The Minimum Wage, Teenage Employment and the Business Cycle*

by

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Abstract

This paper examines the effect of increases in the federal minimum wage on monthly black and white teenage employment based on recent disequilibrium theory, at the level of the firm, which predicts regime changes between the demand and supply of labor with business cycle phases. Results from both exploratory data analysis and econometric testing find significant negative employment effects in contractions. and positive or zero, but insignificant, effects in expansions. The statistical results support the hypothesis of changing regimes and suggest that minimum wage policy should depend upon the phase of the business cycle.

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I. Introduction

Estimates of the employment effect of an increase in the minimum wage sometime suggest that employment is determined by labor demand and at other times by an upward-sloped or vertical labor supply curve.[1] One explanation is that the determination of employment effects may best be described by a disequilibrium model (Neumark and Wascher, 2002).

This paper presents an empirical investigation of a disequilibrium theory of the labor market that has its roots in the research on the microfoundation of macroeconomic fluctuations. The theory predicts that in business cycle contractions the employment effect of an increase in the minimum wage will be determined by labor demand, whereas in expansions it will be determined by an upward sloped or vertical labor supply. This implies that the effects of macroeconomic fluctuations cannot be captured in conventional reduced form type regressions that include both supply and demand side variables, even those that include business cycle variables such as the adult rate of unemployment, year effects and intercept shifters. This may also explain why reduced form type regressions are sensitive to the measurement of macroeconomic conditions (Card and Krueger, 1995; Hamermesh, 1995; Welch, 1995; Currie and Fallick, 1996; Burkhauser, Crouch and Wittenburg, 2000) and sample period (Neumark and Wascher, 2007). Instead, demand and supply regimes must be separately estimated.

We test the predictions of this model using monthly Current Population Survey data for white and black U.S. teenagers and NBER dates to identify observations associated with contractions (demand regime) and expansions (supply regime). In contractions, an increase in the minimum wage is found to have a substantial and very significant negative effect on both white and black teenage employment that is more adverse for black teenagers: a 10% increase in the minimum wage decreases white and black employment by 3.10% and 5.03%, respectively. These estimates are larger than

most estimates based on reduced form type regressions of data that pool contractionary and expansionary regimes, including the estimates that Neumark and Wascher (2002) obtained for their demand regime based on a switching regimes model, albeit not related to the phases of the business cycle.[2] In expansions, no significant negative employment effect is found. A 10% increase in the minimum wage is associated with a change of + 0.16% and - 0.58%, respectively for whites and blacks. These findings are consistent with a vertical labor supply curve.

The paper is organized as follows. In section II, we present the empirical data that motivated this study - 12 month changes in white and black U.S. teenage employment associated with increases in the federal minimum wage or expansions of coverage since 1954. These have been usually consistently positive during business expansions and consistently negative in contractions (with one exception each). This suggested to us that macroeconomic conditions may produce a disequilibrium labor market.

As discussed in Section III, recent business cycle empirical research suggests that macroeconomic fluctuations may be driven by the combination of aggregate demand shocks with nominal wage rigidities.[3] This creates the potential for disequilibrium in the labor market, where employment is determined by the minimum of demand and supply, as assumed by Benassy (1995, 2002) and Holmes and Hutton (1996, 2005, 2008). In contractions, employment is determined by labor demand and the introduction of or increase in a minimum wage is predicted to reduce employment. In expansions, employment is determined by labor supply and a minimum wage increase, so long as it is not "too large", has a zero or positive effect on employment, depending upon the slope of labor supply.

The theoretical analysis presented in Section IV guides our econometric specification. The theory has implications for the exogeneity of the minimum wage, variable choices and their appropriate measurement for the demand and supply regimes, and how to identify the two regimes. In light of criticism that generally times series studies do not adequately account for non-stationarity in

the data (Kennan, 1995; Park and Ratti 1998; Williams and Mills, 2001) and for serial correlation in the regression residuals, we describe in detail the techniques used for both testing and correcting for nonstationary data and serial correlation.

Our estimates for the employment effects of increases in the federal minimum wage and/or its coverage, based on seasonally adjusted monthly employment for U.S. 16-19 year olds, are presented in Section V. Although minimum wage research has moved away from aggregate time-series studies, such studies have traditionally provided both the strongest evidence of negative employment effects and it is the effect of increases in the federal minimum wage that has been the focus of most policy debates. Additionally, time series data offer multiple opportunities to measure the impact of changes in business cycle phases and in the changes in the minimum wage (Williams and Mills, 2001).

Our findings of no deleterious employment effects associated with a minimum wage increase in expansions suggests the possibility of achieving increased income benefits for low wage workers through minimum wage increases. Hence, in Section VI, we propose and evaluate the potential effectiveness of a simple policy rule for implementing a minimum wage increase intended to achieve the income benefits without incurring the adverse employment effects associated with such legislated changes during contractions. The paper ends with our conclusions.

II. Exploratory Data Analysis

Table 1 presents 12 month changes in seasonally adjusted employment for U.S. 16-19 year olds corresponding to the effective dates of increases in the federal minimum wage and/or its coverage for the period 1954:1 to 2007:4 for whites and 1972:1 to 2007:4 for blacks.[4] Following the usual practice in cross-sectional analyses, the 12 month employment change (L_t) is measured from 3 months before until 9 months after the effective date of each legislated change. If, based on NBER

cycle dates, a contraction occurred during the 12 month period, this is indicated by "CON". Otherwise the period is classified as an expansion.

Table 1: Percent Changes in Employment (L_t) of White and Black Teenagers Associated with Minimum Wage Law Changes and Business Cycle Phase.

Increase in Nominal Minimum Wage			Increase in Coverage Only		
Effective Date	%Δ L_t	%Δ L_t	Effective Date	%Δ L_t	%Δ L_t
	White	Black		White	Black
3/1/56	-0.61	n.a.	9/3/64	6.46	n.a.
9/3/61	2.94	n.a.	9/3/65	**20.56**	n.a.
9/3/63	6.53	n.a.	2/1/69	8.66	n.a.
2/1/67	-6.96	n.a.	2/1/70 CON	-3.20	n.a.
2/1/68	6.15	n.a.	2/1/71	4.75	n.a.
5/1/74 CON	-5.37	-7.33	1/1/77	6.27	**10.41**
1/1/75 CON	-4.89	**-12.54**			
1/1/76	4.33	-2.39			
1/1/78	3.74	**11.46**			
1/1/79	-2.02	-6.97			
1/1/80 CON	-4.72	-4.81			
1/1/81 CON	-6.75	**-12.17**			
4/1/90 CON	**-10.06**	**-23.88**			
4/1/91 CON	-5.57	4.66			
10/1/96	1.51	1.82			
9/1/97	4.82	**38.32**			
Average	-1.06	-1.26	Average	+7.25	+10.41

Note: Changes over 10% in absolute value are considered substantial and are bolded.

In contractions, employment changes associated with increases in the minimum wage are almost exclusively negative and, in expansions, the changes are almost exclusively positive. All substantial changes, defined as over 10% in absolute value, fit this pattern. The most dramatic increase was associated with the 1997 legislated increase in the minimum wage when black teenage employment increased 38% within 12 months - presumably as the result of an increased participation rate during the economic expansion induced by the higher minimum wage. The average negative change in employment during contractions (-5.79% for whites and -9.35% for blacks) is large in comparison

to previous reported results for pooled data, but are almost exactly canceled out by the average increase in expansions (+4.48% for whites and +8.78% for blacks), which is also large. This canceling out, may be the explanation for the weak findings of studies that pooled data for expansions and contractions (including this one as reported in Table 4 below).

Coverage-only changes increase the nominal minimum wage paid to newly covered workers. This should theoretically impact employment in exactly the same direction as increases in the nominal minimum wage. The second part of Table 1 appears to strongly support this hypothesis; the only decrease in employment, -3.2%, occurred during a contraction.

In one sense, the data are not surprising because contractions are generally associated with decreased employment and expansions with increased employment.[5] On the other hand, the data also suggest the possibility that the employment/minimum wage relationship is determined along the labor demand curve during contractions but along the labor supply curve during expansions. To sort out the possibilities, we first turn to theory and then econometric analysis.

III. A Disequilibrium Theory of the Labor Market with Aggregate Demand Shocks

Recent business cycle empirical research suggests that macroeconomic fluctuations are driven by aggregate demand shocks combined with nominal wage rigidities. In most current general equilibrium based models of the economy that have rigid or sticky wages, adjustment costs are assumed to explain why the nominal wage does not change after an unexpected shock, as the optimal decision of wage-setting representative agents (Taylor, 2000; Woodford 2003). Because the firm is owned by its employees and maximizes the total income produced by both labor and capital, it is reasonable to assume that employees supply labor as determined by firms. Consequently, any disequilibrium that results from a higher or lower than expected shock to aggregate demand generates a relationship between the real wage and employment that is always negative, because the marginal product of labor is negative. In such a framework a minimum wage increase should always have a negative employment effect.

Benassy (1995, 2002) and Holmes and Hutton (1996, 2005, 2008) replace the representative agent framework with heterogeneous agents for whom the emolument of the owners of the firms can come at the expense of the income and welfare of their employees or vice versa. This is a better fit with Card and Krueger's (1995) suggestion that, in minimum wage research, models and empirical analysis be based on what Osterman described as "an individualistic view of the labor market, that is, on ideas of firms optimizing vis-à-vis workers" (1995, p. 841).

In the Benassy and the Holmes and Hutton frameworks, nominal wage rigidity is either assumed or derived as an optimal indexation choice. Why the nominal wage cannot adjust after an unexpected demand shock in the absence of indexation is unexplained by Benassy and Holmes and Hutton (1996, 2005). However, Holmes and Hutton (2008) derive sufficient conditions for an incomplete future market for labor after an employee is initially hired, from the optimal decision of firms in response to hiring costs. An incomplete future market for labor is necessary for indexing to arise.

These various approaches differ in terms of whether firms or workers have the indexation choice, and whether they are wage setters or wage takers in the spot labor market. However, when nominal wage rigidity arises and a higher or lower than expected shock to aggregate demand occurs, employment is determined by the minimum of labor demand and supply, consistent with optimizing behavior by both firms and workers. The impact of a demand shock in the labor market and the imposition of or increase in the minimum wage is similar in each framework. This is exposited in the following partial equilibrium model of the labor market in which output price (generated solely by demand shocks) is stochastic.

Assume that are *K* representative firms in this labor market. A firm's marginal product of labor (MPL) determines their demand for labor, *D*, and employment, L_t, is a function of the real wage, W_t / P_t, where;

$$L_t = D\left(W_t / P_t, X_t^D\right),\ D_1 < 0\,. \tag{1}$$

W_t is the nominal wage paid, P_t is the price received by the firm for output, and X_t^D is a vector of other demand variables that affect the firm's decision to hire workers.

The market supply of labor, i.e. $K \cdot S(\cdot)$, is assumed to be upward sloped in a range and then bounded, due to both the maximum number of workers who can participate in the labor market and/or the maximum number of hours any individual worker can be employed. In a competitive market each representative firm receives their share of market supply;

$$L_t = S\left(W_t/P_t, X_t^S\right), \quad S_1 > 0, \text{ for } W_t/P_t = w_t < w_t^k \text{ and } S_1 = 0, \text{ for } w_t \geq w_t^k. \tag{2}$$

X_t^S is a vector of other supply variables that affect the decision of potential workers to become employed and w_t^k is the real wage at which the supply of labor is kinked and becomes vertical.

The time sequence of events, learning, and decision-making is the same as that assumed in macroeconomic literature in which monetary policy is effective, e.g. Benassy (1995, 2002), Woodford (2003, p.155). Firms and workers first learn (if they are competitive) or set (if they have some monopoly power) the nominal wage and choose the indexation parameter for future wages in their employment contract before the random monetary shocks and the resulting stochastic output price are realized. After learning the price they will receive for the output that will be produced by their employees, both firms and employees choose the level of employment consistent with utility/profit maximization. Because the futures market for labor is incomplete (does not exist), this implies that a firm may abrogate the employment contract of a worker if that maximizes the firm's profit and the unemployed will not be rehired at a lower wage, even if the firm has a surfeit of job applicants. Similarly, an individual may abrogate the employment contract with a firm by quitting and withdrawing from the labor force (or deciding to not enter the labor force), if that is optimal, independent of the employment desires/decision of any firm. This implies that realized employment at a firm consistent with optimizing behavior by all agents is,

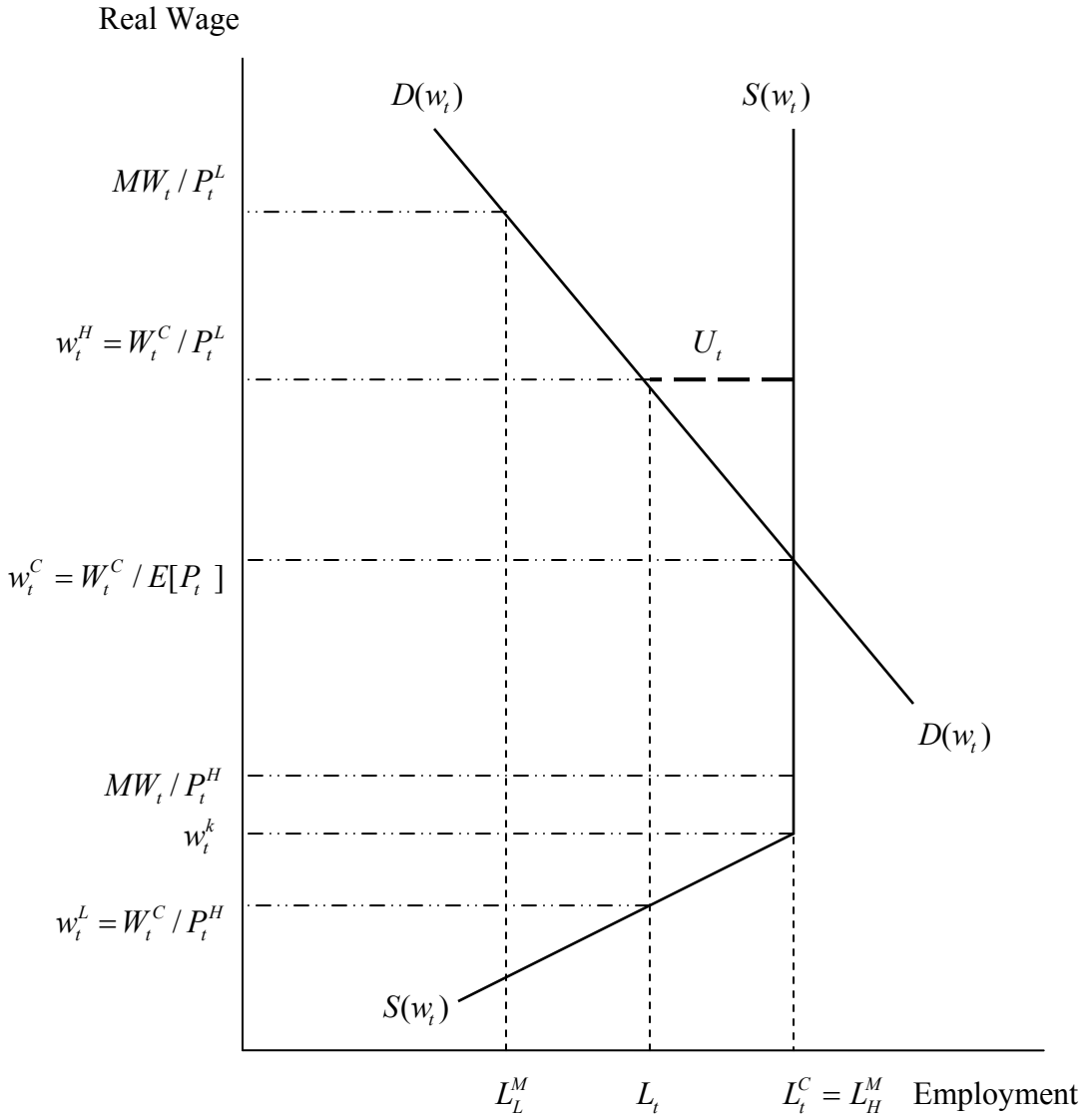
$$L_t = Min[D\left(W_t/P_t, X_t^D\right), S\left(W_t/P_t, X_t^S\right)]. \tag{3}$$

Figure 1 portrays the labor market for a firm. The firm's demand for labor in equation (1) is denoted $D(w_t)$, where $w_t = W_t / P_t$ and all other demand factors, X_t^D, are assumed constant. The supply of labor to the firm is denoted $S(w_t)$, where all other supply factors, X_t^S, are assumed constant. At the real wage w_t^k all potential workers are labor market participants and the supply of labor is kinked and becomes vertical for $w_t > w_t^k$. $D(w_t) = S(w_t)$ at the competitive, spot market clearing, real wage, w_t^C. If w_t^C is independent of the output price received by a firm, P_t, then the expected (and actual) nominal competitive, spot market wage, W_t^C, can be defined as $W_t^C = E[w_t^C \cdot P_t] = w_t^C \cdot E[P_t]$. This is the wage at which all employees, L_t^C, are initially hired in the spot market.

In Figure 1 if the nominal wage is rigid at W_t^C, then a lower than expected aggregate demand shock, associated with a contraction, produces a low output price, e.g. P_t^L, and a high real wage , $w_t^H = W_t^C / P_t^L > w_t^C$.[6] The firm can voluntarily choose not to employ more workers than it finds profitable, e.g. L_t, and involuntary unemployment (and layoffs) of U_t will result. If the minimum wage, MW_t, is introduced (or increased), this will increase the real wage, e.g. to MW_t / P_t^L, and employment will decrease further, e.g. to $L_L^M < L_t$. This corresponds to the conventional prediction of a negative effect of an increase in the minimum wage in the competitive labor market model. The profit of the firm will be less than if it paid W_t^C and hired L_t^C, due to the under utilization of capital.

Alternatively, consider an expansionary shock that generates a higher price, P_t^H, and a real wage lower than the competitive market clearing real wage, $w_t^L = W_t^C / P_t^H \leq w_t^C$. The firm will want to hire according to its MPL, where $D(w_t^L) > S(w_t^L)$, but this will not be feasible because the supply of labor, $S(w_t)$, is binding. Some employees will be unwilling to work at such low real wages and, if the realized real wage is low enough, i.e. below w_t^k, some workers will quit, e.g. $(L_t^C - L_t)$.

Figure 1. The Employment Effects of an Increase in the Minimum Wage in a Market with Nominal Wage Rigidity and Aggregate Demand Shocks



Notice that at this low real wage the firm makes an extra profit whenever the realized real wage actually paid is less than w_t^C. For example, when $w_t = w_t^L$, this extra profit is equal to $(w_t^H - w_t^L)L_t$. Because the firm rationally expects its employment decision to be constrained by its portion of the supply of labor at w_t^L, the choice of a rigid wage can be optimal for a firm if the probabilities of these extra profits, when $w_t < w_t^C$ occurs, i.e., an expansionary shock, are large enough.

If the minimum wage, MW_t, is introduced (or increased) when there is an expansionary shock, the real wage will increase, e.g. from $w_t^L = W_t^C / P_t^H$ to MW_t / P_t^H. If the initial equilibrium

was on the upward sloped or vertical section of the supply of labor, and the minimum wage is not too high,[7] employment will be determined by the supply of labor and an increase in the minimum wage can increase or not change employment, e.g. employment increases from L_t to L_H^M in Figure 1. The introduction of the minimum wage can make the choice of a rigid nominal wage even more appealing to the firm because, in a contraction, a firm cannot choose to reduce the wage paid below the legislated minimum wage when lower output prices are generated and, in an expansion, when higher output prices are generated, the firm can still earn extra profits with a rigid wage whenever the realized real wage is below w_t^C, e.g. at MW_t / P_t^H the firm makes an extra profit of $(w_t^C - MW_t / P_t^H)L_t^C$.[8]

An increase in the workers covered by a minimum wage, if effective, increases the nominal wage paid such workers and their employment is predicted to decrease in a contraction when the negatively sloped MPL curve is binding and to increase or not change in an expansion when an upward sloped or vertical supply curve is relevant.[9]

IV. Model Specification, Variable Measurement and Business Cycle Phase

A. Disequilibrium Model Specification

The disequilibrium theory implies estimating separate relationships between employment and the minimum wage for contractions and expansions, as given by

$$L_t = f^D(MW_t, X_{1,t}^D, \ldots, X_{q,t}^D) + \varepsilon_t^D \quad . \tag{4}$$

$$L_t = f^S(MW_t, X_{1,t}^S, \ldots, X_{k,t}^S) + \varepsilon_t^S \quad . \tag{5}$$

Equation (4) is relevant in contractions and equation (5) is relevant in expansions. L_t is a measure of employment and MW_t is a measure of the minimum wage in period *t*. $X_{1,t}^D, \ldots, X_{q,t}^D$ are demand side control variables and, $X_{1,t}^S, \ldots, X_{k,t}^S$ are supply side control variables. ε_t^D and ε_t^S are assumed to be i.i.d. error terms that may have different variances. To pool the data and estimate a Chow type equation involving dummy variables for contractions and expansions that allow the explanatory

variables and coefficients to differ by business cycle phase requires the assumption that the variances of ε_t^D and ε_t^S are equal.

Card and Krueger (1995) and Hamermesh (1995), among others, have expressed concerns regarding the potential endogeneity of the minimum wage. This is an important issue in a complete and competitive equilibrium labor market. In our (disequilibrium) theoretical model, the sequence of decision-making determines one-way causality from the nominal and real wage to employment. We can think of no plausible reason for a profit maximizing firm to lay off or hire minimum wage workers before the minimum wage is actually changed; such workers are not unionized and do not have long-term contracts, nor do their jobs involve large investments by the firm in training costs. This suggests that specifying L_t as the dependent variable and MW_t as an independent variable is justified. Additionally, Williams and Mills (2001) addressed the causality question in a reduced form type equation framework using VAR methodology and found strict one-way causality from the minimum wage to employment.

The specification of a cotemporaneous relationship between employment and the minimum wage is representative of the majority of previous analyses and virtually all studies using annual data. As discussed below, all data series in this study are measured by 12-month differences to make the data stationary. This makes our specification similar in dynamic structure to previous specifications that use annual data, and consistent with Williams and Mills' (ibid.) finding that the dynamic lag in employment to changes in the minimum wage and other control variables can be captured within three to six months. Our results suggest that we adequately capture the negative employment effect during contractions predicted by the theory with this specification.

B. Variable Definitions, Measurement and Transformations

Most researchers measure employment as an employment/population ratio. However, according to the disequilibrium theory, population is a supply control variable that is only relevant in

expansions. Hence, L_t is measured by actual employment and population, POP_t, is included it as a separate variable in equations (5) and (6) .

The minimum wage is typically measured by the Kaitz (1970) index, a coverage-weighted ratio of the nominal minimum wage to average hourly earnings of non-teenagers. For several reasons, Card, Katz and Krueger (1994) and Card and Krueger (1995) recommend decomposing the Kaitz index into separate variables. We follow this recommendation for the additional reason that the non-teenage wage, measuring the price of a substitute in production for teenage labor, is only relevant when labor demand is binding and should not be included in the supply regime. The minimum wage variable, MW_t, is measured by the statutory federal minimum wage. The non-teenage wage, W_t, is measured by the hourly wage of production and nonsupervisory workers in manufacturing.[10]

Instead of measuring the impact of extensions of coverage by the coverage rate for all workers, which Card, Katz and Krueger (1994) argued may be deficient, we measure the impact of these extensions, including increases in the sub-minimum wage, by a set of indicator/dummy variables denoted DYY_t. Each variable measures extensions of coverage and changes in the lower statutory minimum wage associated with the date YY_t of a specific legislative change.[11] To be consistent with the assumption about the dynamics of the teenage labor market discussed above, we assume that the employment effect of extensions in coverage take place within 12 months. Hence, DYY_t equals 1 for the first 12 months following an extension and 0 otherwise.

Past studies have included a measure of the adult rate of unemployment, U_t, presumably to control for the state of the business cycle. In our model, it is intended to capture the month-to-month intensity of the effects of demand shocks in the contractionary phase of the business cycle when involuntary unemployment exists. U_t is included as an explanatory variable in equation (5) when cyclical unemployment is expected to be nonzero and negatively related to L_t. In an expansion, cycli-

cal unemployment should be zero and unrelated to L_t. Thus, U_t should be excluded from the supply regime.[12]

Changes in the purchasing power of the wage paid can theoretically influence labor supply. Although its relevance in affecting the behavior of teenagers can be questioned, we measure this with the consumer price index, CPI_t. Because teenagers are largely employed in the retail sector, CPI_t can also be considered a labor demand variable in so far as it measures the value of output produced by teenagers. [13]

In light of the demonstrated potential for nonstationarity of the dependent and/or independent variables to generate spurious estimates of minimum wage employment effects (Kennan, 1995; Park and Ratti, 1998; Williams and Mills, 2001), each non-binary data series was expressed in logs and tested for both stationarity and deterministic trend. All data were found to be non-stationary and were 12-month differenced, which produces stationarity and also removes any seasonality that may remain after the U.S. Department of Labor seasonally adjustment. As stated earlier, this transformation also plausibly captures the dynamic lags between the changes in the explanatory variables and the change in teenage employment.

A deterministic trend was estimated using Schwarz's Bayesian Information Criterion (BIC) to select the optimal polynomial for each (stationary) data series. The residuals from this regression were then used as input. However, two of the series, CPI_t and W_t, each appeared to have a structural break in trend at approximately January, 1982. (This break plausibly is associated with the well known change in monetary policy that occurred about this time and apparently affected the structure of the rates of inflation.) For this reason, for these two series, separate optimal polynomials for detrending were estimated before and after this breakpoint. In order to allow the exact replication of our estimates, the optimal polynomial degree and the augmented Dickey Fuller test statistics for each series are available upon request.[14]

NBER business cycle dates are used to separate the samples used to estimate equations (4) and (5). Just as Burkhauser et al. (ibid.) used NBER dates to create an intercept shifter, we exogenously categorize observations using NBER dates. NBER business cycle dates are well understood, most frequently used to implement public policy, accord well with endogenously determined cycle dates (Hamilton, 1989; Perron and Wada, 2005), and have been demonstrated to identify shocks that generate high real wages and employment determined by labor demand, and generate low real wages and employment determined by labor supply (Holmes and Hutton, 1996; Woitek 2005). An observation is classified as expansionary if the 12-month period it includes was entirely expansionary and all other observations are classified as contractionary.

With the data separated into contractions and expansions, some coverage variables apply to both demand and supply regimes while others apply to only one of the regimes. This implies the following specifications of equations (4) and (5) with the theoretically expected sign of each coefficient denoted below the respective variable.

$$\begin{array}{l} L_t = d_0 + d_1 MW_t + d_2 CPI_t + d_3 W + d_4 U_t + d_5 D61_t + d_6 D69_t + d_7 D70_t + d_8 D71_t + d_9 D74_t \\ \quad\ (-)\ (-) \qquad (+) \qquad (+) \qquad (-) \quad (-) \qquad (-) \qquad (-) \qquad (-) \qquad (0,+) \\ \\ \quad + d_{10} D75_t + d_{11} D76_t + d_{12} D90_t + \varepsilon_t^D . \\ \quad\ (0,+) \qquad (-) \qquad (-) \end{array} \tag{6}$$

$$\begin{array}{l} L_t = s_0 + s_1 MW_t + s_2 CPI_t + s_3 POP_t + s_4 D61_t + s_5 D64_t + s_6 D65_t + d_7 D67_t + d_8 D71_t + d_9 D76_t \\ \quad (+)\ (0,+) \quad (0,-) \quad (0,+) \qquad (0,+) \quad (0,+) \quad (0,+) \qquad (0,+) \quad (0,+) \quad (0,+) \\ \\ \quad + d_{10} D77_t + d_{11} D90_t + d_{12} D97_t + \varepsilon_t^D . \\ \quad\ (0,+) \qquad (0,+) \qquad (0,+) \end{array} \tag{7}$$

The coefficients for the 1974 and 1975 coverage dummy variables in the demand equation are expected to be zero or positive sign because this corresponds to the cotemporaneous oil shocks which presumably measure supply rather than demand shocks to the labor market.

V. Empirical Estimates

Equations (6) and (7) are estimated with data for the time period 1954:1 to 2007:4 for white teenagers and 1972:1 to 2007:4 for black teenagers, using a maximum likelihood autoregressive procedure in order to eliminate serial correlation.[15] An AR(3) process was usually required to obtain serially independent residuals, the coefficients of which are reported for each regression.[16] The estimates are presented in Table 2.

Table 2. Estimates of Equations (6) and (7).

Variable	Eq. (6) (Con) White	Eq. (7) (Exp) White	Eq. (6) (Con) Black	Eq. (7) (Exp) Black		Variable	Eq. (6) (Con) White	Eq. (7) (Exp) White	Eq. (6) (Con) Black	Eq. (7) (Exp) Black
Const.	-.021**	.009	-.045**	.030*		$D70_t$	-.015	–	–	–
p-value	(.001)	(.07)	(.002)	(.03)		p-value	(.18)	–	–	–
MW_t	-.310**	.016	-.503*	-.058		$D71_t$	-.015	-.018	–	–
p-value	(.001)	(.43)	(.03)	(.43)		p-value	(.17)	(.16)	–	–
CPI_t	.386	-.340	-2.018*	-.737		$D74_t$	.054*	–	.198**	–
p-value	(.09)	(.11)	(.02)	(.25)		p-value	(.02)	–	(.002)	–
W_t	-.289	–	-2.261*	–		$D75_t$	.002	–	.064*	–
p-value	(.15)	–	(.02)	–		p-value	(.46)	–	(.03)	–
U_t	-.023**	–	-.038**	–		$D76_t$	.002	.002	.048	-.043
p-value	(<.001)	–	(.001)	–		p-value	(.46)	(.46)	(.20)	(.23)
POP_t	–	.910**	–	.859*		$D77_t$	–	.019	–	-.045
p-value	–	<.001	–	(.05)		p-value	–	(.13)	–	(.21)
$D61_t$	-.003	-.004	–	–		$D90_t$	.002	-.000	0.017	-.060
p-value	(.45)	(.42)	–	–		p-value	(.49)	(.49)	(0.36)	(.20)
$D64_t$	–	.015	–	–		$D97_t$	–	-.009	–	-.002
p-value	–	(.18)	–	–		p-value	–	(.27)	–	(.49)
$D65_t$	–	.052**	–	–						
p-value	–	(.001)	–	–		R^2	0.85	0.74	0.76	0.41
$D67_t$	–	-.019	–	–						
p-value	–	(.16)	–	–		*d.f.*	164	403	103	286
$D68_t$	-.009	.016	–	–						
p-value	(.36)	(.23)	–	–		AR(1)	-0.409	-0.486	- 0.584	-0.401
$D69_t$	-.009	.013	–			AR(2)	-0.139	-0.203	-0.120	-0.267
p-value	(.36)	(.26)	–	–		AR(3)	-0.128	-0.129	0.341	-0.012

p-values are for one-tail tests. * and ** denotes significance at the .05 and .01 critical values, respectively.

The first notable result is the intercepts, which capture the impact of business cycle phase holding all other factors, including the minimum wage, constant. A contraction very significantly

decreases both white and black teenage employment, whereas an expansion increases employment. This confirms Burkhauser et al.'s research strategy to include an intercept shifter to account, at least in part, for macroeconomic conditions. It is noteworthy that the effect of changes in the phase of the business cycle on the percentage change in black teenage employment is more than twice that of whites, both to decrease it in a contraction and to increase it in an expansion.

That an intercept shifter is insufficient to control for macroeconomic fluctuations is supported by the estimated employment effect of an increase in the minimum wage that differs in contractions versus expansions. The estimated effect during a contraction is negative and statistically significant for both white and black teenagers. A 10% increase in the minimum wage decreases white teenage employment by 3.1% and black teenage employment by 5.0%. The more adverse impact on black teenagers is noteworthy because, although it is often asserted on a priori grounds that blacks are more adversely affected than whites by the minimum wage, previous empirical estimates that used pooled data have not usually supported this assertion. During expansions, an increase in the minimum wage has no significant impact on either white or black teenage employment, consistent with a vertical labor supply, although the coefficient is actually positive for whites. Hence, the results conform with the predictions of the disequilibrium theory.

The estimated coefficients of all other exogenous variables are either not significant or have signs consistent with the disequilibrium theory with two exceptions - the production worker wage rate and the CPI for blacks in contractions. We argued above that both of these variables are of questionable relevance; the wage rate of production workers in manufacturing may be a particularly poor measure of the cost of a substitute in production for teenage labor and the CPI of the purchasing power of black teenage workers.[17] The coefficients of white and black teenage population variables are statistically significant and consistent with a very steep or vertical supply of labor (as portrayed in Figure 1) that shifts to the right as population increases: a 10% increase in teenage population increases white and black employment by 9.1% and 8.6% , respectively. A 10% increase in the adult

unemployment rate is associated with 0.23% and 0.38% decrease in white and black employment, respectively. Although each is small in magnitude, each is also highly significant statistically. The dummy variables measuring the effect of extensions in coverage are not significantly different from zero with the exceptions of the increase in coverage during the expansion in 1965 and the supply/oil shocks of 1974 and 1975. The positive effects in each of these years are consistent with the prediction of the disequilibrium theory when supply is relevant.

The estimated intercepts and minimum wage coefficients are sufficient to suggest the assumption of common parameter values in contractions and expansions does not hold. To provide more formal evidence of this, we estimated two equations. The first is a Chow type equation involving dummy variables for contractions and expansions that allow the explanatory variables and/or coefficients to differ by business cycle phase in the manner described in the previous section. The second equation, equation (8), should be considered the null hypotheses as it pools the explanatory variables from both phases and restricts the coefficients to be equal.

$$L_t = f(\, MW_t,\, X^D_{1,t},\, \ldots,\, X^D_{q,t}, X^S_{1,t},\, \ldots,\, X^S_{k,t}) \;+\; \varepsilon^P_t \,. \qquad (8)$$

To be consistent, each of these equations was estimated using the same data series transformed by the AR coefficients found using maximum likelihood estimation of equation (8) to eliminate serial correlation.[18] The resulting F-test results are presented in the first row of Table 3. The null hypothesis of equal coefficients is rejected at the 5% level for white teenagers, but not for black teenagers.

The validity of these tests is based on the assumption of a common error variance in contractions and expansions. To test this second hypothesis, one must for consistency, (re-)estimate equations (6) and (7) using the same AR (3) transformation as that used in estimating the restricted coefficients equation (8). This we did. The test of the null hypothesis of equal variances reported in the bottom row of Table 4 is rejected for black teenagers, but not white teenagers. Hence, the F test results suggest that the most reliable estimates are those of equations (6) and (7) using separated sam-

ples, allowing for unequal variances, and the separate corrections for serial correlation, as reported in Table 2.

Table 3. F-Tests for the Equilibrium versus the Disequilibrium Model.

Equilibrium vs. Disequilibrium	White		Equilibrium vs. Disequilibrium	Black
Equal coefficients			Equal coefficients	
F(11, 567) (p-value)	1.94 (0.03)		F(8, 386) (p-value)	1.04 (0.41)
Equal Variances			Equal Variances	
F(164, 403) (p-value)	1.07 (0.30)		F(283, 103) (p-value)	1.40 (0.02)

As a benchmark for previous reduced form type equation estimates, we report in Table 4 the estimates of the restricted model, equation (8), in which the data for expansions and contractions are pooled. Despite many differences in model specification, variable measurement, and methods of detrending and stationarity adjustment, the results are similar to most other aggregate time series studies that used pooled data. In particular, we find that increases in the minimum wage have a negative but small and insignificant effect on employment.

Previous empirical research for the U.S. does not refute the prediction of a business phase dependent relationship between employment and minimum wage increases. Most of the studies surveyed by Neumark and Wascher (2007) used pooled data from both contractions and expansions for which, according to the disequilibrium theory, any estimate could be obtained. None employed data corresponding entirely to a contractionary period. (Although the national economy was already in a recession when Katz and Krueger (1992) began collecting their Texas fast-food employment data in December, 1990, Texas unemployment statistics indicate that the national contraction did not impact Texas until the later half of 1991 and after the authors completed their data measurement (July-early August, 1991).

Table 4. ML Estimates of Equation (8), the Null Hypothesis Model,

$$L_t = f(\, MW_t,\, X^D_{1,t},\, \ldots,\, X^D_{q,t}, X^S_{1,t},\, \ldots,\, X^S_{k,t}) \;+\; \varepsilon^P_t$$

Variable	White	Black		Variable	White	Black
Constant	-0.001	0.000		$D70_t$	-0.02	
(p-value)	(0.74)	(0.98)		(p-value)	(0.28)	
MW_t	-0.02	- 0.10		$D71_t$	-0.02	
(p-value)	(0.68)	(0.64)		(p-value)	(0.27)	
CPI_t	-0.12	-0.61		$D74_t$	-0.01	0.02
(p-value)	(0.54)	(0.44)		(p-value)	(0.70)	(0.78)
POP_t	0.80**	1.19**		$D75_t$	0.00	0.04
(p-value)	(<.0001)	(0.01)		(p-value)	(0.99)	(0.42)
W_t	-0.17	0.44		$D76_t$	0.00	-0.02
(p-value)	(0.38)	(0.64)		(p-value)	(0.99)	(0.64)
U_t	-0.02**	-0.06**		$D77_t$	0.02	-0.04
(p-value)	(<.0001)	(<.0001)		(p-value)	(0.26)	(0.40)
$D61_t$	-0.02			$D90_t$	-0.02	-0.04
(p-value)	(0.20)			(p-value)	(0.25)	(0.45)
$D64_t$	0.02			$D97_t$	-0.00	0.01
(p-value)	(0.24)			(p-value)	(0.92)	(0.81)
$D65_t$	0.06**					
(p-value)	(<.0001)			R^2	0.79	0.53
$D67_t$	-0.02			*d.f.*	581	397
(p-value)	(0.20)			AR(1)	-0.43	-0.44
$D68_t$	0.00			AR(2)	-0.15	-0.23
(p-value)	(0.82)			AR(3)	-0.14	0.06
$D69_t$	-0.01					
(p-value)	(0.67)					

A number of studies used data for just an expansionary period and predominately reported a zero or positive employment effect. One exception is Kim and Taylor's (1995) finding of a negative employment effect associated by California's 1988 minimum wage increase. Such an employment effect is predicted by the disequilibrium model only if the increase in the minimum wage is very large. Interestingly, the 1988 California minimum wage increase was 25%, approximately twice the average size of federal minimum wage increases (see fn. 7). Another exception is a study by Partridge and Partridge (1999) of the effect of state level minimum wages during the mid 1980s. They report estimated cotemporaneous employment effects that are zero or positive, although the lagged effect is negative.

VI. A Phase-Contingent Rule for the Implementation of a Minimum Wage Increase.

Our results suggest that it is reasonable for legislators and policy makers to be concerned about potentially large negative employment effects of an increase in the minimum wage. However, it raises the possibility of increasing the minimum wage without adverse employment effects for low wage workers if the minimum wage increase is implemented during an expansion. Could an implementation rule be devised that achieves the potential income benefits that come in expansions but avoids the deleterious employment effects associated with contractions?

Because this study has focused on teenage employment, we consider a simple contingent policy prescription: a minimum wage increase should become effective only when the unemployment rate for teenagers is below a 12-month moving average for two consecutive months and the economy is not in a recession. To evaluate the potential success of such a policy in avoiding future negative employment impacts associated with contractions, we consider what might of have been the historical consequences of such a policy.

The first 3 columns of Table 5 present the dates of each of the increases in the minimum wage legislated since 1956, the actual state of the economy as of that date, and whether employment had increased or decreased in the preceding 12 months. These are followed by the teenage unemployment rate (U^T) for months $t-3$ and $t-2$, because the date upon which an increase in the statutory federal minimum wage becomes effective can be based on data no more recent than month $t-2$ due to the restriction of when the Bureau of Labor Statistics collects data.[19] These are followed by; the 12-month moving average of the teenage unemployment rate at time t, $\mathrm{MA}U^T$, the effective date of implementation implied by this part of the policy rule, and the phase of the business cycle on that date.

Table 5. Effective Dates of Minimum Wage Changes Implied by Unemployment Policy Rules

Legislated Min. Wage Date	State of Economy	Employment Change	U^T $(t-3)$	U^T $(t-2)$	MA U^T	New Date Moving Average	New Date State of Economy
3/1/56	Expansion	Decrease	11.7	11	11.1	4/1/56	Expansion
9/3/61	Expansion	Increase	15.8	16.6	15.9	3/1/62	Expansion
9/3/63	Expansion	Increase	18.7	17.2	15.9	4/1/64	Expansion
9/3/64	Expansion	Increase	16.4	16.8	16.8	9/3/64	Expansion
9/3/65	Expansion	Increase	14.8	15.3	15.9	9/3/65	Expansion
2/1/67	Expansion	Decrease	12.6	11.8	12.8	2/1/67	Expansion
2/1/68	Expansion	Increase	13.7	13.8	12.8	7/1/68	Expansion
2/1/69	Expansion	Increase	11.8	12.2	12.6	2/1/69	Expansion
2/1/70	Contraction	Decrease	12.6	11.6	12.3	3/1/70	Contraction
2/1/71	Expansion	Increase	16.7	17.4	14.8	12/1/71	Expansion
5/1/74	Contraction	Decrease	14.6	14.9	14.6	3/1/76	Expansion
1/1/75	Contraction	Decrease	17.0	17.2	15.5	3/1/76	Expansion
1/1/76	Expansion	Increase	19.5	19.8	19.7	3/1/76	Expansion
1/1/77	Expansion	Increase	18.6	16.1	16.4	1/1/77	Expansion
1/1/78	Expansion	Increase	18.0	17.2	18.2	1/1/78	Expansion
1/1/79	Expansion	Decrease	16.4	16.1	16.4	1/1/79	Expansion
1/1/80	Contraction	Decrease	16.5	16.5	16.2	5/1/82	Expansion
1/1/81	Contraction	Decrease	18.0	18.4	17.5	5/1/82	Expansion
4/1/90	Contraction	Decrease	15.3	14.8	14.9	7/1/90	Contraction
4/1/91	Contraction	Decrease	17.4	18.6	15.9	4/1/93	Expansion
10/1/96	Expansion	Increase	16.2	17.1	17.2	10/1/96	Expansion
9/1/97	Expansion	Increase	16.0	16.8	16.5	12/1/97	Expansion

For example, when the minimum wage increase was implemented on March 1, 1956, the economy was in an expansion. However, teenage employment had decreased since the same date in the preceding year and the teenage unemployment rate was below the 12-month moving average for only one month, $(t-2)$. This policy rule would have delayed the minimum wage increase on March 1, 1956 and assuming that this would have not affected the unemployment rates that fol-

lowed, combined with the fact that the economy was still in an expansion, would have delayed implementation until April 1, 1956.

Had it been in effect, the moving average requirement alone would have required that 13 (of 22) legislated increases be postponed and the majority of these (8) would have been postponed more than 3 months. More important, the requirement would have postponed implementation until the economy was expanding in all but two cases. The remaining two could have been avoided by the second part of this policy rule. In 1970, the first part of this rule would have postponed the implementation by one month, but by that time the economy was in contraction, which by the second part of the rule would have further postponed implementation. Postponing an increase until two successive periods of below-average unemployment occurring during an expansion, would have postponed implementation until December, 1971. The first part of the rule would have also postponed the 1990 legislated increase for three months, at which point the economy was contracting and the second part of the rule would have required further postponement of the legislated increase. The two-part rule was satisfied when minimum wage increases were made effective on 2/1/67 and 1/1/79, but employment decreased. Hence, the two-part rule provides no guarantee that increases in the minimum wage will not be associated with employment decreases. However, these decreases all occurred during expansions and were relatively small.

One also cannot say with certainty whether the actual increases in the minimum wage contributed to the contractions that occurred or not and how the relationship between the unemployment rate and moving average of the unemployment rate in period *t* would have changed had legislated wage increases been postponed. Other factors may plausibly influence the reliability and/or usefulness of a policy rule. Nonetheless, the analysis indicates that avoiding deleterious employment effects of the minimum wage may be an achievable policy goal if effective dates of legislated minimum wage increases depend upon both the phase of the business cycle and the state of the labor market.

VII. Conclusions

We have demonstrated that the evidence that the employment effect of an increase in the minimum wage sometimes appears to be determined by labor demand and at other times by an upward-sloped or a vertical labor supply curve is consistent with a labor market in which aggregate demand shocks combined with nominal wage rigidities create disequilibrium. Such a labor market is consistent with the microfoundations of general equilibrium macroeconomic models of the economy, even when not resulting in equilibrium. The theoretical predications are that the employment effects of increases in the minimum wage are determined by labor demand during contractions and by labor supply during expansions. The empirical implication is that the effects of macroeconomic fluctuations cannot be adequately captured in a reduced form type equation which includes both supply and demand side variables, even including year effect and intercept shift variables.

Our careful specification of the relationships that determine employment in each phase of the business cycle, variable measurement considerations, data transformations and error correction methods reflect both theoretical considerations and empirical research that suggests that estimates of minimum wage effects are highly sensitive to such choices.

Our empirical analysis strongly supports the predictions of the disequilibrium model. Our estimates indicate that increases in the minimum wage during contractions have had a significant and substantial negative impact on teenage employment that has been more adverse for black teenagers. On the other hand, there are on average, no significant adverse employment effects during expansions and at times large positive effects have occurred. These results suggest that the welfare of teenage workers can almost certainly be improved through increases in the minimum wage when implemented following a policy rule contingent upon the state of the economy.

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Endnotes

[1] See the extensive survey by Neumark and Wascher (2007).

[2] By comparison, aggregate time series analyses by Brown, Gilroy and Kohen (1983), and Brown (1999), found increases in the in the statutory federal minimum wage decreased both black and white teenage employment about -1% on average.

[3] E.g. Taylor (1993), Clarida, Gali and Gertler (1999, 2000), Woodford (2003), Boivin and Giannoni (2006). Baker, Gibbs, and Holmstrom (1994), Ghosal and Loungani (1996), Campbell and Kamlani (1997), Cho, Cooley, and Phaneuf (1997), Kahn (1997),

[4] Bureau of Labor Statistics Series LNS12000015 and LNS12000018. These as well as the other series used are listed by the United States Department of Labor on its website http://www.dol.gov/esa/minwage/chart.htm.

[5] Commenting upon an earlier draft of this paper, the late Milton Friedman wrote, "It is not surprising that the reaction to a minimum wage increase would be different in periods of expansion from periods of contractions". He went on to suggest essentially this study. (Personal correspondence dated July 15, 2003, available at the website of the principle author.)

[6] It may be helpful to think of the Bernoulli distribution as a paradigm of price (aggregate demand) shocks.

[7] In an expansion, a large enough increase in the minimum wage could make the labor demand curve binding. In fact, the average percentage increase in the minimum wage has been slightly less in contractions (12.7%) than in expansions (13.1%) and a t-test of the null hypothesis that these are not different produced a p-value of 0.90.

[8] This need not occur if the real wage is below that which would be optimal for a conventional monopsonist.

[9] If there is a change in regime then the positive/negative employment effect of the change in regime may work in opposition to the negative/positive employment effect of the minimum wage increase. Hence, it is possible for employment to decrease, remain unchanged or increase when there is a change in regime. Because there are too few observations to measure such transitions we do not do so.

[10] One could plausibly question whether there are more relevant measures of a substitute in production for teenage employment than this.

[11] The legislated extensions in coverage sometimes coincided with increases in the level of the minimum wage and sometimes did not. The dates of the latter are listed in the second part and the dates for the former can be deduced from the first part of table 1.

[12] The sources of these data are BLS series; LNU00000015, LNU00000018, CES3000000033, CUSR0000SA0, and LNS14000060.

[13] Card, Katz and Krueger (1994) argue that other possible supply side variables, such as the fraction of the teenagers in the overall population, school enrollment or training program participation rates, may b[13] See the extensive survey by Neumark and Wascher (2007).

[13] By comparison, aggregate time series analyses by Brown, Gilroy and Kohen (1983), and Brown (1999), found increases in the in the statutory federal minimum wage decreased both black and white teenage employment about -1% on average.

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[13] The legislated extensions in coverage sometimes coincided with increases in the level of the minimum wage and sometimes did not. The dates of the latter are listed in the second part and the dates for the former can be deduced from the first part of table 1.

[13] The ias the results and in any case are not available monthly.

[14] Co-integration tests were also performed and, with the exception of CPI_t and W_t (for which these tests are questionable because of the structural break), the variables were found not to be co-integrated.

[15] The residuals of OLS estimates for both white and black teenagers of equation (4) were serially correlated (tested using Godfrey's test for AR(1)- AR(4) with each found to be highly significant (p-value < 0.001)).

[16] An AR (3) process based on monthly data is comparable to the AR(1) process employed by Park and Ratti (1998) and Williams and Mills (2001) using quarterly data.

[17] Moreover, these two series appear problematic because they appear to have a structural break about 1982:1 and also appeared to be co-integrated (with no simple remedy).

[18] These are presented in Table 4.

[19] The Bureau of Labor Statistics collects employment and unemployment data during the week that includes the 12th day of each month.