Transportation and Industrial Real Estate Valuations: An Application of Dow Theory

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Abstract

This research study tests contentions of Dow Theory, providing insight into U.S. industrial property prices, returns and the influence of the transportation market. Traditional discussion of real estate values with regards to transportation have generally been in the domain of residential real estate. We examine this relationship in the context of commercial real estate; specifically we construct a short and long term model of industrial real estate prices to include a variety of freight transportation modals. Rail carloads, the futures prices of gasoline and crude oil, the NAREIT Industrial Index and Dow Jones Transportation Index are significant covariates.

Keywords: Industrial Real Estate, Valuation, Dow Theory, Transportation

Introduction

A debate over Charles Dow's original theories[1] has enthralled researchers for years and led the way for financial theory's such as the random walk hypothesis and efficient market theory. Hamilton (1922), Cowles (1934), Brown, Goetzmann and Kumar (1988) and others have argued for and against applications of "Dow Theory" for close to a century.

In essence, Dow was expecting the transportation and industrial sector to provide evidence on the market movements and thus the economy. As he contends (Nelson, 1902) that:

> *The market is always to be considered as having three movements, all going on at the same time. The first is the narrow movement day to day. The second is the short swing, running from two weeks to a month or more: the third is the main movement covering at least four years in its duration. (Chapter VII entitled "Three General Lines of Reasoning" on December 20, 1900)*

Charles Dow's indices included the Dow Jones Railroad Average (now Transportation Index) and the Dow Jones Industrial Average (Sheimo, 1989).[2] These indices were to provide an accurate representation of the firms traded on the New York Stock Exchange and to provide an indicator for this market as a whole.

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[1] The Dow theories noted by the author in this research are taken from Wall Street Journal editorials in the years 1900 – 1902. For a list of such theories, see Bishop, Jr. (1960).

[2] The Dow Jones Railroad Average is now known as the Dow Jones Transportation Average.

In this study, we extend the current literature by testing variations on Dow's contentions focusing on the primary and secondary market trends. Although the makeup of the economy has substantially diversified over time proving the application of Dow Theory for broad market forecasting potentially challenging, Dow Theory provides a useful theoretical and practical application for this particular study. We use a combination of transportation (e.g., railroad carloads and truck shipments), futures prices (e.g., gasoline and crude oil), and financial market (e.g., Dow Transportation and FTSE NAREIT Industrial Indices) variables as our indicators of industrial real estate values.[3]

In addition to being an interesting real estate environment relevant to the application of Dow Theory, industrial real estate is an important in terms of portfolio diversification.[4] Industrial real estate also provides space for industrial and manufacturing jobs, an area of the economy that has seen a recent resurgence and is expected to be a stabilizing influence on US jobs (NAIOP Research Foundation, June 2013). This has the potential to yield additional interest from institutional and retail investors focused on the diversification benefits of direct industrial real estate. The findings of this study provide useful insights into the pricing patterns of industrial real estate and its reciprocity to Dow Theory.

The collective findings from a variety of procedures examining long and short term relationships generally support the contentions of Dow Theory in a real estate environment. The relationship between industrial property prices, and the Dow Jones

[3] Additionally, we expected to test air cargo as a predictor variable, but only annual data was available from the Federal Aviation Administration. Due to the extremely small sample size, this variable has not been included in our study.

[4] In a recent international study parceling the regional and property type effects of direct real estate diversification, Wit (2010) finds industrial property to exhibit considerable diversification benefits and outperformed a "common" market real estate portfolio.

Transportation Index, oil and gas futures, and the financial equity markets are of notable interest. We enhance the existing literature in several ways: 1) we test the relevance of some of the contentions of Dow Theory in a real estate environment, 2) report the effect of transportation on the price discovery process of commercial real estate, 3) document a long- and short-term relationship between industrial property prices and the futures market, 4) and, provide additional support for the lead-lag relationship between the public and private real estate markets.

In the next section, we discuss the relevant literature in the transportation and real estate sectors. This is followed by a description of the data. The penultimate section provides a report on the results and robustness measures. The final section concludes.

Relevant Literature

Traditional discussion of real estate values with regards to transportation have generally led to residential property pricing. In one case from McMillen and McDonald (2004), anticipation of a rapid transit line increased residential property values by $6000 per home. The study covered the opening of the Midway Rapid Transit Line in Chicago and included home sales that were within 1.5 miles of the line. The aggregate estimate for Chicago property values increases was approximately 216 million dollars between 1983 and 1999. Similarly, Jud and Winkler (2006) examine how an airport announcement affects housing prices. Homes within a 2.5 mile radius of the Greensboro/High Point/Winston Salem metropolitan airport in North Carolina decreased in value by 9.2% post announcement.

Theebe (2004) reports that excessive noise levels over 65 dB have a detrimental effect on prices up to 12% regardless of whether air, street or rail. According to the author, homes in quiet areas can sell at a premium up to 6.5%. Even if we view noise as a detriment in the immediate area, Green (2007) finds that between 1990 and 2000 passenger activity is a predictor of economic growth in the US, while cargo activity is not.

Poon (1978) finds that property values are useful in establishing the true cost of railway externalities. He notes that rail relocation away from adjacent residential areas provides a real benefit to society due to railway pollution and disamenities up to 900 feet from the track. Kilpatrick, Throupe, Carruthers, and Krause (2007) note that similar externalities from transit corridors ameliorate at or about 300 feet and residences located on or in close proximity to a tunnel have values diminished by approximately 20%. Single family housing is not the only real estate affected by transportation. Portnov, Genkin and Barzilay (2009) note that multi-family housing prices depreciate approximately 13% within 100 meters of a rail.

Debrezion Pels, and Rietveld (2007) distinguishes the effects of a railway station on commercial and residential property values through the use of a meta-analysis. The authors find that commercial property values are 12.2% higher than residential values within a ¼ mile of the railway station, while at longer distances residential prices are 2.3% higher. Additionally, they show that commuter railways have a more positive effect on value than light and heavy railway stations. Debrezion, Pels, and Rietveld (2011) also test railway accessibility and find that popular railway stations predict home prices better than railway stations that are closer in proximity to a given home. In another study on railway access, Voith (1991) finds that workers living in suburban areas with rail access to a central business district (CBD) pay a 5.4% premium for housing.

There have been few studies in regards to how transportation affects industrial values. Lockwood and Rutherford (1996) examine industrial values from 1987-1991 in Dallas/Fort Worth, Texas and find surprisingly that distance to major roads and having rail access were not significant predictors. Distance to airport has a positive relationship with industrial values as expected and distance to central business district has a negative relationship. This is not unexpected as often industrial property close to a CBD is not close to the airport. Ambrose (1990) finds the location of a rail is a significant predictor of light industrial asking sales prices and rent per square feet in Atlanta, Georgia in 1986-1987. The author also reports that numbers of dock high loading docks and numbers of drive-in doors have a positive significant relationship.

Our study substantially differs from the previous studies as we examine the effect of railroad car loadings and truck tonnage on industrial property values at an aggregate level, rather than the distance or location. We further expand the literature by including futures prices, and the Dow Transportation and FTSE NAREIT Industrial REIT Indices in our analysis.

Data

The industrial property pricing are from the National Council for Real Estate Investment Fiduciaries (NCREIF). NCREIF tracks total returns from a large, geographically diverse sample of U.S. industrial properties which, as of Q42013, was composed of approximately 2800 differing properties valued at approximately $48,186,600,000.

Quarterly total industrial property returns are given by NCREIF and market values in this analysis are computed from these quarterly returns. The industrial market values in the study are computed into an index by dividing the portfolio market value by the number of properties.

Railroad carloads, truck shipments, futures prices of gasoline and crude oil are our primary variables of interest included in our valuation models and are derived from the Association of American Railroads (AAR), American Trucking Association (ATA), and Commodity Systems Incorporated (CSI). The railroad carloads are weekly totals of carloads and intermodal units originated in the United States for all Class 1 and Non-Class 1 Railroads. These carloads contain all 10 commodity types listed by the AAR and are summed to derive a quarterly estimate. Truck tonnage data is reported in a for-hire truck tonnage index accumulated monthly by the ATA. The index began in 1973 and is reported on a non-seasonally and seasonally adjusted basis. The index is compiled from survey responses of members of the association accounting for total tonnage hauled of all types of freight.

Crude oil futures contracts (CL) are based on 1,000 barrels of Light Sweet Crude Oil (WTI). Contracts carried into expiration are settled by physical delivery free-on-board (FOB) to any pipeline or storage facility in Cushing, Oklahoma. The exchange lists all 12 expiration months for the commodity and extends nine years into the future. The minimum fluctuation is \$0.01 per barrel. Trading shall end on the 3rd business day prior to the 25th calendar day of the month proceeding the delivery month. Gasoline futures contracts (RB) are based on 42,000 gallons of Fungible F Grade, Reformulated Regular Gasoline Blendstock (RBOB) to be blended with 10% Denatured Fuel Ethanol. Contracts are settled by physical delivery (FOB) to the New York Harbor facility with the seller paying all costs and fees. The contract trades in all 12 months and the minimum price fluctuation is $0.0001 per gallon. Trading ceases on the last business day of the preceding the delivery month.

An industrial real estate investment trust (REIT) index and the Dow Jones Transportation Index (DJTI) are also examined to control for financial market effects. This data was collected from the National Association of Real Estate Investment Trusts (NAREIT), and Dow Jones (DJ). The DJTI is the oldest U.S. Stock index, and is often used to study Dow Theory. This price weighted index is representative of the stock performance of large US transportation companies. The FTSE NAREIT Industrial index comprises REITS with at least 75% of its gross invested book assets in the industrial sector.

Lastly, we control for general market conditions of the economy by including the US gross domestic product (GDP). Real GDP is the inflation adjusted measure for all good and services produced by labor and property in the United States. It is reported quarterly in billions of chained U.S. dollars on a non-seasonally and seasonally adjusted basis. GDP data is collected from the Bureau of Economic Analysis.

The industrial property values, as measured by NCREIF, suffer from appraisal smoothing. Smoothing is the dampening of measured risk in appraisal-based indices that results from the appraisers' partial adjustments at the disaggregate level and temporal aggregation when constructing the index at the aggregate level (Geltner, 1993). We adjust for smoothing using 0.371 similar to Chau, MacGregor and Schwann's (2001) factor for the industrial sector. This is shown by the following equation:

$$k^*_t = \frac{k_t - (1 - \alpha)\, k_{t-1}}{\alpha} \qquad (1)$$

where k_t is the appraisal based return in year t and k^*t is the actual return after the correction procedure.

Summary statistics for the data are presented in Table 1. The Industrial index increased approximately 600% from a minimum of 371 to a maximum of 2269 over the 25 year study period. Only the commodity futures contracts and the NAREIT industrial index had larger ranges. The futures contracts appeared to have much higher upward price spikes as compared to our other data when comparing maximum values relative to their means. Each of the two futures contracts had somewhat similar volatility when examining their standard deviations. Railroad carloads appeared to have least amount of growth on a percentage basis during our study period.

Research Method

The first stage of the analysis is to estimate whether a long term relationship exists between industrial real estate values and the selected freight transportation indicators. We can apply the cointegration test suggested by Johansen (1991), to investigate this posited relationship. This methodology should give us an indication of Dow's implied primary movement of a long-run trend between these variables. This technique is shown by the following model:

$$\Delta X_t = \mu + \Gamma_1 \Delta X_{t-1} + \ldots. + \Gamma_{k-1} \Delta X_{t-k+1} + \prod X_{t-k} + \Phi D_t + \epsilon_t \qquad (2)$$

where X_t is the vector of p $I(1)$ variables, μ is a $p \times 1$ vector of intercepts, $\Gamma 1$, Γk, $\prod$ and Φ are $p \times p$ matrices of coefficients, D_t are the seasonal dummy variables, ϵ_t is the is the p

x 1 error term that is assumed to be normally and independently distributed with a mean of zero and a variance matrix of Ω, and Δ is the first difference operator. There are 3 possible cases to show whether the matrix $\prod$ has information on long-run equilibrium relationships between the series. For our hypothesis of long run relationships between the variables to be correct, the rank of the matrix of the coefficients X_{t-k} has to have a finite value < p. Each of the coefficients given by the model will have an appropriate sign for any negative or positive relationship after the dependent variable is separated from the other terms in the vector. Also, we determine if the differences of each of the independent variables does not have a zero mean and all of the variables are allowed to drift around an unrestricted intercept term in the cointegrating equation (CE), and test vector autoregressive model (VAR).

Next, we examine Granger causality (Granger, 1969) to determine if the transportation indicators "Granger causes" industrial real estate values. These short-run time-series tests should provide evidence as to Dow's on secondary movements of the market. Granger Causality test whether the explanation of variable Y can be improved by lagged values of variable X (Bohl, Salm, and Schuppli, 2010, Yunus, Hansz and Kennedy, 2012). The Granger Causality test can be equated as follows:

$$\Delta y_t = \alpha_0 + \alpha_1 \Delta y_{t-1} + \ldots + \alpha_l \Delta y_{t-l} + \beta_1 \Delta x_{t-1} + \ldots + \beta_l \Delta x_{-l} + \varepsilon_t \quad (3)$$

$$\Delta x_t = \alpha_0 + \alpha_1 \Delta x_{t-1} + \ldots + \alpha_l \Delta x_{t-l} + \beta_1 \Delta y_{t-1} + \ldots + \beta_l \Delta y_{-l} + u_t \quad (4)$$

for all possible pairs of (x, y) series in the group. The reported p-value results from the Wald statistics for the joint hypothesis:

$$\beta_1 = \beta_2 = \ \ldots \ = \beta_l = 0 \qquad (5)$$

The null hypothesis is that x does not Granger-cause y in the first regression and that y does not Granger-cause x in the second regression.

Empirical Results

We begin by testing each of the time-series variables for a unit root. As expected, all of the economic time series variables are integrated to the order of one or I(1). In the level series, each of the variables fails to reject the null hypothesis of a unit root at the 10% level. Appropriate unit root lag length is determined by Schwarz's Information Criterion (SIC). Next we test 6 models for cointegration as reported in Table 2. All models indicate at least one cointegrating equation in the vector at a 5% level.[5]

Our VECM long-run cointegrating coefficients are provided in Table 3. Models 1 and 2 presents the results from 1988Q1 to 2012Q3. As a result of potential for collinearity, and suppression with our covariate estimates, we have modeled multiple parsimonious models. We find a positive long-run relationship between quarterly railroad carloads, crude oil and gasoline futures prices, and industrial property values. These results support the theory that transportation indicators do indeed have a statistically significant relationship with US industrial property values. Interestingly, we find quarterly truck tonnage has a negative long-run relationship. Our control variable, GDP, has the expected significant positive relationship as expected.

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[5] We utilize the Trace test while modeling Johansen's cointegration. The Maximum Eigenvalue test was also examined and provided similar results.

Next, we examine slightly shorter models from 1993Q4 to 2012Q3. These models (3-6) are truncated due to data availability with regards to our financial variables. We find similar positive long-run equilibrium relationship between industrial property values, 6 month crude oil and gasoline futures prices, and the DJTI. Again, we find a negative long-run equilibrium relationship between truck tonnage and industrial property values. We also find a negative relationship with the FTSE NAREIT Industrial REIT Index, possibly suppression resulting from collinearity issues between the variables as the bivariate correlations between the two variables is high.[6]

After having detected the presence of a long-run relationship between several of our variables of interest and industrial property values, we model reduced form OLS regression models and present the results in Table 4. In our longer period models, industrial values have a significant positive relationship with railroad carloads, crude oil and gas futures prices, and GDP confirming our previous results. We fail to find significance with regards to truck tonnage. In models 3-6, we find that both of our differenced financial variables have the expected positive relationship with industrial property values. The FTSE NAREIT Industrial Index appears to have a considerable significant positive short-run impact on the change in industrial property values. This result is contrary to the VECM in regards to the sign, pointing to possibly collinearity issues with the level series. While positive, we do not find a significant relationship between the NCREIF industrial index and the DJTI.

[6] A correlation matrix inclusive of our variables supports the contention of a strong positive relationship between these variables.

In the short-run, crude oil and gasoline futures Granger cause industrial property values as shown in Table 5. These results imply that oil and gas futures prices are helpful in predicting short run changes in industrial property values. We also find that both the Dow Transportation and the FTSE Industrial REIT Indices have an effect upon the industrial property market in the United States, as our financial variables Granger cause industrial property values. As expected, the results show that the public equity markets are a barometer of forthcoming private sector property values. Lastly, changes to industrial property values Granger causes quarterly railroad carloads. This implies that as industrial properties are increasing in value, in the short run, it leads to an increase in railway shipments. Based on this finding it would seem that industrial property values are efficient in this respect, and are signaling future increases in railway shipments. Table 6 illustrates generally similar results for our Granger Causality tests over the total study period, sans our financial variables due to data availability.

Additionally, we examine the variance decompositions (VDC) to provide supplementary evidence to increase our understanding of the impact of the covariates on industrial property values in the short run. A 2.5 year forecast horizon estimates the impact of 1 standard deviation shocks to the time-series variables in the VECM. Ordering of the variables was performed with a Cholesky decomposition, where the most exogenous variables are shown first, while the industrial index is shown last.[7] VDCs provide estimates of the impact that each of explanatory variables have in initiating responses to unanticipated shocks in the variables (Xu and Fung, 2005). If there is little interaction between the variables, the diagonal element of this exhibit would have values close to

[7] We examined different orderings of the variables for the VDCs and the results were reasonably consistent. Gross domestic product, as shown in Table 7, was the leading explanatory variable.

100%, while stronger relations lead to much smaller percentages (McCue and King, 1994).

Table 7 shows the decomposition of the errors of the variables. Gross domestic product tends to explain the most forecast error variance in the industrial property values over the time period. For example, in model 5, gross domestic product explains 48% of the squared forecast error after 5 quarters. As expected, the futures prices have a substantial initial impact that dampens after 6 months. This shows their initial influence in the change of industrial valuations. Industrial REIT prices have an initial impact that steadily grows over time. The railroad carloadings, truck tonnage and DJTI appear to have little bearing overall. The aggregate of the variables predict between 50-76% of the squared forecast error over a 5 quarter time horizon. The decompositions appear to be very useful as they show that changes in GDP, crude oil and gasoline futures prices, and industrial REIT prices do affect the error in the short run.

Summary and Conclusions

In this study, we examine variations on some of Dow's contentions focusing on primary and secondary market trends, in a real estate environment. We contend that Dow Theory can provide a useful theoretical, and practical, application in the real estate markets, and particularly beneficial for this study providing insight into the U.S. industrial property prices and returns. We examine the short- and long-run relationship of industrial property prices with a combination of transportation (railroad carloads and truck shipments), futures prices (gasoline and crude oil), and the transportation and industrial real estate financial equity markets (Dow Transportation and FTSE NAREIT Industrial Indices).

The applicability of Dow Theory and the resurgence of manufacturing in the US afford relevance and appropriateness to the study.

The VEC models show positive long-run relationship between quarterly railroad carloads, crude oil and gasoline futures prices, and industrial property values. These results support the theory that transportation indicators do indeed have a statistically significant relationship with US industrial property values. The truncated sample inclusive of the financial equity market variables points towards a similar long-run equilibrium relationship between industrial property values, 6-month crude oil and gasoline futures prices, and the Dow Jones Transportation Index. Variance decomposition results points towards Gross Domestic Product, Oil and Gas Futures, and publicly traded industrial REITs has having substantial impact on industrial property values.

The results from the reduced form OLS models generally support the VEC findings, with significant positive relationships detected between changes in railroad carloads, crude oil and gas futures prices, and changes in industrial property values. The Granger-causality tests provide additional support verifying a short-run relationship between some of our variables of interest, as crude oil and gasoline futures, and the Dow Transportation and the FTSE Industrial REIT Indices, all Granger cause industrial property prices. We also find that industrial property prices seem to signal an increase in railway shipments.

In summary, the collective findings provide support in favor of the application of Dow Theory in this market. The oil and gas futures and financial equity market results are of notable interest, substantially increasing our understanding of the long- and short-run industrial property price discovery process. However, as our focus is structurally on the covariates, of potential concern is the possibility of collinearity in our long-run models. Even though we have been parsimonious in the selection of covariates, this is of particular concern with the interpretation of the coefficient on the FTSE NAREIT Industrial Index. The short-term relationship provided in the reduced from models and Granger causality test, helps substantially with our understanding of the relationship between the public and private industrial real estate markets. Public industrial REITs tend to lead the private industrial property market.

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Acknowledgements

We thank Colin Lizieri, Pamela Wardner, Michael Hefferan, Hugh Devereaux, and Chris Hannum for their helpful comments. We are grateful for the remarks of participants at the 2014 American Real Estate Society meetings at Coronado, California. Lastly, we are indebted to NCREIF, NAREIT, the AAR, ATA, CSI, Inc. and the BEA for the data utilized in this research.

Table 1 – Summary Statistics

Variable	Obs.	Minimum	Maximum	Mean	Std. Dev.
Industrial Index	99	371.74	2269.25	1047.83	629.58
Railroad Carloads	99	3293369	4596043	4220952.9	274811.13
Truck Tonnage	99	50.05	123.72	94.51	21.44
GDP	99	8440.5	15539.6	12141.9	2323.9
Crude Oil Futures	99	12.95	142.59	40.71	30.18
Gasoline Futures	99	0.38	3.44	1.13	0.79
REIT Index	76	100	934.17	372.72	232.66
DJTA Index	76	121.62	490.21	303.07	99.82

Notes: This table presents summary statistics on the sample of variables modeled. The first column contains the number of quarterly observations. The railroad carloads are summed weekly totals for the given quarter, crude oil and gasoline futures prices are end-of-day prices on the first day of the quarter. The other variables are reported as level indices.

Table 2 – Johansen's Cointegration Test

Number of Cointegrating Vectors	Eigenvalue	Trace Statistics	Critical Value at 5%	*p*-value
Model 1 (IV, RR, TT, CF, GDP)				
0	0.380	84.933	69.818	0.002
1	0.206	40.930	47.856	0.190
2	0.129	19.690	29.797	0.444
3	0.056	6.981	15.494	0.579
4	0.017	1.648	3.841	0.199
Model 2 (IV, RR, TT, GF, GDP)				
0	0.285	82.575	69.818	0.003
1	0.236	49.927	47.856	0.031
2	0.116	23.716	29.797	0.212
3	0.094	11.743	15.494	0.169
4	0.021	2.139	3.841	0.143
Model 3 (IV, RR, TT, CF, RE, GDP)				
0	0.492	129.222	95.753	0.000
1	0.392	80.319	69.818	0.005
2	0.343	44.386	47.856	0.102
3	0.087	14.119	29.797	0.833
4	0.068	7.535	15.494	0.516
Model 4 (IV, RR, TT, GF, RE, GDP)				
0	0.466	133.341	95.753	0.000
1	0.438	88.077	69.818	0.000
2	0.359	46.463	47.856	0.067
3	0.092	14.407	29.797	0.817
4	0.075	7.429	15.494	0.528
Model 5 (IV, RR, TT, CF, DI, GDP)				
0	0.420	105.498	95.753	0.009
1	0.304	66.160	69.818	0.094
2	0.210	40.013	47.856	0.222
3	0.177	23.005	29.797	0.245
4	0.094	8.963	15.494	0.368
Model 6 (IV, RR, TT, GF, DI, GDP)				
0	0.421	103.956	95.753	0.012
1	0.276	64.024	69.818	0.132
2	0.204	40.426	47.856	0.207
3	0.168	23.694	29.797	0.213
4	0.101	10.199	15.494	0.265

Table 2 (continued)

Notes: This exhibit presents the unrestricted cointegration rank test (Trace). Each model indicates at least 1 cointegrating equation at the 5% confidence level. The parameter estimates are from the Johansen's test using quarterly data over the time periods included in the study. Models 1 and 2 cover the study period 1988Q1 to 2012Q3, while models 3-6 cover 1993Q4 to 2012Q3. The variables are as follows: IV = NCREIF Industrial Property Index, RR = Railroad carloadings, TT = Truck tonnage, CF = Crude oil futures prices, GF = Gasoline futures prices, RE = NAREIT Industrial Index, DI = Dow Jones Transportation Index and GDP = Gross domestic product.

Table 3 – Vector Error Correction Model (VECM) Cointegrating Coefficients

Model	1	2	3	4	5	6
Industrial Values	1.00	1.00	1.00	1.00	1.00	1.00
Railroad Carloads	0.57**	1.14**	4.28***	3.22***	0.34	3.07***
Truck Tonnage	-1.95***	-2.61***	-2.47***	-1.72***	-2.07***	0.23
Crude Oil Futures	0.12***		0.38***		0.19***	
Gas Futures		0.17*		0.36***		0.37***
REIT Index			-0.50***	-0.37***		
DJTI					-0.06	0.65***
GDP	5.32***	6.17***	7.73***	6.33***	5.09***	1.80**

Notes: This exhibit presents the multivariate VECM cointegrating coefficients. Industrial values are the quarterly market property values in the NCREIF industrial index. Railroad carloads are the United States railroad carloads and intermodal units from the Association of American Railroads, while Truck Tonnage is collected from the For-Hire United States Truck Tonnage Index as surveyed by the American Truck Association. Futures prices are the 6 month crude oil and gasoline future price collected from Commodity Systems, Inc. The REIT index is the FTSE NAREIT Industrial Index and the DJTI is the Dow Jones Transportation Index. GDP is the United States gross domestic product. Models 1 and 2 cover the study period 1988Q1 to 2012Q3, while models 3-6 cover 1993Q4 to 2012Q3. The standard errors are in parentheses. *, **, *** denotes significance at 10%, 5% and 1%, respectively.

Table 4 – Ordinary Least Squares (OLS) First Difference Regression Results

Model	1	2	3	4	5	6
Intercept	-5.204	-1.898	19.011	19.163	10.052	9.518
	(16.757)	(16.359)	(22.614)	(22.400)	(25.871)	(25.392)
Δ Railroad Carloads	0.000***	0.000***	0.000**	0.000**	0.000**	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Δ Truck Tonnage	-0.728	-0.421	-0.453	-0.486	-0.590	0.453
	(1.628)	(1.568)	(1.647)	(1.605)	(1.896)	(1.831)
Δ Crude Oil Futures	1.807***		0.384		1.314*	
	(0.604)		(0.653)		(0.735)	
Δ Gas Futures		78.434***		24.881		61.879**
		(22.624)		(24.950)		(27.884)
Δ REIT Index			0.573***	0.551***		
			(0.119)	(0.120)		
Δ DJTI					0.339	0.287
					(0.253)	(0.252)
Δ GDP	0.201***	0.214***	0.063	0.069	0.171**	0.182**
	(0.073)	(0.072)	(0.080)	(0.080)	(0.088)	(0.087)
Adjusted R-squared	0.254	0.276	0.461	0.467	0.293	0.310
F-statistic	5.707	6.285	8.925	9.093	4.829	5.156

Notes: This exhibit presents results from a multivariate regression of the NCREIF industrial real estate index on the modeled variables. Railroad carloads are the quarterly total of United States railroad carloads and intermodal units from the Association of American Railroads, while Truck Tonnage is collected from the For-Hire United States Truck Tonnage Index as surveyed by the American Truck Association. Futures prices are the 6 month crude oil and gasoline future price, collected from Commodity Systems, Inc. The REIT index is the NAREIT industrial index return and the DJTI is the Dow Jones Transportation Index. GDP is the United States gross domestic product. Models 1 and 2 cover the study period from 1988Q1 to 2012Q3, while models 3-6 cover 1993Q4 to 2012Q3. The standard errors are in parentheses. *, **, *** denotes significance at 10%, 5% and 1%, respectively.

Table 5 – Granger Causality Results (1994 – 2012)

Null Hypothesis	*F*-Stat.	*P*-value
Railroad Carloads does not Granger Cause Industrial Value	0.33	0.85
Industrial Value does not Granger Cause Railroad Carloads	7.02	0.00
Truck Tonnage does not Granger Cause Industrial Value	3.01	0.02
Industrial Value does not Granger Cause Truck Tonnage	0.72	0.58
U.S. GDP does not Granger Cause Industrial Value	8.82	0.00
Industrial Value does not Granger Cause U.S. GDP	0.82	0.51
Crude Oil Futures does not Granger Cause Industrial Value	20.23	0.00
Industrial Value does not Granger Cause Crude Oil Futures	1.84	0.13
Gasoline Futures does not Granger Cause Industrial Value	14.34	0.00
Industrial Value does not Granger Cause Gasoline Futures	2.54	0.05
Industrial REIT Prices does not Granger Cause Industrial Value	3.83	0.01
Industrial Value does not Granger Cause Industrial REIT Prices	1.25	0.30
Dow Transportation Index does not Granger Cause Industrial Value	2.23	0.07
Industrial Value does not Granger Cause Dow Transportation Index	0.73	0.57

Notes: This table presents the results of the Granger Causality tests on the differing variables in the multivariate VAR models. Industrial Values are the quarterly industrial real estate values provided by the National Council of Investment Fiduciaries (NCREIF). Railroad Carloads represent the total of United States carloads originated for all commodities, while Truck Tonnage is collected from the American Trucking Association's (ATA) for hire trucking index. Crude Oil Futures and Gasoline Futures are the 6 month Light Sweet Crude Oil (CL) and Gasoline (RB) futures prices. Industrial REIT Prices are obtained from the FTSE NAREIT Equity Industrial Index and the Dow Transportation Index (DJIT) is a price weighted index of the returns of some of the largest United States transportation companies. Each test includes 4 lags of the variables. Only relationships with Industrial Values, our main variable of interest, are shown here for the sake of brevity. Other results between all variables can be provided upon request.

Table 6 – Granger Causality Results (1988 – 2012)

Null Hypothesis	*F*-Stat.	*P*-value
Railroad Carloads does not Granger Cause Industrial Value	0.55	0.69
Industrial Value does not Granger Cause Railroad Carloads	7.12	0.00
Truck Tonnage does not Granger Cause Industrial Value	2.60	0.04
Industrial Value does not Granger Cause Truck Tonnage	0.50	0.73
U.S. GDP does not Granger Cause Industrial Value	9.91	0.00
Industrial Value does not Granger Cause U.S. GDP	0.52	0.72
Crude Oil Futures does not Granger Cause Industrial Value	3.02	0.02
Industrial Value does not Granger Cause Crude Oil Futures	0.81	0.52
Gasoline Futures does not Granger Cause Industrial Value	2.12	0.09
Industrial Value does not Granger Cause Gasoline Futures	1.67	0.17

Notes: This table presents the results of the Granger Causality tests on the differing variables in the multivariate VAR models. Industrial Values are the quarterly industrial real estate values provided by the National Council of Investment Fiduciaries (NCREIF). Railroad Carloads represent the total United States carloads and intermodal units originated for all commodities, while Truck Tonnage is collected from the American Trucking Association's (ATA) for hire trucking index. Crude Oil Futures and Gasoline Futures are the 6 month Light Sweet Crude Oil (CL) and Gasoline (RB) futures prices. Each test includes 4 lags of the variables. Only relationships with Industrial Values, our main variable of interest are shown here for the sake of brevity. Other results between all variables can be provided upon request.

Table 7 – Variance Decomposition of Industrial Values in the Multivariate Models

Model 1	IV	RR	TT	CF	GDP	
1	91.78083	0.639892	0.026766	1.876988	5.675523	
2	63.16324	0.884707	3.779612	9.960836	22.21160	
3	58.23571	4.487735	6.445870	5.893601	24.93709	
4	53.74325	8.928220	10.83425	4.430890	22.06340	
5	54.98841	10.65748	9.778453	2.632533	21.94313	
Model 2	**IV**	**RR**	**TT**	**GF**	**GDP**	
1	92.35559	0.265754	0.084247	3.199302	4.095109	
2	68.18265	1.567775	1.560341	7.426224	21.26301	
3	58.03247	1.015195	1.039456	7.422588	32.49029	
4	53.15311	0.918685	0.739659	7.014102	38.17444	
5	51.10039	0.814205	0.648696	6.585551	40.85116	
Model 3	**IV**	**RR**	**TT**	**CF**	**RE**	**GDP**
1	77.45541	1.055490	0.016637	11.59958	8.063264	1.809618
2	42.88149	0.950408	0.135433	31.76770	8.033030	16.23194
3	37.66434	0.484523	2.071281	19.11192	12.98168	27.68626
4	32.92671	0.580985	4.827837	15.78036	16.24507	29.63904
5	29.74157	1.039449	6.273278	11.65453	21.11466	30.17651
Model 4	**IV**	**RR**	**TT**	**GF**	**RE**	**GDP**
1	71.92427	2.286707	0.287812	20.99995	1.884290	2.616979
2	32.26697	2.034450	0.303102	39.57149	3.240237	22.58375
3	29.56060	0.932650	2.291805	24.00672	6.843628	36.36459
4	25.38006	0.608636	4.923201	19.62277	8.914627	40.55071
5	23.39564	0.650479	6.250363	14.47226	12.46502	42.76625
Model 5	**IV**	**RR**	**TT**	**CF**	**DI**	**GDP**
1	88.29076	1.695810	0.049348	4.386426	0.021706	5.555954
2	55.12084	1.058589	0.036240	18.92731	0.423966	24.43305
3	47.14135	0.580302	1.299987	9.263768	0.847840	40.86675
4	41.65382	0.335477	3.357564	6.409652	2.794771	45.44872
5	38.28193	0.251538	4.104770	4.171752	4.765709	48.42430
Model 6	**IV**	**RR**	**TT**	**CF**	**DI**	**GDP**
1	82.08426	6.031115	0.003516	9.381067	0.008949	2.491097
2	50.27362	4.637950	0.144575	24.76560	0.012052	20.16620
3	50.23627	2.590627	1.343660	14.36086	0.016055	31.45253
4	49.02336	1.519769	2.329159	10.15515	0.015976	36.95659
5	50.24772	1.035429	2.094650	6.865598	0.011434	39.74517

Notes: The table entries are the percentage of industrial property index forecast error variance explained by a one standard deviation shock in the variables included in the VEC models. The forecast is for a 2.5 year time horizon, but only quarters 1-5 are shown. The variables are defined as follows: IV = NCREIF Industrial Property Index, RR = Railroad carloadings, TT = Truck tonnage, CF = Crude oil futures prices, GF = Gasoline futures prices, RE = NAREIT Industrial Index, DI = Dow Jones Transportation Index and GDP = Gross domestic product. A Cholesky decomposition ordering is utilized with the dependent variable included last in the order.