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A TIME SERIES ANALYSIS OF WAGES IN DEREGULATED INDUSTRIES: A STUDY OF MOTOR CARRIAGE AND RAIL

KRISTEN MONACO*

California State University Long Beach

TAGGERT J. BROOKS

University of Wisconsin – La Crosse

JOHN BITZAN

North Dakota State University

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Using time series techniques, we contrast the impact of deregulation in trucking and rail labor markets. During regulation both labor markets were characterized by wages considerably higher than manufacturing wages. In fact, trucking and rail wages had a stable, deterministic relationship prior to deregulation. After deregulation, however, the mean trucking wages fell considerably, approaching manufacturing wages, while rail wages remained relatively constant. We also find that deregulation's negative impact on trucking wages was non-discrete and occurred primarily between 1980 and 1984.

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I. Introduction

Typically, studies of wages in the trucking and rail industries focus on the impact of deregulation on labor markets. There is little doubt that deregulation had a major impact on the labor markets in both industries, especially in trucking where wages fell precipitously in the late 1970s and early 1980s. However, there is also reason to believe that other factors were affecting these labor markets concurrent

* Kristen Monaco (corresponding author): Department of Economics, California State University Long Beach, 1250 Bellflower Blvd., Long Beach, CA 90840 (kmonaco@csulb.edu). Taggert Brooks: Dept. of Economics, University of Wisconsin – La Crosse, 4030 North Hall, LaCrosse, WI (brooks.tagg@uwlax.edu). John Bitzan: Department of Management, Marketing, and Finance, Putnam Hall, North Dakota State University, Fargo, ND 58105 (john.bitzan@ndsu.nodak.edu).

with deregulation. Examples include declining union power, skill-biased technological change, falling real wages due to inflation and recession, rising interest rates, and a real appreciation of the dollar leading to decreased domestic demand for labor.

Though motor carriage and rail were deregulated at approximately the same time, the effect on their labor markets differs substantially. Trucking wages plummeted significantly in the post-deregulation period, while rail wages were not significantly affected. Employment changed significantly in both, though the changes were in opposite directions. In the trucking industry, many drivers entered as competition increased, while the rail industry experienced large reductions in employment due to work rule changes and the abandonment of unprofitable routes.

Many studies of wages in rail and trucking have relied upon repeated cross-sectional data, comparing labor market conditions in the pre-deregulation period to the post-deregulation period, incorporating a dummy variable to measure the impact of deregulation.¹ These analyses are limited in two ways. First, the inclusion of few macroeconomic and time controls in these studies fails to account for the downward pressure on wages that was occurring economy-wide in the late 1970s and early 1980s at the same time as regulatory changes were enacted in both industries. The failure to account for the recession and other factors is likely to result in a bias that overstates any negative impact on wages resulting from deregulation. Second, when using a dummy variable to capture the effects of deregulation, there is an inherent assumption that deregulation occurs at a discrete point in time. However, railroad and trucking deregulation were not discrete events. Rather, administrative deregulation was actually a process that began in the 1970s and culminated with the passage of the Motor Carrier Act and the Staggers Rail Act in 1980.² Since the industries likely experienced deregulation in a non-discrete way and since both industries were deregulated at a time when real wages were declining economy-wide, it seems that special attention should be given to the analysis of wages in these industries over time.

Using a purely time series approach to the analysis of wages seems to be an alternative which can control for other macroeconomic (time specific) factors and allows for deregulation's impact to be endogenously determined and modeled as non-discrete. This yields the potential to distinguish the impact of deregulation

¹ Examples include, but are not limited to, Rose (1987), Hirsch (1988 and 1993), Belman and Monaco (2001).

² In fact, Keeler (1983) notes that pro-reform Interstate Commerce Commission (ICC) members appointed by President Carter in 1979 pursued liberalized regulatory policies towards railroads before the Staggers Rail Act was passed.

from the other factors that caused wage declines. Using time series techniques to examine the trends in wages in trucking and rail we find what can be referred to as the two stories of deregulation's effect on labor markets. Trucking deregulation resulted in a labor market that increasingly looks similar to manufacturing production workers, while in rail there is no evidence of any wage effects from deregulation. Most importantly, though, other factors besides deregulation had sizeable impacts on wages of rail and truck workers. In the case of trucking, deregulation magnified reduced trucking wages from other factors, while in the case of rail, deregulation offset declines from other factors.

II. Deregulation of surface transportation

Economic theory does not provide a unique prediction of the impacts of regulation on labor. On the one hand, regulation may create economic rents for firms by restricting entry and by price setting. These economic rents provide an opportunity for increased union wages, through rent sharing, and increased employment. On the other hand, regulation may limit the firm's ability to make productivity gains through various restrictions on pricing and service, limiting the growth of the marginal product of labor, and, therefore, earnings and employment. To the extent that regulations limiting the ability to change pricing and service are accompanied by a requirement to serve certain markets, they may enhance employment.

A. Trucking

Regulation of trucking was legislated with the passage of the 1935 Motor Carrier Act, resulting in entry restrictions and price fixing through rate bureaus. If higher rates and restricted entry reduced the need to cost minimize, firms may have been willing to incur above equilibrium labor costs (Rose 1987 and Hirsch 1988). The strength of the Teamsters union in concert with the ability of firms to pass on higher costs to their customers seems to explain the relatively high wages in the unionized segment of the trucking labor force.

As the industry moved to a more competitive environment after deregulation, wages fell precipitously. Rose (1987) and Hirsch (1988) find that deregulation lowered wages of union drivers on the order of 15%, using data from the Current Population Survey. Belzer (1994), using firm-level data, finds a 20% wage decline across workers due to deregulation. The wage studies typically use a benchmark of 1979 as the

start of the post-deregulation period, theorizing that deregulation's effect in labor markets was felt in the period of administrative deregulation, prior to the Motor Carrier Act of 1980.

B. Rail

Railroads were regulated under the Interstate Commerce Act of 1887, which outlawed railroad pooling agreements, prohibited personal price discrimination, required rates to be "just and reasonable," and outlawed charging higher rates for short hauls than long hauls over the same line (Keeler 1983). While regulation served the railroads well in the beginning, it eventually contributed to major problems in the rail industry; rail's share of U.S. intercity freight declined from 65 to 35 percent between the end of World War II and the mid-1970s (Gallamore 1999). Rail was characterized by firms in financial distress and the absence of cost-minimizing behavior. This, combined with the strength of organized labor in the industry, resulted in wage premia.

Congress passed the Railroad Revitalization and Regulatory Reform Act (4-R Act) in 1976, which gave the railroads greater pricing flexibility, and eased restrictions on railroad abandonment and mergers. However, the Interstate Commerce Commission did not allow the railroads to use much of the new pricing flexibility allowed by the 4-R Act before 1979 (Friedlaender and Spady 1980 and Keeler 1983).

The Staggers Rail Act of 1980 provided major changes in railroad regulation. These changes included allowing railroads to enter into confidential contracts with shippers, allowing railroads to cancel joint rates that did not meet certain revenue thresholds, setting time limits on abandonment, allowing railroads to increase rates in step with cost changes without being challenged, and requiring the Interstate Commerce Commission to consider the revenue adequacy of the railroads in setting maximum rate guidelines (U.S. General Accounting Office 1990).

Several studies show large productivity gains (cost decreases) resulting from deregulation (Berndt, Friedlaender, Wang Chiang, and Velturro 1991, Wilson 1997, Bereskin 1996, Gallamore, 1999, Ellig 2002, and Bitzan and Keeler 2003). These trends of increasing profitability and productivity for railroads suggest that we should not expect large declines in railroad wages with the onslaught of deregulation, like we see with trucking. Previous studies examining the impacts of deregulation on the wages of unionized rail employees have found mixed results. Hendricks (1994) finds increases in the wage premium of railroad workers in comparison to manufacturing workers. MacDonald and Cavalluzzo (1996) find increases in earnings premiums in the first part of the 1980s with slight declines starting in the late 1980s. Talley and Schwarz-Miller (1998) find slight declines in earnings relative to the unregulated sector for engineers, while Belzer (1998) finds increases in

earnings relative to the unregulated sector for train conductors. While the findings of such studies are mixed, they certainly do not suggest the large declines in wage premiums that were experienced in trucking.

In sum, though trucking and rail both experienced above equilibrium wage levels during regulation, the different experiences of the industries after deregulation illustrate two stories of deregulation's effect on labor markets and wages. Trucking experienced significant entry of new firms (mainly small firms that employed non-union workers), increasing the size of the labor force, and wages dropped precipitously throughout the 1980s. For rail, deregulation provided no significant decline in the rail wage, rather its effect was felt through declines in employment in the sector (Hendricks 1994 and MacDonald and Cavaluzzo 1996). As stated by Belous (1986), "As a result of these economic and institutional factors, many railroad union members have won substantial compensation increases in the 1980s, while many workers in other transport industries felt lucky if they could remain even with the level of inflation in the 1980s."

C. Macroeconomics surrounding deregulation

Wages were changing economy-wide concurrently with the changes in the regulatory environment in trucking and rail. Though the average real hourly earnings of the work force remained constant and those of white-collar workers rose by 7.4% between 1973 and 1997, the earnings of blue-collar workers fell by 11.8% (Mishel, Bernstein and Schmidt 1999). Research using inter-industry data suggests that the decline in the earnings of blue-collar, less educated, or "less skilled" workers originated in a number of factors. Bound and Johnson (1992) focus on the unfavorable shifts in the demand for less educated labor induced by skill-biased, technological change. Others focus on the supply side of the market; the increase in the supply of less skilled workers through rising immigration (Borjas, Freeman, and Katz 1991).

Institutionally, the real value of the minimum wage was declining, as was unionization of the labor force (DiNardo and Lemieux, 1997 and DiNardo, Fortin, and Lemieux, 1996). Unionization was declining economy-wide, not simply in the industries experiencing regulatory changes. Even in industries that were highly unionized, the unions had begun to provide wage concessions to preserve union employment (Easterbrook 1983).

Finally the inflation of the late 1970s and twin deficits of the 1980s caused a decline in real wages and employment in manufacturing industries. Revenga (1992) finds that the significant appreciation of the dollar in the early/mid 1980s caused a significant change in import prices which in turn caused employment and wages to decrease in manufacturing industries. Katz and Murphy (1992) find evidence that

the demand for goods, and thus labor, declined due to the deficits of the 1980s. As the demand for transportation services is a derived demand, trucking and rail labor markets should be sensitive to macroeconomic performance.

The fact that the impacts of deregulation and other issues are likely intertwined has received attention in prior research. Moore (1986) acknowledges that it is difficult to disentangle the simultaneous events of the recessions in 1980 and 1981-2 and regulatory change in the trucking industry (p. 34) and Engel (1998) echoes this. Clearly, if these larger effects are not controlled for in a model, then it is clear that their impact will be captured by the variable(s) measuring deregulation, overstating deregulation's impact. Unfortunately, the bulk of the deregulation literature fails to control for these factors. By approaching this problem from a time series perspective, we can attempt to distinguish between industry-specific wage effects of deregulation and economy-wide wage trends.

III. The model and analysis

Time series estimation techniques are used to examine trends in wages between the regulated industries (trucking and rail) and an unregulated industry with comparable workers (manufacturing). Typically, wage equations for these workers are estimated based on a structural model of labor supply and demand using cross-sectional data. The dependent variable, most often the hourly wage, is assumed to be a function of demographic characteristics (gender, race, ethnicity, region of residence) as well as human capital (age, education, union membership).

If true panel data were available, a wage equation could be estimated for the entire sample of trucking, rail, and manufacturing workers that controlled for worker characteristics as well as macroeconomic conditions, deregulation, and other dynamic changes. The differences between the three groups of workers could be captured by dummy variables, which would capture the differences between the groups that are not explained by demographics and human capital differences.

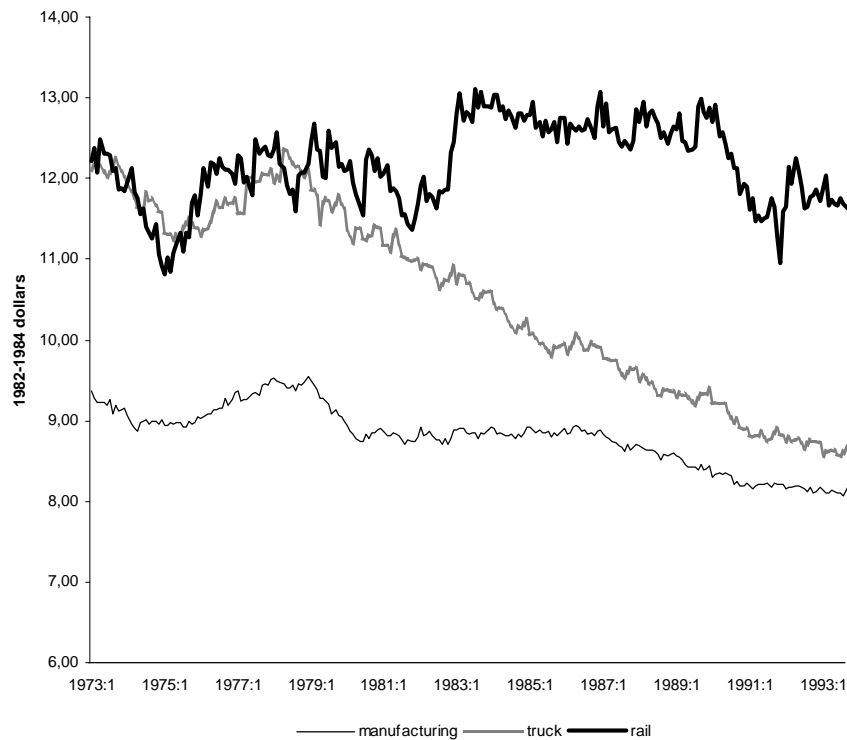
Since true panel data is not available for the period in question³, time series techniques are used, which allow for the effects of deregulation and macroeconomic changes to be controlled, but do not control for human capital and demographic differences between the groups. To determine whether this is problematic for our

³ The two large national panel data sources, the Panel Study of Income Dynamics and National Longitudinal Survey of Youth would not work for our study. The NLSY begins in 1979, which does not provide data before the onset of deregulation. Though the PSID starts before deregulation, 3 digit occupational and industry codes were not gathered in the 1970s data which make it impossible to identify workers in trucking and rail.

sample, we use cross-sectional data from the 1975-1977 Current Population Survey to assess the characteristics of workers in rail, trucking, and manufacturing. We find that the three groups have similar age and education distributions. Manufacturing and trucking have similar racial distributions, whereas rail has fewer blacks (7 percent versus 11 percent in trucking and manufacturing). Not surprisingly, trucking and rail have very few female workers while approximately one-third of manufacturing workers were female.⁴

Given the similarity of the characteristics of these three labor forces, we believe that we are not losing a considerable amount of information from estimating a pure time series model. While we cannot control for the relationship between personal characteristics and the wage, we can capture the time dynamics of deregulation

Figure 1. Real wages by industry



⁴ Detailed tables of these characteristics are available from the authors upon request. Differences in age and education between workers in rail, trucking, and manufacturing are not significant at the 5 percent level.

and macroeconomic events that cannot be modeled using repeated cross-sectional data.

Figure 1 shows the trends in the average hourly wages for these three series from the first month of 1972 through 1993 (deflated with the monthly CPI-U in 1982-1984 dollars). The data source used is Employment, Hours and Earnings from the Bureau of Labor Statistics and the series used are the average hourly wages of non-supervisory workers in rail, trucking, and manufacturing (U.S. Department of Labor 1994). As is evident, trucking and manufacturing wages have declined in real terms over time, while rail has remained relatively stable. It is also notable that trucking wages began their decline in the late 1970s (pre-deregulation) and real manufacturing wages began to decline at approximately the same time. Again, this provides evidence that macroeconomic conditions impacted the labor market significantly.

We estimate two models that compare wages over time. First, wages in trucking and rail are compared. Specifically, the natural log of the wage differential is computed, which captures the percentage wage premium of workers in rail, and analyzed using univariate techniques.⁵ We expect that if workers in both industries received rents in the regulatory period there should be a stable relationship between the series during this period and, thus, the premium of rail over trucking should be a stationary series. A priori, we would expect non-stationarity post-deregulation as the labor markets in the two industries responded very differently to a change in regulatory regimes.

Second, wages in trucking are compared to the manufacturing wage. Given that labor is fairly mobile between industries, there are a few possible explanations for the wage differential between trucking and manufacturing, including skill differences and compensating differentials, however, the main differential pre-1980 appears to be regulatory rents. The differential between trucking and manufacturing would be expected to change given shocks that were felt solely by workers in one of these industries – trucking deregulation would be one of these shocks.⁶ If this series were stationary around distinct means before and after deregulation, then the difference in means would give an estimate of deregulation's effect.

⁵ For background on stationarity and unit roots, refer to Granger and Newbold (1974), Phillips (1986), Enders (1995), Harvey (1993), and Greene (1997).

⁶ Clearly the break could be due to any shock that was felt asymmetrically. The most likely cause of the two labor markets (which are closely intertwined) having asymmetric wage changes is deregulation.

A. Model 1: Trucking and rail

As explained above, we hypothesize that rail's premium over trucking should be stationary during regulation and then increase substantially when deregulation's effect is felt by the labor markets. This increase is due to the fact that trucking wages fell substantially post-deregulation, while rail wages remained relatively constant. If the premium were stationary over the entire time period, this would suggest that the wage differential were stable across time, suggesting no differential wage effect from deregulation.

To test for stationarity we implement two unit root tests. These are the Augmented Dickey-Fuller (ADF) and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) tests.⁷ Results of these tests are presented in Table 1. The tests over the entire period (1972-1996) show non-stationarity. This finding is robust as the ADF statistic fails to reject the null of non-stationarity and the KPSS statistic rejects the null of stationarity.

Table 1. Tests of stationarity on the rail-trucking wage differential

Time period	Unit Root Tests		Perron's Test ³		
	ADF ¹	KPSS ²	Break Point	alpha	t-stat (alpha=1)
1972:01 – 1996:02	1.8709	0.186 **	1985:02	1.203	-1.355
1972:01 – 1985:01	3.386 *	0.2089 **	1981:01	-0.717	-6.181 ***
1985:02 – 1996:02	2.58	0.49 ***			

Notes: 1) The lag for the ADF test was selected using the Akaike Information Criterion (AIC). 2) The KPSS test reports the ETA(tau) test statistic when 4 lags are used with the Bartlett window. 3) The model allowed for both a change in the intercept and a change in the trend. *, **, *** denote significance at 10%, 5%, and 1% level respectively.

We next test the wage premium for the presence of a structural break. A trend stationary process with a structural break is often indistinguishable from a difference stationary process (Perron 1989). If the wage differential could be

⁷ The ADF and KPSS tests have contrasting null hypotheses (the null of ADF is non-stationarity and the null of KPSS is stationarity). If we reject the null of KPSS and "accept" the null of ADF this corresponds to a robust acceptance of the existence of a unit root. If the null of ADF is rejected and the null of KPSS is "accepted", this is a robust acceptance of stationarity (Cheung and Chinn 1996).

represented by a stationary process with a structural break corresponding to deregulation then the difference in means would capture the wage effect of deregulation. A unit root test by Perron (1997) allows for endogenous determination of the break point. This is especially important as the actual date of deregulation's impact on labor markets is hard to determine.

Perron's test suggests a structural break in 1985, though the test rejects the hypothesis of stationarity around this break (we fail to reject the null hypothesis of non-stationarity). Splitting the sample pre and post 1985, the ADF and KPSS tests again find non-stationarity. However, Perron's test finds that the wage differential is stationary over the entire period 1972-1985 with a structural break in the first quarter of 1981. It is non-stationary in the post-1985 period (at a one percent level of significance). This supports the theory that both industries experienced above equilibrium wages under regulation and that the labor markets reacted very differently to deregulation. It also appears that deregulation's differential effect on these two labor markets was felt in 1981, substantially later than the typical assumption made in the literature on trucking deregulation.

B. Model 2: Trucking and manufacturing

Test results for the model of the trucking-manufacturing wage differential are presented in Table 2. We do not find stationarity over the entire time period using the KPSS and the ADF tests. Again this finding is robust with the KPSS test rejecting the null hypothesis of stationarity at the 5 percent level and the ADF test failing to reject the null of non-stationarity.

Table 2. Tests of stationarity on the trucking-manufacturing differential

Time period	Unit Root Tests		Perron's Test ³		
	ADF ¹	KPSS ²	Break Point	Alpha	t-stat (alpha=1)
1972:01 – 1996:02	-2.65	0.614 ***	1980:05	0.965	-2.22
1972:01 – 1980:04	-3.11	0.202 **			
1980:05 – 1996:02			1984:06	0.853	-4.66 *
1980:05 – 1984:05	-3.28 *	0.072			
1984:06 – 1996:02	-3.76 **	0.125 *			

Notes: 1) The lag for the ADF test was selected using the Akaike Information Criterion (AIC). 2) The KPSS test reports the ETA(tau) test statistic when 4 lags are used with the Bartlett window. 3) The model allowed for both a change in the intercept and a change in the trend. *, **, *** denote significance at 10%, 5%, and 1% level respectively.

Perron's test suggests a structural break in May 1980. This is interesting as it corresponds to the passage of the MCA of 1980, but is significantly later than the start date of 1979 used in cross-sectional studies. However, the trucking premium is still non-stationary, since we fail to reject the null hypothesis. One potential reason for this finding could be the existence of yet another structural break. Visual inspection of Figure 1 suggests that another structural break occurred in the mid-1980s. Applying Perron's test to the post deregulation data (after May 1980), we find that the trucking premium is stationary (at the 10 percent level) after allowing for a structural break at June 1984. KPSS and ADF tests on the subsamples confirm this result. These findings are robust. We reject the null of non-stationarity for the ADF test and fail to reject the null of stationarity in the KPSS for both subperiods (1980:5 - 1984:05) and (1984:6 - 1996:02) at the five percent level. It should be noted that we reject the null of stationarity in the KPSS test at the ten percent level for the subperiod (1984:6 - 1996:02).

These findings suggest that the relationship between the hourly trucking and manufacturing wages has been deterministic, fluctuating around a linear trend with two different break points. The first break point occurs in May 1980 and the second occurs in June 1984. It is important to note that in all cases the premium was trending downward, which implies convergence in wages began before deregulation. Using the deterministic trend in the wage premium prior to May 1980 and the trend in the wage premium after June 1984 we can infer the effects of deregulation. If we attribute the entire reduction in the premium to a reduction in the average hourly wages in the trucking industry we can calculate the trucking wage had deregulation not occurred. We accomplish this by extrapolating the trucking premium that existed before deregulation in the post deregulation period and then generating a forecast of the trucking wage. The deregulation effect can be inferred from the percentage difference in the forecast and the actual trucking wage.

In May 1980 deregulation accounted for a 6.99% decline in the average hourly wages of truck drivers and by June 1984 that percent had climbed to 8.42%. In February of 1996, the average hourly wage of truck drivers was 12.43% lower than it might otherwise have been. Though this is significant, it is less than half of the 27.8% decline in trucking wages over the period 1972-1996.

IV. Summary and conclusions

Using time series estimation techniques to examine wages in trucking and rail illustrates the two very different labor market effects of surface transportation deregulation. Rail and trucking wages appear to have a stable, deterministic, relationship prior to deregulation, supporting the hypothesis that workers in both

industries received wage premia prior to deregulation. There is a substantial break in the relationship between the two markets in 1981 (marking the beginning of deregulation) and there appears to be no stable relationship post deregulation.

These findings are explained by changes in the rail and trucking labor markets after deregulation. First, the changes in the nature of employment in rail resulted in post deregulation wages that look similar to the high wages in the regulated period. This is consistent with Hendricks' (1994) observation that regulation limited management's ability to use rail labor efficiently.

Second, trucking wages declined precipitously post-deregulation as competition resulted in the wages of drivers becoming similar to those of other production workers. Using the manufacturing wage as a benchmark, the effect of deregulation in trucking appears to be non-discrete with the biggest wage loss, 7%, experienced from 1980-1984. The final impact of deregulation on the wage appears to be 12.43%. Though deregulation significantly decreased trucking wages, market, institutional, and macroeconomic factors that affected the wages of low-skilled labor were just as important as deregulation in explaining the wage declines in trucking. This suggests that cross-sectional studies that fail to control for these factors significantly overstate deregulation's impact.

It is, of course, impossible to fully distinguish between the "direct" and "indirect" impacts of deregulation. What we are attempting to capture in the time series estimation is the "direct" effect of deregulation. It is also clearly the case that deregulation, especially in trucking, led to a more competitive market which likely accelerated the de-unionization felt elsewhere in the labor force and made the trucking labor market more sensitive to macroeconomic effects since trucking firms were more vulnerable to economy-wide shocks post-deregulation.

Important in the findings is that both the trucking-rail relationship and the trucking-manufacturing relationship seem to indicate that the effect of deregulation was felt in labor markets in late 1980 or early 1981, substantially later than the date of deregulation assumed in most studies of trucking deregulation. This would suggest that arbitrarily assigning 1979 as the date of deregulation will bias the measured impact of deregulation.

A potential extension of this study would be to investigate the trends in wages in a time series framework, using workers with identical characteristics. This could be done in the period from 1979 onward using the monthly Current Population Survey, but could not be done in the period before deregulation. It would, however, allow us to capture skill-biased technological change across industries in the 1980s and 1990s.

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