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An Industry-Level Panel Analysis of Vedder and Gallaway's Adjusted Real Wage Model in the Interwar Era

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Abstract

In their 1993 book, Richard Vedder and Lowell Gallaway contend that US unemployment during the twentieth century can be largely explained by movements in the "adjusted real wage rate", that is, the real hourly wage rate divided by labor productivity. In particular, the authors suggest that high-wage policies by both Presidents Herbert Hoover and Franklin Roosevelt played a major propagation role in the Great Depression of the 1930s. A potential criticism of Vedder and Gallaway's simple time-series model is that wages and employment may be endogenous. We employ techniques such as a Pedroni Dynamic Panel OLS and a Panel VAR, that explicitly allow for endogeneity. The results suggest, consistent with Vedder and Gallaway's thesis, that shocks to an industry's adjusted real wage rate caused negative movements in industry employment between June 1920 and December 1938. This supports the Austrian interpretation that the Great Depression was less a failure of markets than a failure of policy.

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Introduction

In 1993, Richard K. Vedder and Lowell Gallaway published *Out of Work: Unemployment and Government in Twentieth-Century America*. Many of the main findings from the book were published six years earlier in an article entitled "Wages, Prices, and Employment: Von Mises and the Progressives" which appeared in the first volume of *The Review of Austrian Economics*. In these works, Vedder and Gallaway demonstrate that throughout the twentieth century the rate of unemployment can be explained largely by movements in what they call the "adjusted real wage"—that is the inflation-adjusted hourly wage rate divided by labor productivity (output per labor hour). Their simple empirical model predicts the actual unemployment rate quite well, even during the 1930s when it rose to 25 percent. In what may be the most important contribution of their book, at least from the perspective of the field of economic history, Vedder and Gallaway suggest that the Great Depression of the 1930s was worsened by a series of high-wage policies implemented by Presidents Herbert Hoover and Franklin Roosevelt, which increased the adjusted real wage further above its equilibrium level rather than allowing it to fall to where the labor market could clear. Absent these policies, they contend that the downturn of 1929-30 would have been a relatively normal economic recession. Thus, rather than being a failure of markets, the Great Depression was a failure of policy makers who continuously intervened in the labor market to the detriment of the economy.

Vedder and Gallaway explicitly labeled their approach as Austrian. They employed this nomenclature at the strong urging of Murray Rothbard, a leading Austrian economic authority on the Great Depression. Austrian economists ("Austrians") believe that business cycles are primarily caused by monetary interventions that create malinvestments that lead to a temporary boom. The "bust" follows during the process that brings the market back to its optimum efficiency. Importantly, many Austrians believe that the optimal government response to an economic shock is to stay largely out of the way and allow the market adjustment process to work and that government policies that interfere with this process will only lengthen and/or worsen downturns.[1] Furthermore, Austrians generally believe that long periods of disequilibrium in the labor market are caused by government actions preventing wage adjustment—there is always a wage rate at which the labor market will clear, and unemployment results from wages exceeding this level. Such views, which Rothbard expressed in his 1963 book *America's Great Depression*, were effectively taken into the realm of empirics in *Out of Work*. Vedder and Gallaway extended their analysis far beyond the 1929-1933 period that Rothbard studied, moving not just into the New Deal era (1933-1945) but across most of the twentieth century.

Vedder and Gallaway acknowledged that their methodology, which was based upon a simple ordinary least squares (OLS) model of wage rates, prices, and productivity, would be viewed as "unfashionable" by many. Mainstream economists, they noted, would likely view their work as "naively low tech" (Vedder and Gallaway 1993, 40). Furthermore, they anticipated that some Austrians would be inherently skeptical of *Out of Work* because of its reliance on regression analysis. "The approach used by us is criticized by one group of economists as being insufficiently empirical and by another group as being excessively empirical and quantitative" (Vedder and Gallaway 1993, 41). Nevertheless, *Out of Work* was met with many accolades and the book has been cited more than 250 times.

[1] Lawrence White (2008) emphasizes that Hayek's business cycle theory suggested that the total money stream, *MV*, should remain constant in order to minimize cyclical disruptions. Thus, Hayek's and other Austrian models suggest that the US Federal Reserve should have intervened to halt the simultaneous downturn in both *M* and *V* during the early years of the Great Depression. White (2008, 755), therefore, objects to the interpretation of Austrian theory during the Great Depression as "do nothing monetary policy".

The goal of this article is to see whether Vedder and Gallaway's "adjusted real wage" model can explain unemployment during the interwar era, using a monthly industry-level panel analysis. Economic historians of the Great Depression and New Deal have increasingly focused on industry-level analyses rather than relying exclusively on time-series macroeconomic data and have employed monthly data as opposed to annual. We obtain interwar data on monthly output, hourly earnings, hours worked, employment, and prices for nine industries and then restructure Vedder and Gallaway's time series analysis into various panel investigation methodologies such as fixed effects, panel cointegration, and panel vector autoregression (VAR). The results strongly confirm the Austrian hypothesis—changes in employment during the interwar era were associated with increases in the adjusted real wage paid to workers. This suggests, consistent with Vedder and Gallaway's Austrian model, that an important factor behind the length and depth of the Great Depression was the inability of wages to adjust to their equilibrium level.

Wage Rates and the Great Depression: How Mainstream is the Austrian View?

To Austrian or "Austrian-friendly" economists, the notion that unemployment during the Great Depression was, at its core, a reflection of wage rates being pushed above their equilibrium—or not allowed to fall back to equilibrium after being shocked—may sound obvious. But the neo-Keynesian framework is largely oriented toward finding ways that labor market equilibrium can be achieved without relying on wage rates to adjust, such as through aggregate demand management—effectively shifting the labor demand curve rightward until it intersects with labor supply to re-establish equilibrium at the -prevailing wage rate. Such views continue to dominate the policy landscape today as they were effectively at the heart of President George W. Bush's Economic Stimulus Act of 2008, President Barack Obama's American Recovery and Reinvestment Act of 2009, and the Coronavirus Aid, Relief, and Economic Security Act (CARES) of 2020. As Ludwig von Mises (1953) noted, "To discuss the [level] of wages is taboo for the 'progressives' … the [level] of wage rates has nothing to do with unemployment and must never be mentioned in connection with it" (quoted in Gallaway and Vedder 1987, 37).

Friedrich Hayek also disagreed strongly with the Keynesian orthodoxy of unemployment being a result of too little aggregate demand. Instead, Hayek believed that "The cause of unemployment … is a deviation from the equilibrium prices and wages which would establish themselves with a free market and stable money" (quoted in Vedder and Gallaway 1993, 18). Austrians explicitly reject the views held by underconsumptionists and high-wage advocates, which claim that depressions are caused by a lack of consumer spending power.

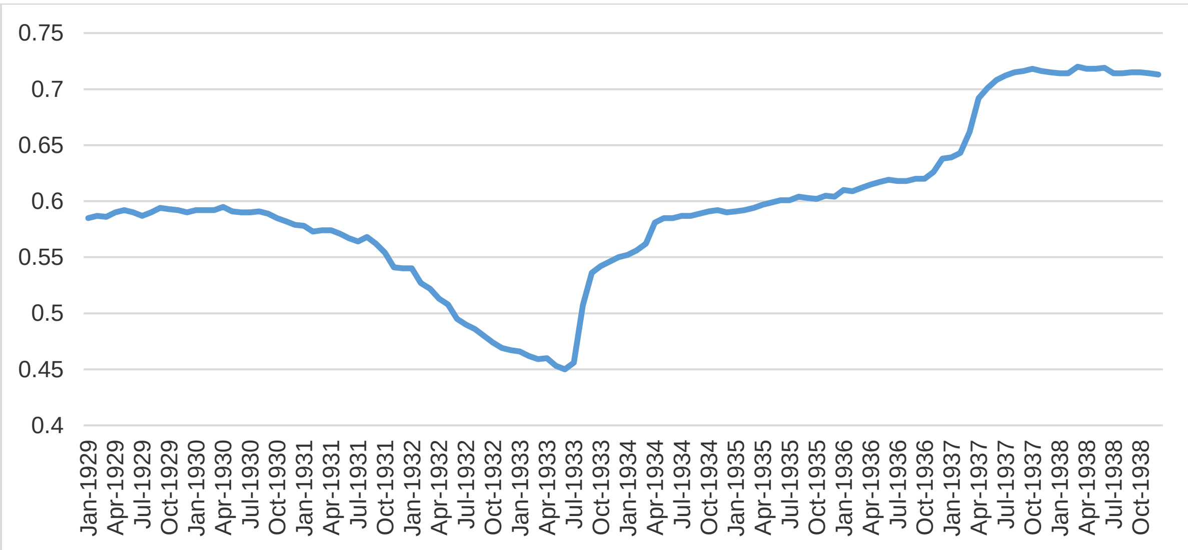
Vedder and Gallaway (1993) were neither the first nor the last economists to place some measure of blame for the Great Depression at the feet of policy makers' interventions in the labor market. The notion that labor market interventions caused or greatly exacerbated the Great Depression, while not universally accepted, has become a standard potential culprit. It regularly appears alongside other broad potential causes such as monetary factors (Milton Friedman and Anna J. Schwartz 1963), non-monetary financial factors (Ben Bernanke 1983), an autonomous decline in consumption and investment (Peter Temin 1976), issues related to the international gold standard (Barry Eichengreen 1992; Douglas Irwin 2012), and the stock market crash (Christina Romer 1990).

The high-wage polices of President Herbert Hoover, which are heavily cited by both Rothbard (1963) and Vedder and Gallaway (1993), are of particular importance in stopping the market adjustment process. A month after the stock market crash of 1929, Hoover hosted two conferences with business leaders. During the first, on November 21, 1929, Hoover met with two dozen industrial leaders and asked them to maintain nominal wage rates despite the sharp economic downturn. During the second conference, held on December 5, 1929, Hoover addressed over 400 business leaders in what was essentially a larger-scaled version of the

November meeting. Again, industries were asked to maintain wage rates at their current levels rather than engage in wage cuts as would normally occur during a downturn. Jonathan Rose (2010) offers some evidence that attendance by firms and industries at these conferences was associated with a longer duration before the first wage cuts were implemented—attendees typically maintained high nominal wage rates until late 1931 or early 1932 while firms and industries that did not attend Hoover's conferences generally cut wages earlier. Douglas MacKenzie (2010) likewise shows that industrial leaders who attended Hoover's wage conferences were more likely to maintain wages than otherwise and that these industries exhibited above-average employment losses as compared to those industries that did not attend the wage conferences.

As the general price level was falling precipitously during these years, the inflation-adjusted real wage rate rose sharply between 1929 and 1932. At the same time the unemployment rate rose dramatically. With regards to the effects of Hoover's high-wage policy, Lee Ohanian (2009) goes so far as to answer the title question of his article, "What—or Who—Started the Great Depression?", with a two-word answer—Herbert Hoover. Ohanian uses the results of his dynamic general equilibrium analysis to conclude that the Depression was largely caused by government policies that increased real wage rates above their competitive levels.

Government pressure to raise real wage rates did not stop with Hoover's defeat in November of 1932. President Franklin Roosevelt enacted a series of policies such as the National Industrial Recovery Act (NIRA) of 1933, the National Labor Relations Act (NLRA) of 1935 (ruled constitutional in April 1937), and the Fair Labor Standards Act of 1938, which put upward pressure on real wage rates. In the years since the publication of Vedder and Gallaway's book, Bernanke (1995), Bernanke and Kevin Carey (1996), Andrew Seltzer (1997), Jim Powell (2003), Harold Cole and Ohanian (2004), Jason Taylor (2011 and 2019), Scott Sumner (2015), and Taylor and Todd Neumann (2013 and 2016), among others, have offered empirical evidence that these New Deal labor polices increased wage rates and hampered economic recovery. Figure 1 shows monthly movements in average hourly earnings in the manufacturing sector between 1929 and 1938.



Source: "Average Hourly Earnings for 25 Manufacturing Industries" (NBER Macrohistory Database Series 0812).

Figure 1
Nominal Wage Movements, 1929 to 1938

Consistent with the narrative above, the average nominal wage in manufacturing was 59 cents at the start of the downturn in August 1929 and it remained near that level until the fall of 1931 before declining sharply. The wage jumped sharply in both the summer of 1933 and the spring of 1937 in response to the NIRA and the NLRA.

Of course, there are detractors to the notion that the high wage policies of Hoover and Roosevelt exacerbated the Depression. Gauti Eggertsson (2008) attributes the recovery of 1933 to 1937 to Roosevelt's policy actions—including the high-wage policies embedded in the NIRA—which brought higher inflation. Eggertsson (2012) employs a dynamic stochastic general equilibrium model with staggered price setting and concludes that while the NIRA's high-wage and cartelization policies would have been contractionary under normal economic conditions, such policies were expansionary due to the emergency economic conditions as they helped break the deflationary spiral.[2] Jordan Roulleau-Pasdeloup and Anastasia Zhutova (2015) employ a New Keynesian model that includes labor union behavior in the wage bargaining process. Plugging their estimates from a log-linear empirical model with Bayesian methods into their general equilibrium theoretical model, their counterfactual suggests that absent Hoover's high-wage push the American economy would have experienced a liquidity trap two years sooner than it did and they contend that this would have made the 1930s downturn even more severe. Jakob Madsen (2004) argues that while wage stickiness likely contributed to the 1930s downturn, price stickiness may have played an even larger role in the failure of markets to adjust to equilibrium. Bruce Kaufman (2012) explores the contemporary case made by J.M. Keynes and J.R. Commons that 1930s high-wage policy was necessary to fight income inequality, underconsumption, and price deflation. Finally, Ranjit Dighe and Elizabeth Schmitt (2010) contend that even though there was a high degree of wage stickiness during the entire interwar era, neither Hoover's wage conferences nor the NIRA were associated with any empirically discernible increase in wage stickiness.

Perhaps most importantly, in a review of *Out of Work*, J. Bradford De Long (1998) argues that Vedder and Gallaway's story that high adjusted real wages brought about economic downturns throughout the twentieth century contains an error in causality. De Long suggests that "real wages were high because unemployment was high—and that steps to reduce wage levels would have deepened, not alleviated the Great Depression" (De Long 1998, 60). In a response to such critiques, Vedder and Gallway published an "updated edition" of *Out of Work* in 1997, which included a detailed appendix whereby more advanced econometric techniques were employed to test their model using quarterly data between 1959 and 1996. Vedder and Gallaway (1997, 330) reported Granger causality tests, which suggested that unemployment was caused by changes in the adjusted real wage and not vice versa during the last four decades of the twentieth century.

The Adjusted Real Wage Model of Unemployment

Vedder and Gallaway (1993, 1997) proposed a simple empirical model of the labor market. Specifically, they examined the degree to which unemployment was negatively related to the "adjusted real wage rate"—that is the real hourly wage rate (nominal wage rate divided by the consumer price index) divided by productivity (output per hour of work). Note that if both productivity and the real wage rate rose four percent in a year, the adjusted real wage would be unchanged. Employment can certainly grow alongside rising real wage rates—in fact this is what a normal process of long-term economic growth suggests happens over time. As labor productivity increases, the demand for labor rises, and hence workers benefit as the equilibrium real wage rate increases—this is of course why wage rates are higher in the United

[2] Romer (1999) concludes that the NIRA wage and price provisions were a major cause of the inflation that occurred between 1933 and 1935 despite the economy being well below trend.

States today than they are in developing economies. While higher real wage rates, per se, do not cause unemployment, if the real wage rate exogenously rises four percent while productivity is unchanged, Vedder and Gallaway's model suggests that firms will cut back on labor, which is now more expensive when adjusted for productivity, and hence employment will fall.

The results of Vedder and Gallaway's (1993, 32-33) bivariate OLS regression for 90 years (1900 to 1989) of annual data suggests that a one percent rise in the adjusted real wage was associated with around a third of a percentage point rise in the national unemployment rate—their coefficient on the adjusted real wage is statistically significant at the 1 percent confidence interval. They perform some extensions by using the lagged adjusted real wage along with contemporaneous observations of the percentage changes in the nominal wage, the consumer price index, and output per hour. This analysis again suggests that the unemployment rate rises when the contemporaneous nominal wage rate rises and when the lagged adjusted real wage rises, ceteris paribus. Armed with evidence of this empirical relationship, Vedder and Gallaway then go through each major era of US history during the twentieth century and show that years in which unemployment rose were generally also years in which the adjusted real wage rose disproportionally—and, importantly, they show that these increases were typically the direct result of government policies which artificially raised nominal wages, or otherwise prevented them from falling, when prices or productivity fell.

In this article, we test Vedder and Gallaway's model empirically by using an industry-level panel of monthly data during the interwar era United States. Unemployment data are not available at the industry level, nor would such a measure be economically meaningful. So, our version of Vedder and Gallaway's model examines whether changes in industry *employment* are related to changes in the adjusted real wage in that industry. While Vedder and Gallaway showed a positive relationship between the adjusted real wage and unemployment, for our results to be consistent with their analysis we would need to demonstrate a negative relationship between an industry's adjusted real wage and its level of employment. To normalize all industry data we first converted all series to indices whereby August 1929 is equal to 100. Then the adjusted real wage index, hereafter ARWI, is assembled for each industry in the following way:

ARWI = (Nominal Wage/Price Level)/(Output/Hours Worked)

For "hours worked", data are available at the industry level for both the average hourly workweek and number of people employed on payrolls each month. Thus, aggregate hours worked per month can be calculated by multiplying these two measures. Rearranging terms we get:

ARWI = (Nominal Wage*Hours Worked)/(Output*Price Level)

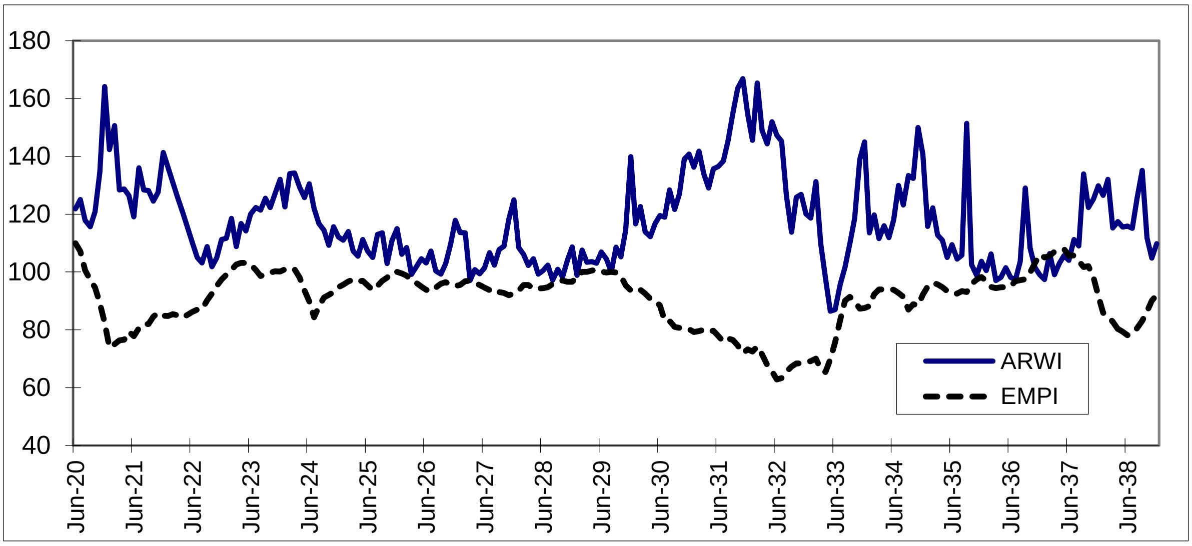
For the following nine industries, Wool Goods, Automobile Manufacturing, Steel Manufacturing, Rubber Manufacturing, Leather Manufacturing, Chemical Manufacturing, Rayon Yarn, Paper and Pulp, and Meatpacking, monthly data are reported in the NBER Macrohistory Database for the period June 1920 through December 1938, for all five of the following variables—employment (number of workers on payroll), output, hourly wage rate (average hourly earnings), prices, and average hours worked per week.[3] Thus we can create the ARWI for each industry and test its relationship with employment.

[3] Our panel is slightly unbalanced as data from the leather manufacturing industry begin in January 1921. Furthermore, several industries are missing observations for wages and hours from January through June of 1922.

One potential issue is that there is a very high degree of seasonality in the ARWI index for the automobiles industry. Every year, automobile output declines sharply in November and December, while employment, average workweek, and nominal wage rates do not move systematically. As output is in the denominator of ARWI, we consistently see a large positive spike in this index in the automobile industry during these two months—this jump is not trivial as it generally ranges between 50 and 150 percent. In short, the automobile industry adjusted real wage rises in November and December not because of a movement in wages, but because of a sharp decline in labor productivity during these two months which is driven by declining output. We do not wish to seasonally adjust our data as we think it important evaluate the relationship between employment and ARWI using the raw data. Given this issue, we run all our analyses both with and without the automobile industry to see whether its inclusion affects the results. Fortunately, the statistical significance of the main results is typically no different whether we go with all nine industries for which the data are available, or just eight industries after dropping automobiles. We will report the analysis with eight industries and we will also discuss any changes that occur when automobiles are also included in the sample.

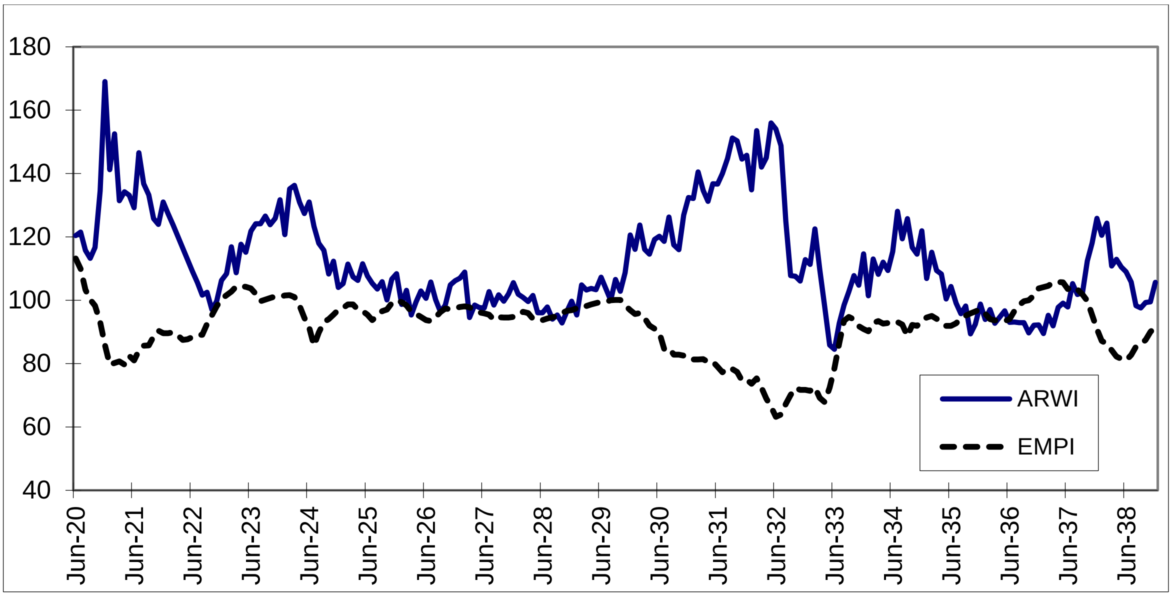
Movements in the Adjusted Real Wage Index and Employment 1920-1938

Figure 2 shows the monthly movement in the ARWI, averaged for our nine industries, and an index of industry employment, likewise averaged, from June 1920 through December 1938. Figure 3 shows the same but for eight industries with automobiles excluded. Note the main difference—in Figure 2, the ARWI has a regular upward spike during the last two months of the year which is driven entirely by the decline in automobile output, while Figure 3 shows no such seasonal spike. Still, both these figures capture much of the essence of Vedder and Gallaway's discussion of the 1920s and 1930s. For this discussion, we will focus on the series shown in Figure 3 with the automobile industry excluded.



Source: Authors' calculations from NBER Macrohistory Database as described in text.

Figure 2
Movements in the Adjusted Real Wage (ARWI) and Employment (EMPI) Indices in a Nine Industry Panel



Source: Authors' calculations from NBER Macrohistory Database as described in text.

Figure 3
Movements in the Adjusted Real Wage (ARWI) and Employment (EMPI) Indices in Eight Industries (Automobile Industry Omitted)

As Vedder and Gallaway noted in their discussion of the sharp postwar recession, the ARWI rose sharply in late 1920 and early 1921, while employment fell almost as sharply—the national unemployment rate reached 11.7 percent in 1921. However, the government did not intervene heavily in labor markets and hence Figure 3 shows that the adjusted real wage fell 42 percent during 1921 and 1922. This is consistent with the textbook discussion of the "self-correcting mechanism" taught in economics principles classes—when unemployment is high, wage rates fall thus increasing the short run aggregate supply curve until the economy is back to full employment. As ARWI fell, employment rose 25 percent and the recession ended.

Again, consistent with the story told by Vedder and Gallaway, between the fall of 1929 and the summer of 1932, the adjusted real wage rose 54 percent in our industries, at least in part because of President Hoover's labor market interventions to prop up nominal wage rates despite a sharp decline in both the price level and output. At the same time, employment plummeted, falling 36 percent during these three years. Unlike what happened during the 1921 downturn, the self-corrective mechanism of the labor market was not allowed to work.

A sharp recovery in employment began in the spring of 1933—employment rose 30 percent during the first half of the year. Taylor and Neumann (2016), extending Temin and Barrie Wigmore (1990), attribute this surge in recovery to rising inflation expectations, gains in business and consumer confidence, and dollar devaluation. The ARWI experienced a sharp decline, falling 31 percent between February and June 1933—most of this decline was caused by a sharp increase in output during the spring of 1933. As output (a major component of productivity) is in the denominator of ARWI, an increase in output causes the adjusted real wage to fall, ceteris paribus. However, the promising recovery in employment ended when the National Industrial Recovery Act's (NIRA) wage-increasing policies were instituted—the ARWI jumped 36 percent between July and December 1933 in our eight industries. The employment index barely budged over the next two years despite massive expansionary fiscal policy in

1933 and 1934.[4] As the NIRA experienced compliance problems (see Taylor 2019), and was eventually ruled unconstitutional in May of 1935, the adjusted real wage experienced a steady decline, falling 31 percent between late 1934 and mid-1937. In a mirror image to this, employment rose steadily in the two years after the NIRA's demise.

Vedder and Gallaway also highlight the role played by the Supreme Court's spring 1937 ruling in favor of the National Labor Relations Act of 1935, which increased power for organized labor, in contributing to the recession of 1937-1938. Indeed, Figure 2 suggests that ARWI rose over 25 percent between June 1937 and February 1938 while employment again shows a mirror image movement, falling around 20 percent. In short both Figures 2 and 3 are very much in line with the narrative and empirical findings presented in Vedder and Gallaway (1993) for the interwar era.

Empirical Methodology

We begin by employing the LLC (Levin and Lin 1993) and IPS (Kung So Im, M. Hashem Pesaran, and Yongcheol Shin 2003) tests to examine the stationarity of all the variables used in our empirical analysis. The results of these tests, shown in Table A1 of the Appendix, suggest that all the variables are stationary in the common or individual unit root process.

It is common for panel studies to employ industry fixed effects in an OLS framework. We began our analysis by using such a framework and indeed there is empirical support for the notion that movement in the ARWI was negatively (and significantly) associated with movements in employment.[5] Still, as De Long (1998) notes, there is a potential endogeneity problem in regressing wage rates on employment in an OLS framework. After all, economic theory suggests that times of rapidly growing employment, when labor becomes scarcer, place upward pressure on market determined wage rates—i.e., positive changes in employment can cause positive changes in wage rates. At the same time, theory suggests that exogenous increases in wage rates can bring about lower employment by pushing the price of labor above its market-clearing level and creating a surplus of labor—i.e. unemployment. Thus, theoretically speaking, higher employment may cause higher wage rates, while at the same time higher wage rates may cause lower employment.

To further investigate this, as did Vedder and Gallaway (1997) using quarterly data from 1959 to 1996, we ran a panel Granger causality test between ARWI and our employment index (EMPI) as well as between the growth rate in these two variables (GRARW and GREMP) for our time period of 1920 to 1938. The results, reported in Table 1 below, suggest that ARWI and EMPI Granger cause each other in both levels and growth rates, although the finding that employment causes wages is only marginally significant in the levels analysis.[6] We employ

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[4] Unlike in other eras shown in the figures, employment did not decline in the face of sharp increases in ARWI in the summer and fall of 1933. A major reason for this is that the NIRA included sharp reductions in workweeks in hopes of promoting "work-sharing". Taylor's (2011) empirical analysis suggests that total hours worked did decline after the NIRA was enacted, but the work-sharing aspects of the NIRA increased the number of workers employed, ceteris paribus.

[5] The coefficient on the log of ARWI from a bivariate fixed effects panel regression whereby the log of the employment index as the dependent variable is -0.128 with a t-statistic of -7.77 in nine industries. The coefficient of ARWI is -0.124 and a t-statistic is -8.13 without the automobile industry. Other regressions whereby ARWI is decomposed into its parts such as real wage rates, hours, and output, likewise consistently show that the coefficient on the real wage rate is negative and statistically significant, consistent with Vedder and Gallaway's empirical findings.

[6] The results reported in Table 1 are for the sample of eight industries, which excludes automobiles because of the seasonal output issue discussed above. In unreported tests that include all nine industries, the results are largely unchanged—specifically, the results suggest that the variables Granger cause each other.

two separate approaches to account for this endogeneity between wage rates and employment.

Table 1
Panel Granger Causality Tests

Null Hypothesis	Obs	F-statistic	P-value
ARWI does not Granger Cause EMPI	1587	39.439	0.000
EMPI does not Granger Cause ARWI		2.482	0.084
GRARW does not Granger Cause GREMP	1574	54.683	0.000
GREMP does not Granger Cause GRARW		4.223	0.015

Note: The lag length selection is based on the Akaike information criterion. The sample does not include the automobile industry. ARWI is the adjusted real wage rate index and EMPI is the employment index. GRARW and GREMP represent the growth rates of these two variables.

Pedroni Cointegration Analysis

Panel cointegration is a technique that examines the correlation between non-stationary time series variables. If two or more series are themselves non-stationary, but a linear combination of them is stationary, the series are said to be cointegrated. Cointegration models can be employed to test the equilibrium relationships among such variables (Robert Engle and Clive Granger 1987). We carry out several panel cointegration tests specified by Peter Pedroni (2004) to test for cointegration in both equations 1 and 2, which are discussed below. The variance (v) statistics, rho statistics, t-statistics, and augmented Dickey-Fuller (adf) statistics are reported in Table A2 and Table A3 in the Appendix. The results suggest that the variables in these two equations do indeed have cointegrating relationships.

We then employ a Pedroni Dynamic Panel OLS (DPOLS) regression to conduct the panel cointegration analysis. Importantly for our task here, the DPOLS estimator also has an additional advantage of dealing with endogeneity in the model, as augmentation with the lead and lagged differences of the regressor suppress the endogenous feedback. To be specific, the primary strategy of DPOLS is to adjust for the second order bias that arises from the dynamic feedback due to the endogeneity of the regressors by using dynamics of the regressors as an internal instrument. Thus, the DPOLS estimation method provides a robust correction of endogeneity in the explanatory variables (see Pedroni 2019).

The panel cointegration model is listed as follows:

$$EMPI_{it} = \beta_0 + \beta_1 ARWI_{it} + \sum_{k=-t_1}^{t_2} \gamma_{1k} \Delta ARWI_{it-k} + u_{it} \tag{1}$$

where $ARWI_{it}$ is the explanatory variable, t_2 is the lead and t_1 is the lag. $\Delta ARWI_{it-k}$ are the differentials and u_{it} are the normally distributed residuals. In this case, we set $t_1 = t_2 = 2$ in line with the Akaike information criterion. In order to make the regression coefficients easier to interpret and to meet the assumptions of the inferential statistics, we log transform all the raw indices before performing our regression analysis.

The β coefficients and the associated t-statistics for each industry are then averaged over the entire panel by using Pedroni's group-mean method. In Table 2 we report these regression coefficients separately for each industry as well as the group-mean average, which is the key coefficient of interest. In Panel A, which reports regressions on the levels of our variables, the coefficient on ARWI is negative in six of the nine industries and is positive in the remaining three. The overall group-mean coefficient of ARWI in nine industries is -0.166, and is statistically significant at the 1 percent confidence level. This suggests that a 10 percent increase in ARWI brings about a 1.66 percent decrease in employment. We also report the group-mean coefficient of ARWI in eight industries, dropping the automobile industry. This coefficient is -0.169 and again it is significant at the 1 percent confidence level. In Panel B, which reports the regressions employing growth rates of our variables, the coefficient on ARWI is negative in seven of the nine industries. Most importantly, the coefficient on ARWI for the overall panel is negative and statistically significant in both specifications. The group-mean coefficient is -0.111 in the overall nine industry sample implying that a 10 percent increase in the growth rate of ARWI is associated with a 1.1 percent decrease in the growth rate of EMPI. The overall group-mean coefficient is -0.092 in the eight-industry sample—again these results suggest that movements in the adjusted real wage are negatively associated with movements in employment, consistent with Vedder and Gallaway's analysis.

Table 2

Pedroni DPOLS Cointegration Panel Results

	Panel A: Level	Panel B: Growth Rate
Wool	-0.570^{***}	-0.430^{***}
	(-9.066)	(-6.737)
Automobiles	-0.003	-0.239^{***}
	(-0.017)	(-3.140)
Steel Manufacturing	-1.073^{***}	-0.291^{**}
	(-3.943)	(-2.463)
Rubber Manufacturing	-0.177^{***}	0.077
	(-3.911)	(1.427)
Leather Manufacturing	-0.796^{***}	-0.434^{***}
	(-7.970)	(-3.179)
Chemical Manufacturing	0.193	0.678^{***}
	(1.042)	(4.761)
Silk Rayon	0.154^{***}	-0.021
	(2.912)	(-0.223)
Paper and Pulp	-0.023	-0.097
	(-0.195)	(-1.134)
Meatpacking	0.162^{*}	-0.028
	(1.881)	(-0.376)
Overall (For 9 Industries)	-0.166^{***}	-0.111^{***}
	(-6.422)	(-3.688)
Overall (Excluding Automobile Industry)	-0.169^{***}	-0.092^{***}
	(-6.806)	(-2.801)

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. We use the coefficient precision to weigh each individual's coefficient estimates to get overall group-mean coefficients.

Next, we run panel cointegration models whereby we decompose ARWI into its component parts. Specifically, we examine how the indices for the real wage rate (RWI), output (QI), and average hourly workweek (HI) affect employment (EMPI) in our industry panel. The regression model is specified in equation (2) below. We again run this using both levels and growth rates.

$$EMPI_{it} = \beta_0 + \beta_1 RW_{it} + \sum_{k=-t_1}^{t_2} \gamma_{1k} \Delta RW_{it-k} + \beta_2 QI_{it} + \sum_{k=-t_1}^{t_2} \gamma_{2k} \Delta QI_{it-k} + \beta_3 HI_{it} + \sum_{k=-t_1}^{t_2} \gamma_{3k} \Delta HI_{it-k} + u_{it} \quad (2)$$

Table 3 reports these regression coefficients separately for each industry as well as the group-mean average, which is the key coefficient of interest. With respect to the levels regressions, in seven of the nine industries the real wage index is negatively associated with the employment index, consistent with Vedder and Gallaway's model. Most importantly, the Pedroni group-mean of these nine industries, reported in the bottom row of results, suggests that higher real wage rates are associated with lower employment and this result is statistically significant at the 1 percent confidence level. The overall group-average coefficient of nine industries is -0.302, implying that a 10 percent increase in the real wage rate would bring a decline in employment of 3 percent. The coefficient for eight industries (dropping the automobile industry) is similar at -0.312.

In the model with growth rates, the estimates are less precise. While the group-mean for the nine industries is negative, the coefficient is not statistically significant (the t-statistic on that coefficient, which is not reported in the interest of space, is -0.710). The overall group-average coefficient for the eight-industry sample is -0.116, but again is not significant (t-statistic is -1.405). Incidentally, the output index performs as expected—higher output is consistently associated with higher employment. The hours index, when examined in levels, is negative in seven of the nine industries, and is negative and statistically significant in the overall group average. This is consistent with the "work-sharing" model which suggests that decreases in workweeks could bring increases in the number of people employed. However, the result does not hold in the analysis of growth rates as the overall coefficient on hours becomes positive, which would be inconsistent with the work-sharing model.

Discussion of Industry Heterogeneity of Results from Tables 2 and 3

While the results from Table 2 suggest that, on average, there existed a negative relationship between an industry's employment and its adjusted real wage rate, in some industries the relationship is reported as positive. For example, in the Chemical Manufacturing industry the coefficient on the ARWI is positive for both the levels and growth rate panels—the industry is unique in this respect. In Table 3, likewise, this industry is a strong outlier as both the real wage and hours worked indices are positively related to employment in both the level and growth rate panels. In most other industries, and in the overall average, this relationship is negative.

This raises the question—why was the Chemical Manufacturing industry seemingly different than others with respect to the relationship between wages, hours, and employment in the interwar era?[7] Taylor (2019) focuses heavily on the heterogeneity of the NIRA codes of fair competition and how they differentially affected different industries. In fact, the Chemical Manufacturing Code of Fair Competition, was not passed until February 10, 1934, making it the last of the nine industries in the sample to have its NIRA code instituted.[8] Furthermore, at

[7] We duplicated the Granger causality tests that were reported for the whole panel in Table 1 for just the Chemical Manufacturing industry and found that employment and the adjusted real wage Granger cause each other in this industry, similar to the results for the panel as a whole.

[8] By date of passage, the median code of our nine industries was the leather industry whose code was passed on September 7, 1933.

Table 3
Pedroni DPOLS Panel Cointegration Results with Decomposed ARWI

		Panel A: Level	Panel B: Growth Rate
Wool	Real Wage Index	-0.332***	-0.185**
	Output Index	0.524***	0.450***
	Hours Index	-0.410***	-0.178
Automobiles	Real Wage Index	0.315**	0.839*
	Output Index	0.513***	0.263***
	Hours Index	-0.095	0.023
Steel Manufacturing	Real Wage Index	-0.668***	0.075
	Output Index	0.703***	0.363***
	Hours Index	-0.622***	-0.211
Rubber Manufacturing	Real Wage Index	-0.160***	-0.044
	Output Index	0.276**	0.070
	Hours Index	0.322***	0.597***
Leather Manufacturing	Real Wage Index	-0.224***	-0.214**
	Output Index	0.639***	0.496***
	Hours Index	-0.108	0.091
Chemical Manufacturing	Real Wage Index	0.423**	0.779***
	Output Index	0.301***	0.765***
	Hours Index	0.443**	0.490*
Silk Rayon	Real Wage Index	-0.445***	0.035
	Output Index	0.236***	0.110
	Hours Index	-0.225	1.011***
Paper and Pulp	Real Wage Index	-0.301***	-0.127
	Output Index	0.511***	0.446***
	Hours Index	-0.002	-0.151
Meatpacking	Real Wage Index	-0.190**	-0.064
	Output Index	0.338*	0.596***
	Hours Index	-0.525***	-0.584***
Overall (For 9 Industries)	Real Wage Index	-0.302***	-0.118
	Output Index	0.447***	0.351***
	Hours Index	-0.196***	0.101
Overall (Excluding Automobile Industry)	Real Wage Index	-0.312***	-0.116
	Output Index	0.431***	0.374***
	Hours Index	-0.187***	0.075**

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The t-statistics are not reported in the interest of space. We use the coefficient precision to weigh each individual's coefficient estimates to get overall group-mean coefficients. The Real Wage Index is the industry's monthly average hourly earnings (indexed where August 1929 =100) divided by an index (August 1929 = 100) of prices for that industry. The Output Index is likewise an index (August 1929 = 100) of each industry's production. The Hours Index is created by multiplying an index for average hours worked per week by an index for number of employees in the industry and then indexing that product to where August 1929 =100.

only 10 pages long, Taylor (2019, 97) shows that the chemical industry code was among the shortest and simplest of the NIRA codes. For comparison, the paper industry code was 60 pages, the rubber industry code 50 pages, and the steel code was 38 pages.

In the Roosevelt Administration's published preface to the chemical industry code, the industry's uniqueness is explicitly highlighted. "Carefully trained employees with a well-developed sense of responsibility are … the rule in most phases of the industry. As a consequence, it is an industry which, as a whole, has been fair to its employees and practically free from the accusations of trouble of others" (US National Recovery Administration 1934, Volume 6, 394). By "trouble" the administration generally meant wage and price cutting and the institution of long hours. The code preface further noted that wages in the chemical industry were relatively high and had also experienced a far smaller decline since the Depression began in 1929 than most other industries. Given all this, it is not too surprising that the Chemical Manufacturing industry is the clear statistical outlier in our analysis of the relationships between labor market variables in the interwar era. Still, a much deeper analysis of the industry would be necessary to better understand why. For example, the demand for chemical products tends to be more price inelastic and the output produced is generally more homogenous than that of most other industries and perhaps some factor like this is driving the differential result. The notion of industry heterogeneity is largely consistent with Austrian thinking and contributes to why Austrians are generally skeptical of macroeconomic policies (or empirical analyses) that treat all industries with the same blunt instrument.

Panel VAR Analysis

An alternative way to examine the relationship between two variables that may be determined endogenously is to use a panel vector autoregression analysis (VAR) whereby each variable has an equation explaining its evolution based on its own lagged values, the lagged values of the other variables in the model, and an error term. As is common in VAR analyses, we detrend the variables with a Hodrick-Prescott filter. According to the selection order criteria**,** three lags are optimal. As our panel VAR contains two variables, ARWI and EMPI, it is estimated simultaneously and shown by equations 3 and 4 below where k = 3.[9] For this analysis we again take the log of all variables.

$$EMPI_{it} = \sum_{j-1}^{k} \alpha_j^{e,1} EMPI_{it-j} + \sum_{j-1}^{k} \alpha_j^{e,2} ARWI_{it-j} + \alpha_0^e + \varepsilon_{it}^e \quad (3)$$

$$ARWI_{it} = \sum_{j-1}^{k} \alpha_j^{a,1} ARWI_{it-j} + \sum_{j-1}^{k} \alpha_j^{a,2} EMPI_{it-j} + \alpha_0^a + \varepsilon_{it}^a \quad (4)$$

The impulse-response functions from the panel VAR model are shown in Figure 4. Panel A shows the result when we use log levels while Panel B shows the results when we use growth rates of our indices. These functions illustrate the dynamic effects that a shock in one variable has on the other.

The impulse-response function between ARWI and EMPI, in the upper right corner of each panel, is of greatest interest. We begin our discussion with Panel A (log levels). Our results suggest that a shock to ARWI has a sharp negative impact on employment which deepens until around the sixth month and then begins to dissipate. Still, the negative impact on employment remains statistically significant until around month 14. This suggests that labor markets were generally slow to adjust to exogenous wage shocks during the interwar era.

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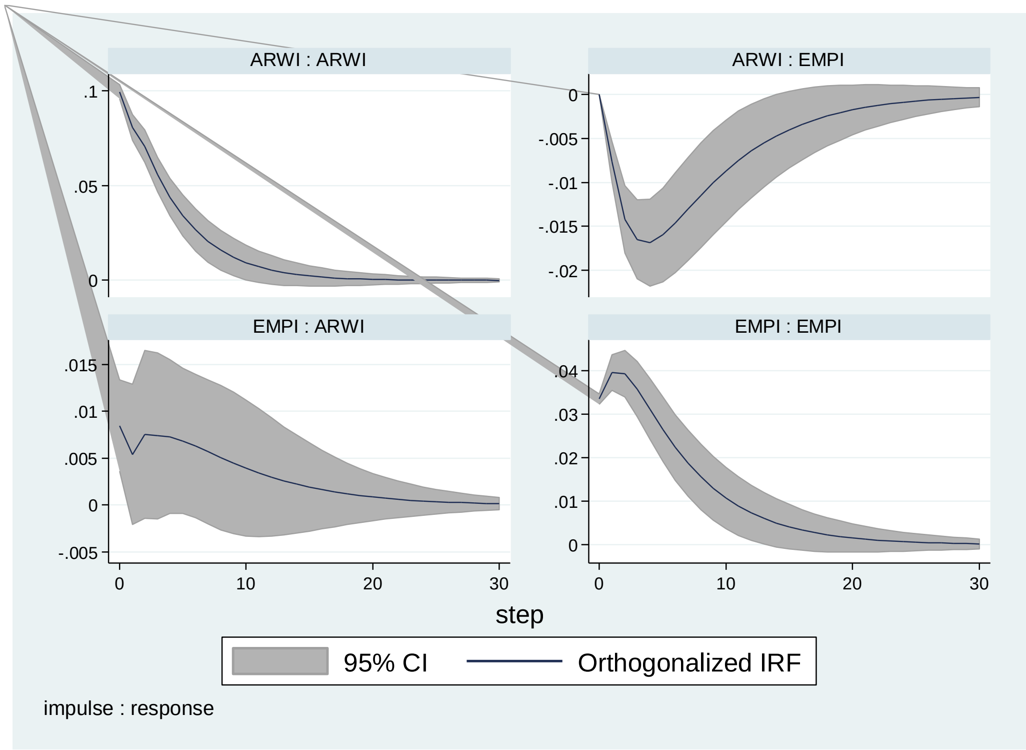
[9] For the selection order criteria, we employed the overall coefficient of determination, which captures the proportion of variation explained by the panel VAR model. The results show that three lags are optimal.

Panel A: Index Log Levels



Panel B: Index Growth Rates

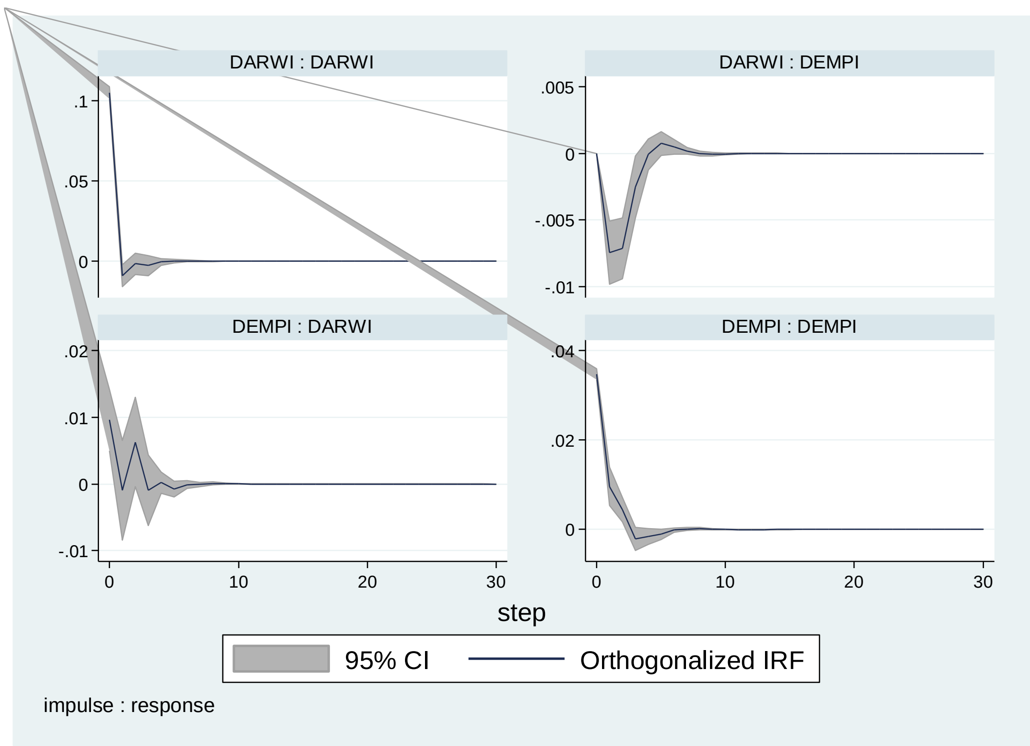


Figure 4

Impulse Response Functions for the Adjusted Real Wage Index (ARWI) and the Employment Index (EMPI)

Note: The sample is for eight industries and does not include the automobile industry. However, the results are not significantly different when the automobile industry is included.

In terms of magnitude, the impulse-response function analysis suggests that a one standard deviation shock in the ARWI decreases EMPI by 0.017, whereby the maximum effect occurs around the fourth month after the shock. These effects converge to zero by around the 13th month. With respect to how a shock to employment affects the adjusted real wage (lower left corner of the panel), a one standard deviation shock to EMPI increases ARWI slightly, but persistently, as the shock diminishes to zero around the 13th month. The largest effect is 0.008 in the first month.

Next, we will discuss Panel B whereby we employ impulse-response functions to analyze the shocks between the growth rate of EMPI and the growth rate of ARWI. The upper right corner of Panel B suggests that a one standard deviation shock in the growth rate of ARWI decreases the growth rate EMPI by 0.007 at the highest point in the second month. This shock converges relatively quickly and is gone by the 10th month. Furthermore, a one standard deviation shock in the growth rate of EMPI on the growth rate ARWI, shown in the lower left corner of panel B, also decreases very quickly, diminishing to zero by the ninth month. The largest effect is 0.01 in the first month.

These results should help alleviate the concerns raised by De Long (1998) that Vedder and Gallaway's findings were driven by a causality that ran in the opposite direction of those postulated—namely that high unemployment caused higher wages. The results of our Granger causality tests suggest that De Long's worry about the potential danger of reverse causality has merit—it appears that causality did indeed run in both directions in our industry sample during the 1920s and 1930s. Still, the results of both the Pedroni Dynamic Panel and, even more so the panel VAR analysis, which can overcome endogeneity problems, suggest that exogenous shocks to the adjusted real wage brought about significant declines in employment, consistent with Vedder and Gallaway's findings in *Out of Work*.

Conclusion

Richard Vedder and Lowell Gallaway's 1993 book, *Out of Work: Unemployment and Government in Twentieth Century America,* employs a simple empirical model which suggests that the rate of unemployment in the twentieth-century United States can be largely explained by movements in what the authors call the "adjusted real wage"—i.e., the inflation-adjusted hourly wage rate divided by labor productivity (output per labor hour). Eras in which unemployment rose were generally those in which the adjusted real wage rose. A major focus of Vedder and Gallaway's book is explaining the role that high wages played in propagating the Great Depression of the 1930s. Both Presidents Hoover and Roosevelt implemented a series of wage-increasing policies that hindered the ability of the labor market to adjust to macroeconomic shocks. Vedder and Gallaway contend that rather than being a failure of markets, the Great Depression was largely a failure of government labor policy.

The notion that wage interventions contributed to the Depression was expressed three decades earlier by the prominent Austrian economist Rothbard (1963), although Rothbard's analysis was limited to the Hoover Administration (it ends when Roosevelt assumes office in March 1933). At Rothbard's strong urging, Vedder and Gallaway explicitly called their adjusted real wage analysis an "Austrian" model of unemployment and published a preliminary version of their main findings in an article in the seminal first volume of *The Review of Austrian Economics*. Indeed, their views are consistent with those of Austrian heavyweights such as von Mises and Hayek who likewise argued that economic downturns such as the Great Depression are often exacerbated by misguided labor policy which does not allow wage rates to adjust to equilibrium.

Vedder and Gallway worried that hard-core Austrians might reject *Out of Work* because of its use of econometric analysis, of which Austrians are often skeptical. At the same time, they anticipated that their analysis would be criticized or rejected by mainstream economists as being far too low-tech. One of the potential empirical criticisms of Vedder and Gallaway's empirical model is that wages and employment may be considered endogenous. Changes in wage rates can influence employment, but at the same time changes in employment can influence wage rates. This was a major part of De Long's (1988) critique of their findings and was a major impetus behind Vedder and Gallaway's updated 1997 version of their book in which they examined their model using quarterly data from 1959 to 1996. This article attempts to test Vedder and Gallaway's adjusted real wage model with a focus on the interwar era using additional empirical techniques that explicitly allow for potential endogeneity. Additionally, as the trend in Depression-era research from the last two decades is increasing use of industry panel analysis in lieu of time-series regressions, we use a nine-industry panel employing monthly data during the interwar era.

In terms of methodology, we first use a Pedroni Dynamic Panel OLS regression to conduct a panel cointegration analysis. Our results suggest, consistent with Vedder and Gallaway's thesis, that movements in the adjusted real wage rate were negatively associated with movements in employment. This result also holds when we break the adjusted real wage into its component parts—i.e., we find that higher real wage rates bring lower employment while holding output and hourly workweek constant. Second, we employ a panel VAR analysis. Again, as is consistent with Vedder and Gallaway's argument, we find that shocks to the adjusted real wage rate caused negative movements in employment. Impulse-response functions suggest that a positive shock to the adjusted real wage rate causes an immediate and sustained decline in employment—this decline peaks around 6 months after the shock occurs and it persists for around 14 months before becoming statistically zero.

The results of our various panel analyses are highly consistent with the findings of Vedder and Gallaway's annual time-series model of the labor market and with the account of the Great Depression expressed by Rothbard (1963). During the interwar era, high-wage policies appear to have exacerbated the unemployment problem and to have both lengthened and deepened the Great Depression. Indeed, this notion has been widely embraced in the economic history literature. While not all scholars exploring the causes of the Depression agree, the notion that policy-induced wage increases exacerbated the Depression is regularly listed alongside other potential culprits such as monetary decline, declines in autonomous consumption and investment, and issues related to the international Gold Standard. This is a clear example of where Austrian thinking has entered into mainstream economic history. Furthermore, empirical evidence consistent with this notion has been shown via a variety of different methodologies including those now employed in this article.

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Appendix

Table A1

Results for Panel Unit Root Test

	ARWI	EMPI	RWI	QI	HI
Panel A: Level					
LLC test	-3.777***	-1.899*	-2.657***	-1.220	-2.969***
IPS test	-4.286***	-5.742***	-1.651*	-3.313***	-2.145**
Panel B: Growth Rate					
LLC test	-27.051***	-35.981***	-38.729***	-10.252***	-33.608***
IPS test	-28.679***	-37.668***	-35.562***	-18.193***	-35.320***

Note: Levin-Lin-Chu (LLC) test assumes common unit root process and Im, Pesaran and Shin (IPS) test assumes individual unit root process. These two tests assume asymptotic normality. The values in the table are the corresponding test statistics for the different tests. Automatic lag length selection is based on SIC. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table A2

Panel Cointegration Test for Equation 1

Test statistics	Panel A: Level		Panel B: Growth rate	
	Panel	Group-mean	Panel	Group-mean
v	5.364***		23.830***	
rho	-5.867***	-5.861***	-64.510***	-58.150***
t	-3.943***	-4.305***	-25.230***	-28.680***
adf	-1.746*	-2.477**	-16.810***	-15.890***

Note: All test statistics are distributed N(0,1), under a null of no cointegration, and diverge to negative infinity (save for panel v). The values in the table are the corresponding test statistics for the different tests. The panel statistics pools the statistics along the within-dimension. Group-mean statistics averages the results of individual test statistics along the between-dimension. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table A3

Panel Cointegration Test for Equation 2

Test statistics	Panel A: Level		Panel B: Growth rate	
	Panel	Group-mean	Panel	Group-mean
v	6.514***		13.940***	
rho	-7.700***	-9.443***	-47.050***	-49.730***
t	-6.222***	-7.335***	-28.180***	-33.950***
adf	-2.392**	-3.178***	-14.400***	-13.450***

Note: as Table A2.