DEREGULATION AND WAGES IN TRUCKING: A TIME SERIES PHENOMENON – A TIME SERIES APPROACH

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ABSTRACT

We approach measuring the wage effect of trucking deregulation from a new perspective using time series estimation techniques. The trucking wage is modeled as a function of the manufacturing wage and the relationship between these series is measured over time. We find that the wage premium of trucking over manufacturing is deterministic over time with two structural breaks in May 1980 and June 1984. This suggests that deregulation's effect on the trucking wage was mainly felt between 1980 and 1984. Using the relationship between the trucking wage and manufacturing wage before deregulation, we find that the initial effect of deregulation was to decrease wages 6.99%. This wage effect increased at a decreasing rate over time and by 1996 the cumulative effect was 12.43%.

Transportation After Deregulation, Volume 6, pages 53–67.

ISBN: 0-7623-0780-3

1. NON-STATIONARITY AND INDUSTRY ANALYSIS

Although much attention has been paid to non-stationarity in analyzing macroeconomic data, the same cannot be said of applied microeconomic analysis, particularly that which measures wages over time. Studies of the effects of government intervention rely largely on panel and repeated cross section data (often from the Current Population Survey).[1] Since these studies measure an intervention which is a non-discrete function of time (such as deregulation), it seems that particular attention should be paid to stochastic time processes in the data. However using cross-section and panel data, little attention has been paid to the data generating processes over time.

We postulate that analysis of deregulation could be done from a time series perspective. Rather than using cross-sectional observations on particular individuals over time, monthly time series data can be used to analyze industry changes. Trucking appears to be an ideal candidate, as most studies of deregulation's effect on trucking wages find significant wage decreases from deregulation. This makes trucking unlike telecommunications, airlines and railroads, where deregulation's effect was felt primarily through employment and not wages (Hendricks, 1994). Studies on trends in trucking wages over the past 20 years have few, if any, time controls, however, trucking deregulation began administratively in the mid to late 1970s and was enacted as law in 1980, a period when there were also strong downward trends in blue collar wages economy-wide.

Though trucking wages fell following deregulation (using 1979 as a benchmark as is common to trucking studies), the downward trends in driver wages preceded this and are mirrored in movements of manufacturing wages (used as a proxy for economy-wide wage trends), see Fig. 1. It is clearly the case that using only a dummy variable to measure deregulation, absent any other time controls, may substantially overstate deregulation's effect. Trucking wage declines found in previous studies may compound deregulation's effect with downward pressure on wages unrelated to deregulation.

Using time series econometric techniques we compare declines in the trucking wage to the manufacturing wage. We can identify periods where the real wage differential between trucking and manufacturing is deterministic, and the points in time where there is a structural break in the differential. Though a structural break could be caused by many factors, such as technology or aggregate demand shocks exclusive to an industry, the structural break of particular interest to this study is deregulation. The goal is to determine whether deregulation explains the change in the trucking wage vis-à-vis a non-regulated industry. A further innovation is that we make no a priori assumptions about the dating of deregulation's impact.

Relying on tests of stationarity we find that the average hourly trucking and manufacturing wage are consistent with a unit root, and therefore not mean reverting. However, the premium of the trucking wage over the manufacturing wage appears to be a deterministic (trend stationary) series with two structural breaks, one at May 1980 and the other at June 1984. This suggests that the relationship between trucking and manufacturing wages, while having fundamentally changed around the time of deregulation, is otherwise predictable. Using the pre and post deregulation trucking premium to forecast the trucking wage we find that in 1980 (month 5) deregulation accounted for a 6.99% decrease in the trucking wage and by 1996 (month 2) a 12.43% decrease in the average hourly wage in the trucking industry.

2. DEREGULATION OF MOTOR CARRIAGE

Regulation of trucking was legislated with the passage of the 1935 Motor Carrier Act, resulting in rents to the industry through entry restrictions and price fixing through rate bureaus. Moore (1978) refers to regulation as “carteliz[ing] the industry” (p. 328). Administrative deregulation was begun by the Interstate Commerce Commission in the late 1970s with the loosening of entry restrictions. The administrative changes of the ICC were passed as law with the 1980 Motor Carrier Act, which also eliminated rate bureaus.

The literature on deregulation’s effect on trucking concentrates on two distinct areas: cost and wages. On the operations side, one would expect firm costs to decrease following deregulation as rate bureaus were eliminated and entry allowed, resulting in a more competitive industry structure (McMullen, 1989). Indeed, motor carriage saw just this change. The post-deregulation period was characterized by upheaval among trucking firms, with many established firms leaving the market and the emergence of smaller firms. Studies which examine the effect of deregulation on firm costs typically use the benchmark of 1977 as the beginning of the post-deregulation period, with the justification that since administrative deregulation began prior to the passage of the Motor Carrier Act, effects on industry structure and costs undoubtedly began earlier than 1980.

The second body of literature which examines deregulation’s effect centers on the labor market. Since the higher rates and restricted entry pre-deregulation resulted in industry rents, it is reasonable to hypothesize that these rents might be shared with workers. The existence of industry rents along with the strength of the Teamsters union seem to explain the relatively high wages in the unionized segment of the trucking labor force during the regulated period. Wages of non-union workers in trucking were not appreciably different than those of manufacturing workers indicating that the rent-sharing was not experienced by the non-union sector, nor is there evidence of appreciable threat effects. As an illustration, the mean hourly wages of drivers in the trucking industry in 1974 were $13.99 for union, $9.47 for non-union, versus $9.48 for manufacturing workers (reported in 1982–1984 dollars) (Belman & Monaco, forthcoming).

As the industry moved to a more competitive environment post-deregulation, wages fell precipitously. In 1984 the mean hourly wages of drivers in the trucking industry were $11.09 for union and $7.93 for non-union, compared to the mean manufacturing wage of $9.02. Not surprising, given the presumed rent-sharing in the union segment of the industry, union drivers were those affected most by deregulation. 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 due to deregulation across workers. The wage studies typically use a benchmark of 1979 as the start of the post-deregulation period, again theorizing that deregulation's effect in labor markets was felt in the period of administrative deregulation, prior to the Motor Carrier Act of 1980.

3. ESTIMATION OF THE RELATIONSHIP BETWEEN WAGES

Approaching the analysis deregulation's effect on trucking wages from a time series perspective first requires some explanation of time series data analysis.[2] The bulk of univariate time series analysis involves forecasting:

$$y_t = \alpha y_{t-1} + \mu + \beta_t + \varepsilon_t \qquad (1)$$

where y is the series of interest, μ is the intercept term, t represents a linear time trend and ε_t is a stochastic error term.

There are basically three types of series, mean stationary, trend stationary, and non-stationary (unit root). A mean stationary series, upon deviation from its mean, tends to revert to the mean. In Eq. (1) this would imply α is less than one and β is zero. If a series is mean stationary then the series will revert back to its mean after any shock (positive or negative value of t). A trend stationary process fluctuates about a linear, or deterministic, trend. This would imply that in Eq. (1), is less than one and takes a value other than zero. A shock to a trend stationary series will dissipate over time and the series will eventually revert to its trend. The final type, a unit root series, does not revert to a mean or a linear trend. This implies that is equal to one and μ and can take any value zero or otherwise. Any shock to the series permanently alters the forecast by the full amount of the shock.

In the context of our analysis, we compare the wages of drivers in the trucking industry to workers in manufacturing. The manufacturing wage was chosen for two reasons. First, we have reason to expect that it can be considered a "reservation wage" for truck drivers as these groups have similar demographic characteristics. Second, there is no reason to expect that trucking deregulation should have any significant effect on the wages in manufacturing.

Figure 1 shows trends in the average hourly wages for these two industries (deflated with the monthly CPI-U in 1982–1984 dollars) from the first month of 1972 to the second month of 1996. The data source used is "Employment, Hours, and Earnings United States, 1909–1994" and "Employment, Hours, and Earnings United States, 1995–1996," published by the U.S. Department of Labor. As is evident, the trucking wage has declined in real terms over time, but these declines are particularly significant beginning in the late 1970s, which also corresponds to the beginning of deregulation. However it is interesting to note that the manufacturing wage also declined precipitously over the same period.

The series of interest is the natural log of the wage differential between truckers and manufacturing workers. This captures the percentage wage premium of drivers (who consistently earn higher wages). Given that labor is fairly mobile between industries, there are two possible explanations for the wage differentials between trucking and manufacturing: skill differentials and compensating differentials. However a major source of the trucking wage premium prior to 1980 was regulation. Rent sharing was prevalent in trucking pre-deregulation, especially for unionized drivers. (Hirsch, 1988 and Rose, 1987).

Looking at changes in the wage premium of trucking over manufacturing across time should provide insight into the effects of deregulation, as we assume that the two groups feel economy-wide macroeconomic shocks in a proportionate manner. A graph of the seasonally adjusted wage premium is presented in Fig. 2. Thus, economy-wide declining unionization[3] and declining real wages should be felt by both groups of workers, thus not significantly affecting the wage differential. This differential would be expected to change given shocks that were felt solely by workers in one industry – trucking deregulation would be one of these shocks.

Changes in the wage premium over time should allow us to infer deregulation's effect. The first step is to analyze this series and determine whether it is stationary, both over the entire time period and within sub-periods (i.e. before and after deregulation). Stationarity would imply a long run stability of the wage premium of trucking over manufacturing. A theoretically appealing result would be to find this series stationary about distinct means before and after deregulation, implying a stable wage premium of trucking, then measure the

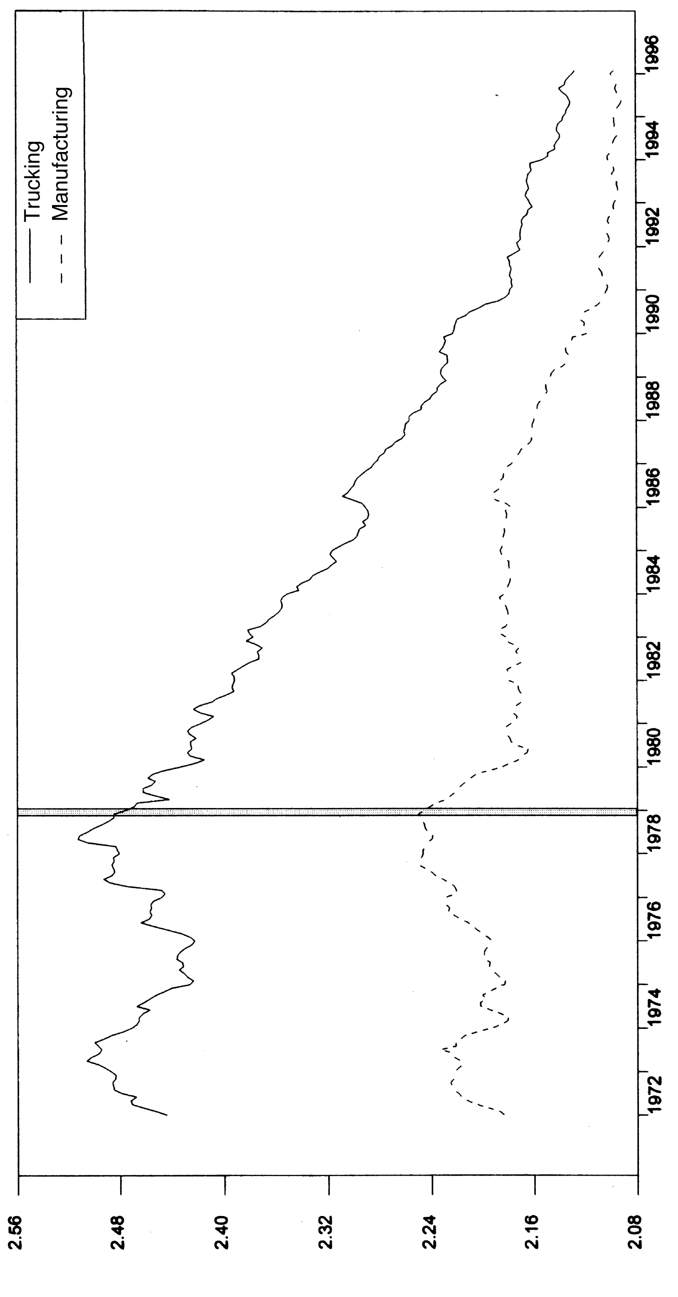

Fig 1. The Log of Real Wages.

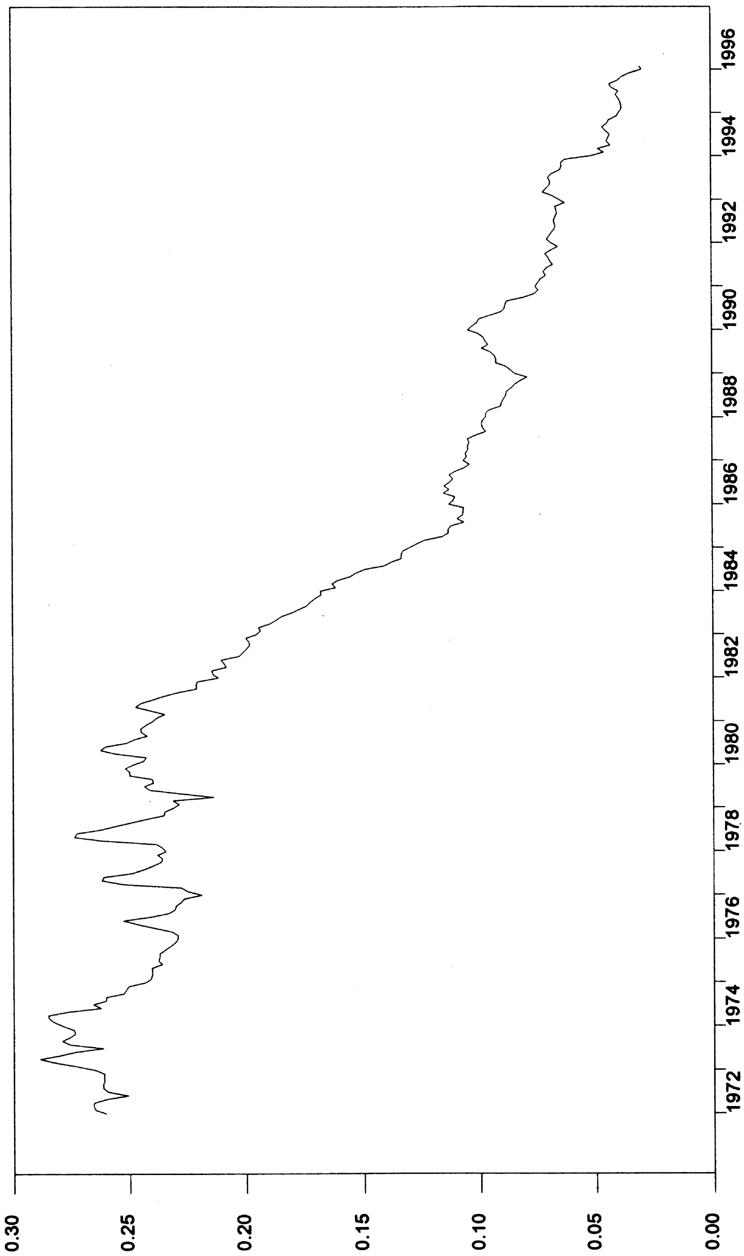

Fig 2. Log of Trucking Wage Premium.

difference in means in the premium between these periods, ostensibly a good proxy for deregulation's effect.

4. DISCUSSION OF UNIT ROOTS

A brief review of unit root tests is provided, as background for interpreting the tables and the implications of the tests for measuring deregulation's effect. A non-stationary series is integrated of order one if its first difference is stationary and reverts to a mean. However, it is not necessarily the case that a unit root characterizes all non-stationary series; non-stationary series could either be trend or difference stationary, the latter the only case that implies the presence of a unit root. To test for the type of stationarity present in the series of the wage premium, we implement two unit root tests. These are the Augmented Dickey-Fuller (ADF) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests.[4,5]

The KPSS relies upon a Lagrange Multiplier test with the null hypothesis of stationarity (trend or difference). For the test of level stationarity it decomposes the process to a random walk and stationary error, and incorporates a deterministic trend to test trend stationarity. The variance of the random walk component is tested, with a null hypothesis of zero variance. The test has one choice parameter, the lag truncation variable associated with the weighting spectral window. We use the Bartlett window as suggested in Kwiatkowski et al. (1992), but use an agnostic approach to the choice of lag parameter due to the size and power distortions inherent in finite samples.

As the ADF and KPSS tests have contrasting null hypotheses (the null of ADF is non-stationarity and the null of KPSS is stationarity) there are four possible outcomes from performing hypothesis tests (Cheung and Chinn, 1994 and forthcoming). The first consists of "accepting" (failing to reject) the null hypothesis for both tests, which tends to occur due to the lack of power of the tests in small samples. The second consists of rejecting the null of KPSS and "accepting" the null of ADF, corresponding to a robust acceptance of the existence of a unit root. The third, where the null of ADF is rejected and the null of KPSS is "accepted" is a robust acceptance of stationarity. Finding stationarity over the entire time period would have suggested that the wage premium of trucking over manufacturing was stable across the entire time period, suggesting no wage effect of deregulation.

5. RESULTS

Table 1 reports the results of the KPSS and ADF tests for the full sample. The ADF test statistic for the trucking wage premium is -2.65 and that of the KPSS

Table 1. Unit Root Test on Full Sample 1972:1 to 1996:2.

	ADF	KPSS
Manufacturing (15)	−3.05	0.614
Trucking (14)	−2.38	0.786
Truck premium (13)	−2.65	0.544

* The lag for the ADF test was selected using the Akaike Information Criterion (AIC) and it appears in parenthesis behind the series name. The critical values for the ADF test are −3.98 at the 1% level, −3.42 at the 5% level, and −3.13 at the 10% level. The KPSS test reports the ETA(tau) test statistic when 4 lags are used with the Bartlett window. The critical values are 0.216 at the 1% level, 0.146 at the 5% level, and 0.119 at the 10% level.

is 0.544, which when compared to the critical values given leads us to reject the hypothesis of stationarity. As we do not find stationarity over the entire time period, 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 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 recent unit root test by Perron (1997) allows for endogenous determination of the break point. This is especially important with the data on trucking, as the actual date of deregulation is hard to determine – Motor Carrier Act of 1980 represented the legal deregulation of trucking, however administrative deregulation preceded this. Many studies use 1979 as the date of deregulation.[6]

Perron's test involves is similar to the Dickey-Fuller test and involves estimating equation 2.

$$y_t = \alpha y_{t-1} + \mu + \theta DU_t + \beta_t + \gamma DT_t + \delta D(T_b)_t + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t \qquad (1)$$

Where y is again the series of interest, μ is the constant term, t incorporates a time trend, e is a stochastic time component, and is the date of the structural break The variable DU is a dummy variable which takes a value of one after the structural break and D(Tb)t is a variable which takes a value of one in the period immediately following the structural break. Finally, DTt takes a value of t for the period after the structural break; allowing the slope as well as the intercept to change following the structural break. The unit root test involves using the t statistic to test $\alpha = 1$. A rejection of the null hypothesis suggests that the series is stationary around a structural break.

The results of applying this test to the trucking premium can be found in Table 2, where the structural break is dated as 1980, month 5 (May). This is interesting as it is closer to the actual passage of the MCA in October 1980 than the structural break 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. Table 3 presents the results of unit root tests on the data series before 1980:5 and while not robust, do to the low power of the truncated sample, they do suggest that this period was stationary. The ADF statistic of 3.11 is very close to the 10% critical value of the test statistic which would allow us to reject the null of non-stationarity. This suggests that the source of non-stationarity stems from the series post 1980:5. Visual inspection of Fig. 2 suggests that another structural break occurred in the mid 80s. Applying Perron's test to the data after focusing on the post deregulation data (post 1980:5), we find that indeed the trucking premium is stationary after allowing for a structural break at 1984:6. The results of Perron's test are presented in Table 4. Tables 5 and 6 confirm this result using the KPSS and ADF tests on the sub samples. Table 5 presents the ADF and KPSS statistics on the trucking wage premium for the period 1980:5 through 1984:5. The test statistic of the ADF of −3.28

Table 2. Perron's Unit Root Test on Full Sample 1972:1 to 1996:2.

	Break Point	alpha	t-stat (alpha = 1)
Truck premium (12)	1980:5	0.965	−2.22

* The model allowed for both a change in the intercept and a change in the trend and the critical values are −5.57 at the 1% level, −4.91 at the 5% level, and −4.59 at the 10% level.

Table 3. Unit Root Test on 1972:1 to 1980:4.

	ADF	KPSS
Manufacturing (15)	−2.61	0.192
Trucking (13)	−4.21	0.203
Truck premium (1)	−3.11	0.202

* The lag for the ADF test was selected using the Akaike Information Criterion (AIC) and it appears in parenthesis behind the series name. The critical values for the ADF test are −3.98 at the 1% level, −3.42 at the 5% level, and −3.13 at the 10% level. The KPSS test reports the ETA(tau) test statistic when 4 lags are used with the Bartlett window. The critical values are 0.216 at the 1% level, 0.146 at the 5% level, and 0.119 at the 10% level.

Table 4. Perron's Unit Root Test on Full Sample 1980:5 to 1996:2.

	Break Point	alpha	t-stat (alpha = 1)
Truck premium (6)	1984:6	0.853	−4.66

* The model allowed for both a change in the intercept and a change in the trend and the critical values are −5.57 at the 1% level, −4.91 at the 5% level, and −4.59 at the 10% level.

Table 5. Unit Root Test on 1980:5 to 1984:5.

	ADF	KPSS
Manufacturing (0)	−2.48	0.073
Trucking (19)	−1.67	0.059
Truck premium(3)	−3.28	0.072

* The lag for the ADF test was selected using the Akaike Information Criterion (AIC) and it appears in parenthesis behind the series name. The critical values for the ADF test are −3.98 at the 1% level, −3.42 at the 5% level, and −3.13 at the 10% level. The KPSS test reports the ETA(tau) test statistic when 4 lags are used with the Bartlett window. The critical values are 0.216 at the 1% level, 0.146 at the 5% level, and 0.119 at the 10% level.

Table 6. Unit Root Test on 1984:6 to 1996:2.

	ADF	KPSS
Manufacturing (1)	−1.29	0.482
Trucking (2)	−2.41	0.352
Truck premium(3)	−3.76	0.125

* The lag for the ADF test was selected using the Akaike Information Criterion (AIC) and it appears in parenthesis behind the series name. The critical values for the ADF test are −3.98 at the 1% level, −3.42 at the 5% level, and −3.13 at the 10% level. The KPSS test reports the ETA(tau) test statistic when 4 lags are used with the Bartlett window. The critical values are 0.216 at the 1% level, 0.146 at the 5% level, and 0.119 at the 10% level.

allows us to reject the null hypothesis of a unit root at the 10% level. The KPSS test statistic of 0.072 means we fail to reject the null hypothesis of no unit root. Recall from the discussion on unit roots that this combination of results allows a robust acceptance of stationarity. The same acceptance of stationarity holds for the period 1984:6 through 1996:2 as evidenced in Table 6. We reject the null of the ADF at the 5% level with a test statistic of −3.76

and fail to reject the null hypothesis of the KPSS test at the 5% level with a statistic of 0.125.

Our findings suggest that the relationship between the average hourly manufacturing wage and the average hourly trucking wage as measured by the wage premium has been deterministic, that is to say it has fluctuated around a linear with two different break points. The first break point occurs in the fifth month of 1980 and the second occurs in the sixth month of 1984. It is important to note that in all cases the premium was trending downward implying a convergence in wages. If we use the deterministic trend in the wage premium prior to 1980:5 and the trend in the wage premium after 1984:6 we can infer the effects of deregulation.[7] Figure 3 represents this graphically. If we attribute this entire reduction in the premium to a reduction in the average hourly wages in the trucking industry we can then calculate the percentage reduction in hourly wages due to deregulation.

In 1980:5 deregulation accounted for a 6.99% decline in the average hourly wages of truck drivers and by 1984:6 that percent had climbed to 8.42%. In February of 1996, the last date for which we have data, the average hourly wage of truck drivers is 12.43% lower then it might otherwise have been. Our findings suggest that previous studies attribute too much of the observed wage declines to deregulation, when in fact some of it stems from factors experienced by other unregulated industries, such as manufacturing. These factors can include, but are not limited to the recession in the early 80s, the rapid appreciation of the dollar brought on by the monetary aggregate targeting, and the increase in the trade deficit.

6. CONCLUSIONS

Our findings suggest that the average hourly wages earned in the trucking industry and the manufacturing industry have enjoyed a predictable relationship since 1972. The relationship is only predictable after accounting for two break points, the first in 1980:5 and the second in 1984:6. Therefore one can think of the impact of deregulation occurring over the middle period from 1980:6 to 1984:5, rather then simply a discrete point in time, such as 1979:1. During this period the trucking industry experienced a rapid attrition of firms in the Less then Truckload (LTL) (high wage) segment, some through failure others through mergers, while the Truckload (TL) (low wage) segment witnessed an explosion in small firms (Burks, 1999).

Many cross-sectional studies of trucking find a wage effect of deregulation on the order of 20% or more (Belzer, 1994, Hirsch, 1988). These studies include only a discrete dummy variable for deregulation and no controls for macroeco-

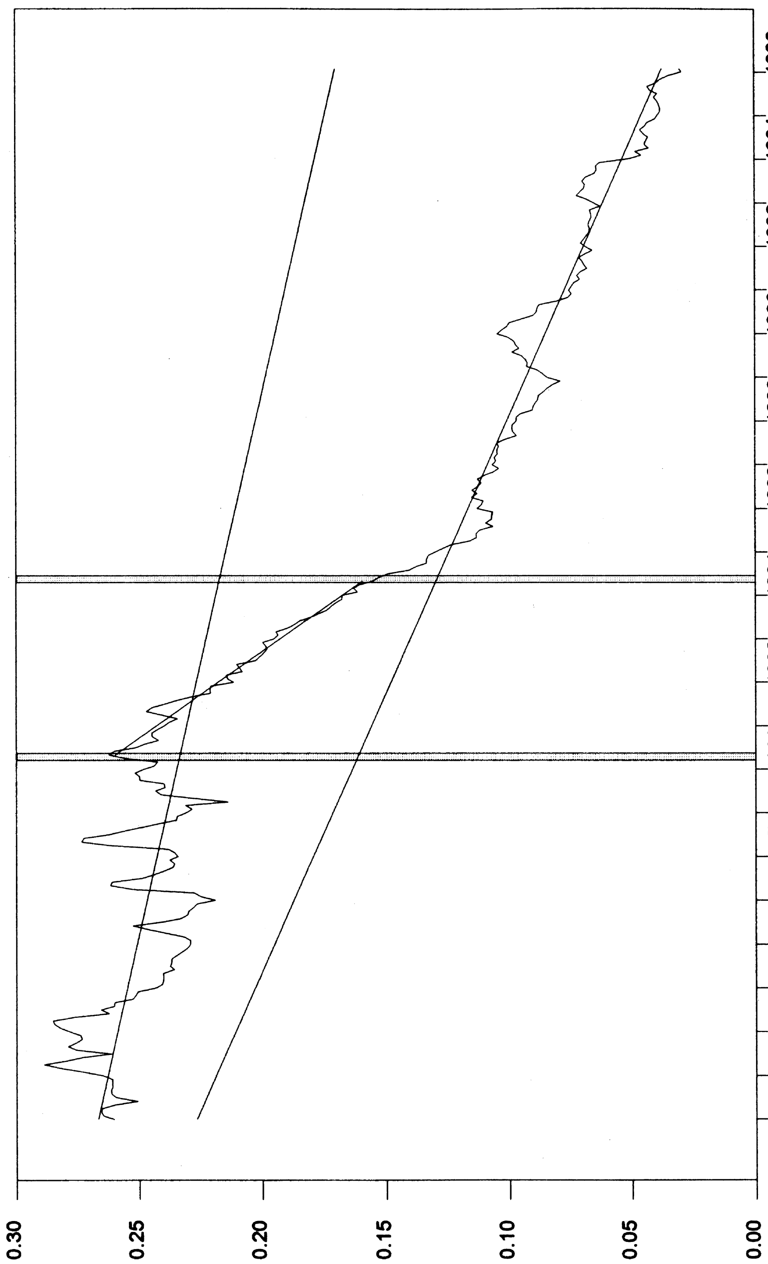

Fig 3. Log of Trucking Premium.

nomic effects. Using the period before deregulation to predict the trucking wage into the other period we find that deregulation accounts for a 6.99% decline in trucking wages in 1980:5 and by 1996:2 that effect compounds to a 12.34% reduction in wages. We find that the effect of deregulation is felt later than previously assumed and, rather than occurring at a discrete point in time, has accumulated over time, with the primary effect felt between 1980:5 and 1984:6.

NOTES

1. Examples are numerous. Cites for the trucking industry alone include Rose (1987), Hirsch (1988, 1993), Heywood and Peoples (1994) and Peoples and Saunders (1993).
2. For a more complete analysis of stationary and non-stationary series refer to Greene (1997, pp. 841–851) and Harvey (1993, pp. 10–11).
3. It can be argued however, that, although both groups experienced declining wages due to de-unionization, deregulation accelerated this de-unionization in the trucking industry and thus it is very difficult to fully disentangle deregulation effects from de-unionization effects for this group.
4. For the ADF the optimal lag length is chosen using the Akaike Information Criterion (AIC).
5. For a discussion of these tests see Cheung and Chinn (1994).
6. For example, Belzer (1994), Rose (1987) and Hirsch (1988, 1993).
7. The equations for these lines are obtained by regressing the trucking wage premium on a constant term and trend term within the period under consideration. For the period 1972:1–1980:4 the resulting equation is $y(t) = 0.295 - 0.0003t$. For the period 1984:6–1992:2 the equation is $y(t) = 0.282 - 0.00065t$. Full estimation results are available from the authors upon request.

ACKNOWLEDGMENTS

The authors would like to acknowledge the generous support of the University of Michigan Trucking Industry Program, funded by a grant from the Alfred P. Sloan Foundation. We would also like to thank Norman Morin, Phil Rothman, G. Colletaz and F. Serranito for providing their RATS code.

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