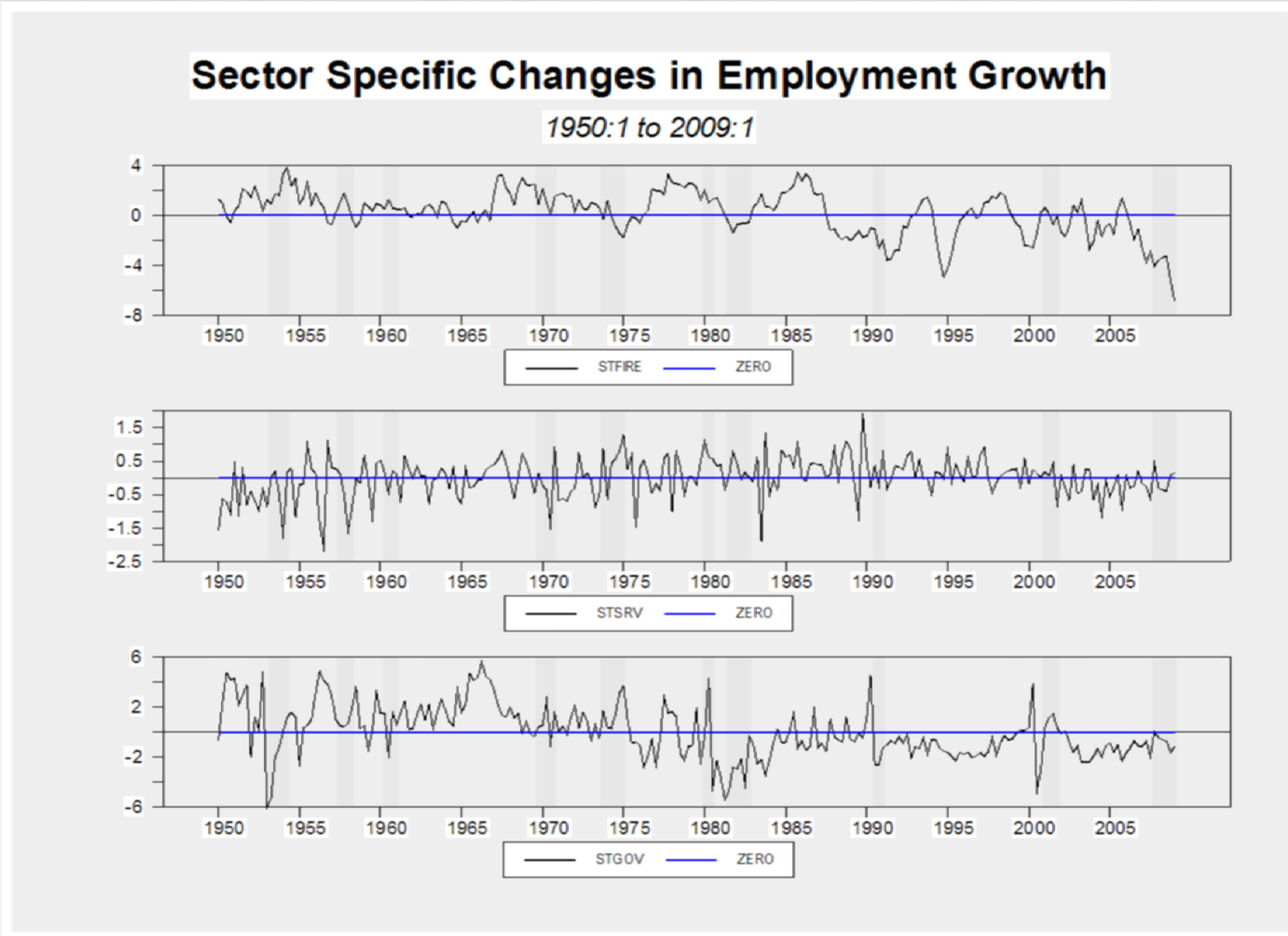
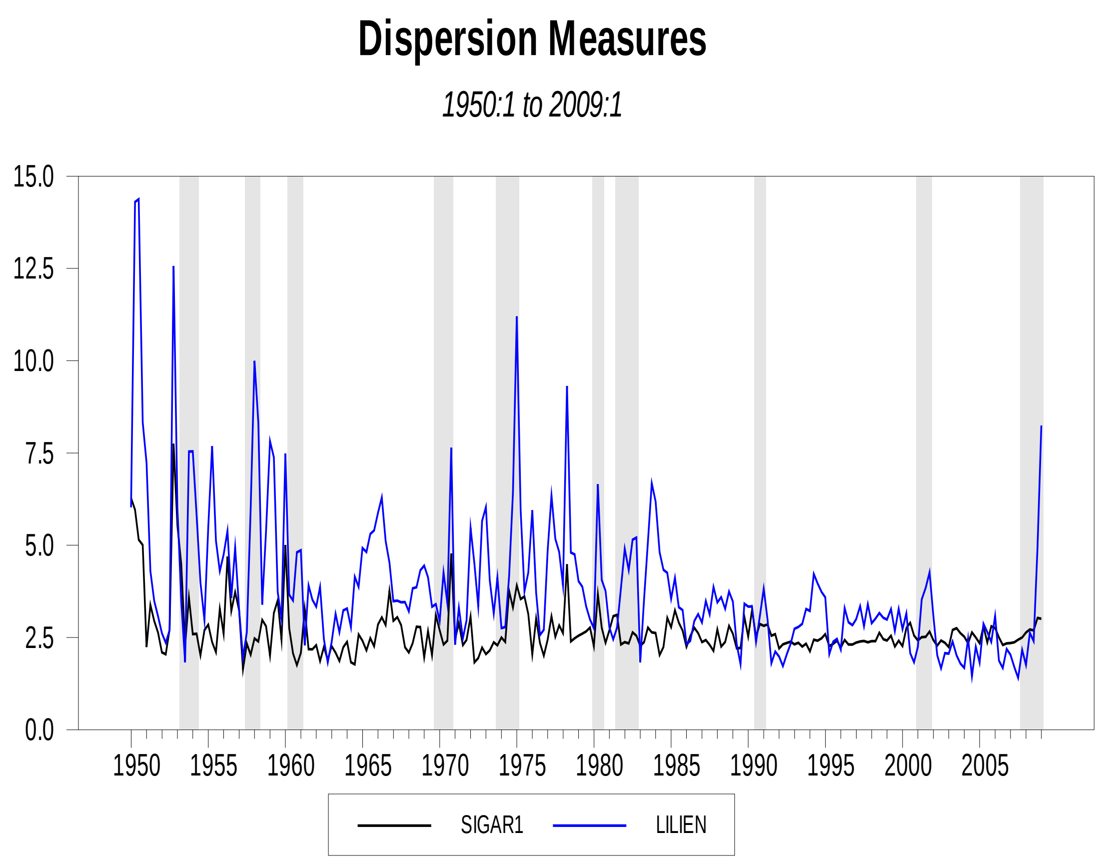

Sector Specific Changes in Employment Growth
1950:1 to 2009:1
4
0
-4
-8
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
STFIRE
ZERO
1.5
0.5
-0.5
-1.5
-2.5
STSRV
ZERO
6
2
-2
-6
STGOV
ZERO

Chart 4



Dispersion Measures
1950:1 to 2009:1
15.0
12.5
10.0
7.5
5.0
2.5
0.0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
SIGAR1
LILIEN

Chart 5

Noncyclical Measures of Structural Change

1950:1 to 2009:1

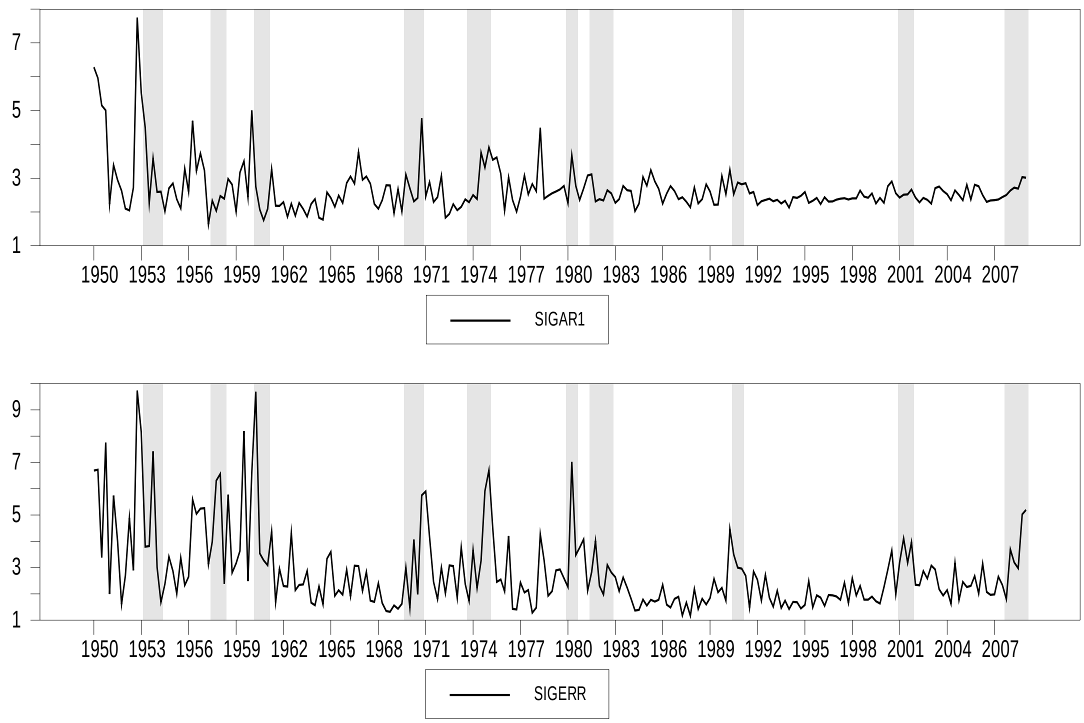


Table 5: OLS Regression estimates, Dependent Variable DUR, Quarterly Data From 1980:01 to 2009:01

X_{it}	λ_i
Construction	-0.0134** (0.0062)
Durable Mfg	-0.0238*** (0.0094)
Nondurable Mfg	-0.0087 (0.0144)
Transportation and Utilities	-0.0207* (0.0115)
Wholesale Trade	0.0072 (0.0133)
Retail Trade	-0.0047 (0.0152)
Finance, Insurance, Real Estate	-0.0032 (0.0081)
Services	0.0215 (0.0426)
Government	0.0023 (0.0073)
$\hat{C}_t$	-0.2388*** (0.0491)
$\bar{R}^2$	0.7976

Note: *** indicates significance level of 2%, ** indicates significance level of 5%, and * indicates significance level of 10%. Other explanatory variables include the participation rate of white women aged 20 and above, two lags of changes in the unemployment rate, two leads and one lag of $\hat{C}_t$.

Box 2: Calculating the variance

Rewriting the model as a vector AR(1) process, define

$$\underline{y}_t = [g_{1t}, g_{2t}, \ldots, g_{It}, C_t, C_{t-1}, C_{t-2}, X_{1t}, X_{2t}, \ldots, X_{It}]' . \tag{1.10}$$

Then

$$\underline{y}_t = \Pi \underline{y}_{t-1} + \underline{\nu}_t \tag{1.11}$$

which has a variance

$$\Omega = \Pi \Omega \Pi' + \Sigma \tag{1.12}$$

that can be solved as:

$$\text{vec}(\Omega) = [I - \Pi \otimes \Pi]^{-1} \text{vec}(\Sigma) \tag{1.13}$$

where $\otimes$ is the Kronecker product of Π with itself and $\text{vec}(x)$ is the vector constructed by stacking the columns of an $n\text{x}m$ matrix into a single column vector. The matrix Π is given by:

$$\Pi = \begin{bmatrix} 0_{I\text{x}I} & B_{I\text{x}3} & \Gamma_{I\text{x}I} \\ 0_{3\text{x}I} & A_{3\text{x}3} & 0_{3\text{x}I} \\ 0_{I\text{x}I} & 0_{I\text{x}3} & \Gamma_{I\text{x}I} \end{bmatrix} \tag{1.14}$$

and the submatrices are given by:

$$B = \begin{bmatrix} b_1^1 & b_1^2 & 0 \\ b_2^1 & b_2^2 & 0 \\ \vdots & \vdots & \vdots \\ b_I^1 & b_I^2 & 0 \end{bmatrix} \tag{1.15}$$

$$A = \begin{bmatrix} \phi_1 & \phi_1 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \tag{1.16}$$

and

$$\Gamma = \begin{bmatrix} \gamma_1 & 0 & \dots & 0 \\ 0 & \gamma_2 & & 0 \\ \vdots & & \ddots & \\ 0 & \dots & 0 & \gamma_I \end{bmatrix}. \tag{1.17}$$

The error term $\underline{v}_t$ is given by

$$\underline{v}_t = [\varepsilon_{1t}, \varepsilon_{2t}, \dots, \varepsilon_{It}, u_t, 0, 0, \varepsilon_{1t}, \varepsilon_{2t}, \dots, \varepsilon_{It}]'. \tag{1.18}$$

End Box 2

Endnotes

---

[i] http://www.nber.org/cycles/dec2008.html

[ii] Groshen and Potter claim that the jobless recovery of the 2000-2001(XXX) recession was a result of structural realignment, rather than economic weakness. However, using their methodology, it is difficult to disentangle their hypothesis from the hypothesis that job growth was weak because of cyclical factors. See Rissman (20XX) on this point.

[iii] Stock and Watson (1989), p 353.

[iv] Services include Information Services, Professional and Business Services, Education and Health Services, Leisure and Hospitality, and Other Services. Mining has been omitted from the analysis for two reasons. First, because of the incidence of strikes, employment growth in this industry is quite volatile. Second, mining accounts for a small fraction of total employment.

[v] The only exception, unreported here, is Mining.

[vi] By setting $\sigma_u^2 = 1$, the scale of the business cycle is determined. For example, an alternative estimate of the cycle $C_t^* = \delta C_t$ would result in estimates of the b_i's scaled by $1/\delta$. Additionally, the timing of the cycle is set by restricting the coefficient on the lagged cycle in durable manufacturing to be zero. Two sets of estimates are possible—both C_t and $-C_t$ -- depending upon the initial values of the parameters. For ease of interpretation, it is assumed that the business cycle has a positive impact on durable manufacturing employment growth.

[vii] The interested reader may obtain further details in Harvey(1989) and Hamilton (1994).

[viii] Stock and Watson (1989) employ the Kalman filter in constructing leading and current economic indicators.

[ix] '^' indicates an estimate.

[x] There was a significant negative quarter in 1951:3. However, the negative cycle did not persist through the following quarter. While meeting the criteria used here, normally recessions are events lasting longer than one quarter. For that reason, it has not been included as a recessionary period using the methodology suggested here.

[xi] There is another notable discrepancy when comparing the NBER business cycle recession dates to those estimated here. The two NBER recessions in the early and mid-seventies were longer by 2 and 3 quarters respectively than those proposed here. Instead, the employment-based measure of the cycle shows a labor market that was quick to return to more normal activity during those times.

[xii] This was apparent in the graphs of industry employment growth presented earlier.