The Logistics Managers' Index

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Abstract

Over the past 18 months, a group of supply chain researchers, in conjunction with the Council of Supply Chain Management Professionals (CSCMP), Supply Chain Quarterly, and DC Velocity have conducted a study measuring movements and rates of growth in the logistics industry. The Logistics Managers Index (LMI) is a tracking metric of logistics activity in the United States. Specifically, it is a bi-monthly measure of activity, as measured by a survey of supply chain professionals. In this article we present the methodology and the results of the first 18 months of the index.

Introduction

The goal of the Logistics Manager's Index (LMI) is to track movements in the logistics industry as we believe many of the metrics we measure function as leading economic indicators. Many measures of economic activity, such as GDP or GNP, are backward-looking in that they report economic growth and contraction after it has already happened, at the final point of consumption. While there is value to lagging indicators, such as GDP, there primary value is not predictive.

The purpose of this index is to track and compile metrics which we believe are leading, predictive indicators of the economy. The metrics used in this endeavor are elements of inventory, warehousing, and transportation. These three metrics are useful as leading indicators because they track economic movement both downstream, near the point of consumption, and upstream within the supply base. Additionally, traditional, consumption-based

measures only track the final sale of a good or service. In reality, the economic impact of many goods extends upstream preceding the final point of sale. Goods need to be purchased, stored in inventory, and shipped multiple times to different points in the supply chain. These activities precede the final point of sale and, if tracked, can act as leading indicators of movements in the economy.

Many industries, particularly retail, are moving away from the old distribution model based on low costs, low inventory, and long distances towards a more complex model which prioritizes delivery speed and customer service. As the economy continues to shift towards online retailing and fulfillment, firms are investing in distribution centers, many of which are being located closer to potential consumers in order to shorten delivery times and improve service levels.[1] With this emphasis on service levels, there is an increased demand put on both warehousing and transportation. Delivery speed is one of the key factors consumers consider when deciding whether to make an online purchase,[2] and firms are paying premiums to ensure flexible shipping capacity on short notice.[3] This increased demand on both transportation and warehouse space, exacerbates the struggle firms face to carry enough inventory to satisfy customer expectations. Amazon will spend billions of dollars over the next few years to build up a warehousing network and transportation fleet to meet customer demand.[4] They would not be making these large expenditures on an area seemingly outside of their core competencies if the retail environment was not shifting.

The eight metrics captured in the LMI are: inventory levels, inventory capacity, warehouse capacity, warehouse utilization, warehouse prices, transportation capacity, transportation utilization, and transportation prices. As more goods are moved, more inventory must be stored in more warehouses, and moved with more trucks. When firms are anticipating more economic activity, utilization and pricing metrics should increase and capacity metrics should decrease. When firms are expecting less economic activity, the opposite should be true. Currently, there are no indices measuring this combination of inventory, warehousing, and transportation metrics, or tracking the relationships between them. The Logistics Manager's Index is designed to fill this gap.

The remainder of this paper is structured as follows: In section two we will describer our methodology, section three is dedicated to an exploration of the eight components of the Logistics Manager's Index, movement in those components over time, and the relationships between them. Finally, we conclude with a discussion of the findings of the first 18 months of the LMI, and look forward to future readings.

Methods

In order to collect data on these metrics, the Logistics Mangers' Index survey is sent out to a panel of respondents and published on a bi-monthly basis. The respondents in this panel are members of CSCMP or subscribers to DC Velocity or Supply Chain Quarterly who are currently working at the director-level or above. Upper-level managers are preferable as they are more likely to have macro-level information on operations within their firm.[5] Data is also collected from subscribers to both DC Velocity and Supply Chain Quarterly as well. Respondents are all based in the U.S., with the majority of them working at firms with annual revenues over a billion dollars. The industries represented in this respondent pool include, but are not limited to: Apparel, Automotive, Consumer Goods, Electronics, Food & Drug, Home Furnishings, Logistics, Shipping & Transportation, and Warehousing.

Respondents are asked to identify the monthly change across each of the eight metrics collected in this survey (Inventory Levels, Inventory Costs, Warehousing Capacity, Warehousing Utilization, Warehousing Prices, Transportation Capacity, Transportation Utilization, and Transportation Prices). In addition, they also forecast future trends for each metric ranging over the next 12 months. Similarly to the Purchasing Manager's Index (PMI), a diffusion index is used to analyze the raw data collected from our panel. Diffusion Indices measures how widely growth or contraction is diffused across a group. It has been found to be superior to other statistical benchmarking techniques when analyzing long-term, repetitive data.[6] The diffusion index measures whether the metric in question is growing or contracting, with any overall value of less than 50.0 indicating contraction, and any value over 50.0 indicating growth.

We compute the Diffusion Index as follows:

PD = Percentage of respondents saying the category is Declining
PU = Percentage of respondents saying the category is Unchanged
PI = Percentage of respondents saying the category is Increasing
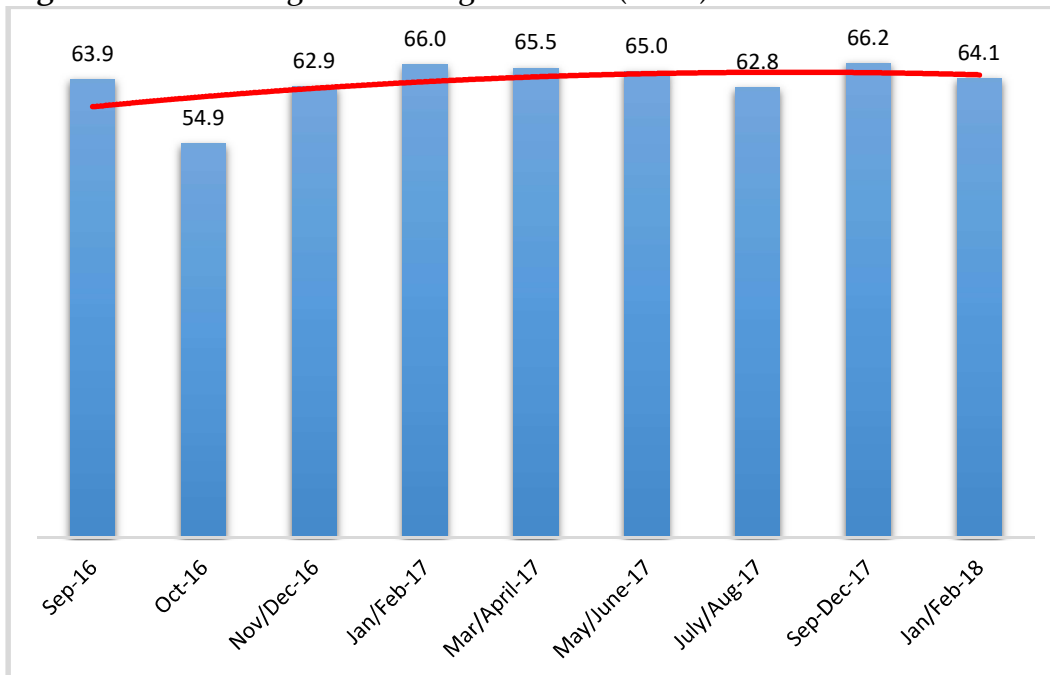*Diffusion Index = 0.0 * PD + 50.0 * PU + 100.0 * PI*

Results

Every reading since the beginning of this project in September of 2016 has indicated growth in the logistics industry. The index scores from every reading, as well as a trend line tracking overall movements, is presented in Figure 1 below. The recent reading made in the fourth quarter of 2017 came in as the highest overall index score in the history of the Logistics Manager's Index. The overall index score for January-February 2018 is 64.1, down slightly from September-December of 2016 but still indicating growth in the overall logistics industry. The overall readings of the LMI, from September of 2016 to

the January and February of 2018, are presented in the figure below. An index score about 50.0 indicates growth in the overall logistics industry. The average of our readings over the first 18 months of this index is 63.5, and no overall index reading has come in below 54.9. The logistics industry has been in a constant state of growth (albeit at varying rates of growth) throughout the 18 months of the LMI. As has often been the case, the overall index growth in the current period is primarily driven by warehousing and transportation prices and utilization. This may reflect the increasing price pressures firms are facing due to shifting consumer expectations.

Figure 1. Overall Logistics Manager's Index (LMI®)

There are eight factors that make up the Logistics Manager's Index: inventory levels, inventory capacity, warehouse capacity, warehouse utilization, warehouse prices, transportation capacity, transportation utilization, and transportation prices. In the following eight subsections below, we will describe the eight components of the LMI, and why we feel they are crucial to understanding the overall movement in the logistics industry and general economy. We also discuss the movement of these components over the eighteen months of the LMI as well as the relationships between them.

Reflecting the tightening in transportation mentioned above, available capacity has been reported to be contracting sharply throughout the second
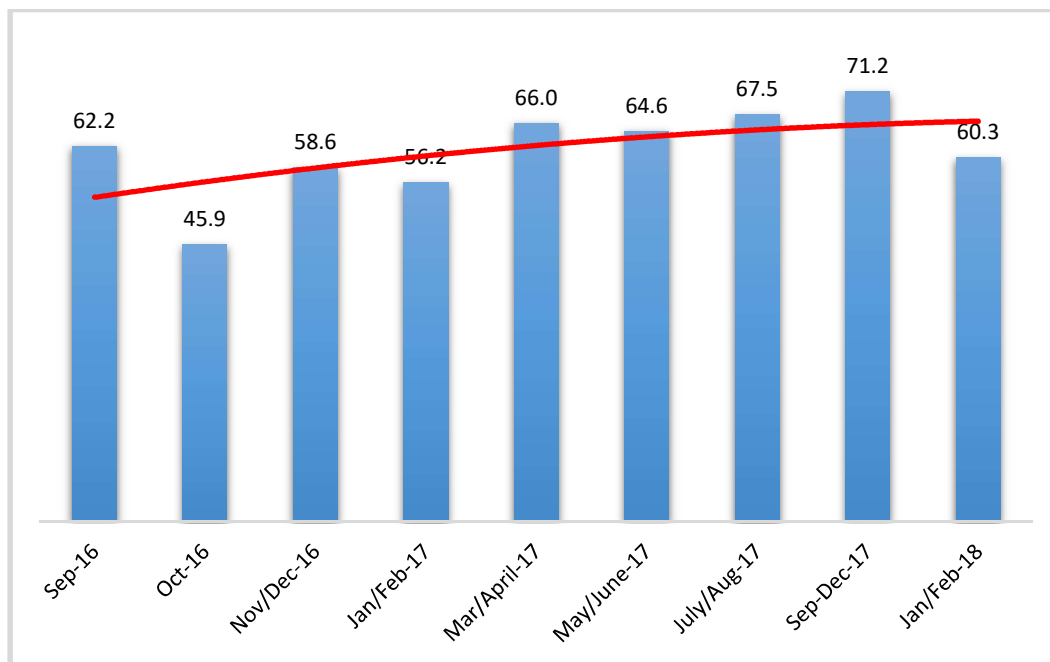
half of 2017. This is likely due to the volume of shipments moving inventory throughout supply chains and towards consumers over the last six months.

Logistics Index Components
Inventory

Inventory functions as a key metric in the overall logistics industry as the level of inventory carried by firms is directly correlated to the amount of inventory they believe they will be able to move. All of the inventory level readings of the first 18 months of the LMI are presented in Figure 2 below. In the second half of 2017 we observe a steep upward trend in the level of inventory being carried by firms. The January/February reading came in at 60.3, over 10 points lower than in the fourth quarter of 2017. This likely indicates that companies are expecting lower sales in the first quarter of 2018 as the retail market cools after the holiday season.

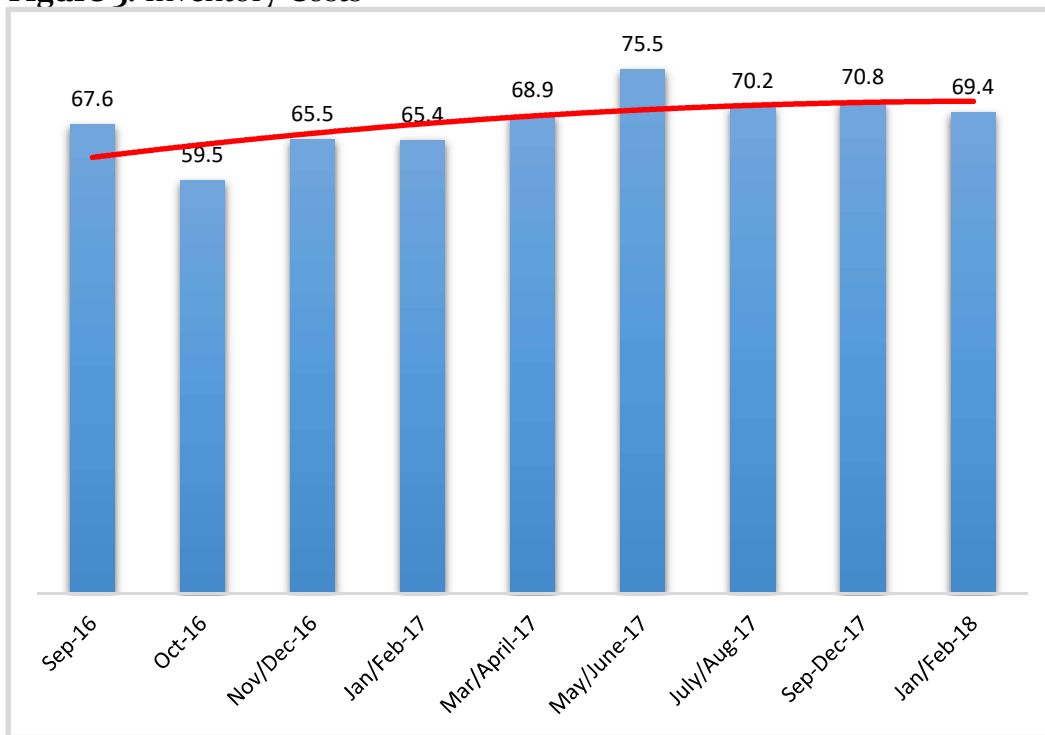**Figure 2.** Inventory Levels

Inventory Costs

The Logistics Manager's Index also measures changes in inventory costs. All previous inventory cost index scores are presented in Figure 3 below. Similar to inventory levels, January/February 2018 inventory costs were down from their previous levels in the fourth quarter of 2017. However, this dip was less significant, decreasing only 1.4 points, compared to a 10.9 point period-to-period decrease for inventory costs. This is representative of an interesting

pattern that has emerged over the first 18 months of the LMI. Linear regression tracing the correlations between inventory levels and inventory costs suggests that, while the two often move together, the moves in inventory levels are greater than the corresponding moves in inventory costs. For every one point movement in inventory levels over the first 18 months of the LMI, analysis revealed a 0.61 point movement in inventory costs. This indicates that wider fluctuations are observed in inventory levels than in inventory costs over the same period of time. Also, unlike inventory levels, inventory costs have displayed at least some level of growth in every period, while inventory levels contracted in October 2016.
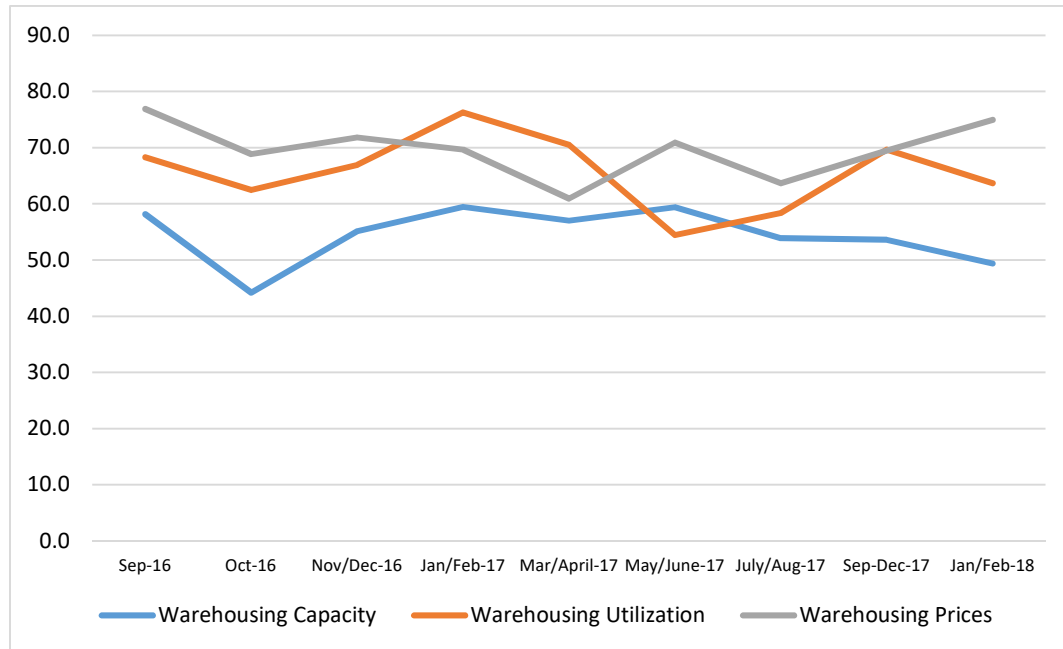
Figure 3. Inventory Costs

Warehousing

The LMI also tracks three warehousing metrics in its assessment of the overall logistics industry. Those three components are warehouse capacity, utilization, and price. Figure 4 below displays the index scores of the three warehousing components of the LMI over the first 18 months of this index. An inverse relationship exists between movements in warehousing prices and warehousing capacity. This inverse relationship seems to have been exacerbated over the most recent readings, with warehousing capacity currently at 49.4 and contracting, and warehousing prices currently at 75.0, which is the highest score for this metric since September 2016. Warehouse

utilization has displayed wider fluctuations than the two other warehousing metrics, it is the only one of the three metrics to have been both the highest and lowest warehouse metric in a given period.

Figure 4. Comparison of Warehousing Metrics

Warehousing Capacity   Warehousing Utilization   Warehousing Prices

Warehousing Capacity

Changes in warehousing capacity over the first 18 months of the LMI is presented in Figure 5 below. For the second time in the 18 months of the Logistics Manger's Index, warehousing capacity contracted in January/February 2018. However, with an index score of 49.4, capacity is only slightly decreasing. The growth in warehousing capacity has been fairly mild. It is the only metric that has never registered a growth rate in the 60's over the 18 months of this index. This indicates that, while warehouse capacity is growing, it is doing so at a slower rate than the other components in the LMI. The only component that displays similar levels of growth is transportation capacity. The rate of growth peaked in early 2017 and has been steadily decreasing since then, finally reaching a point of contraction in January/February 2017.

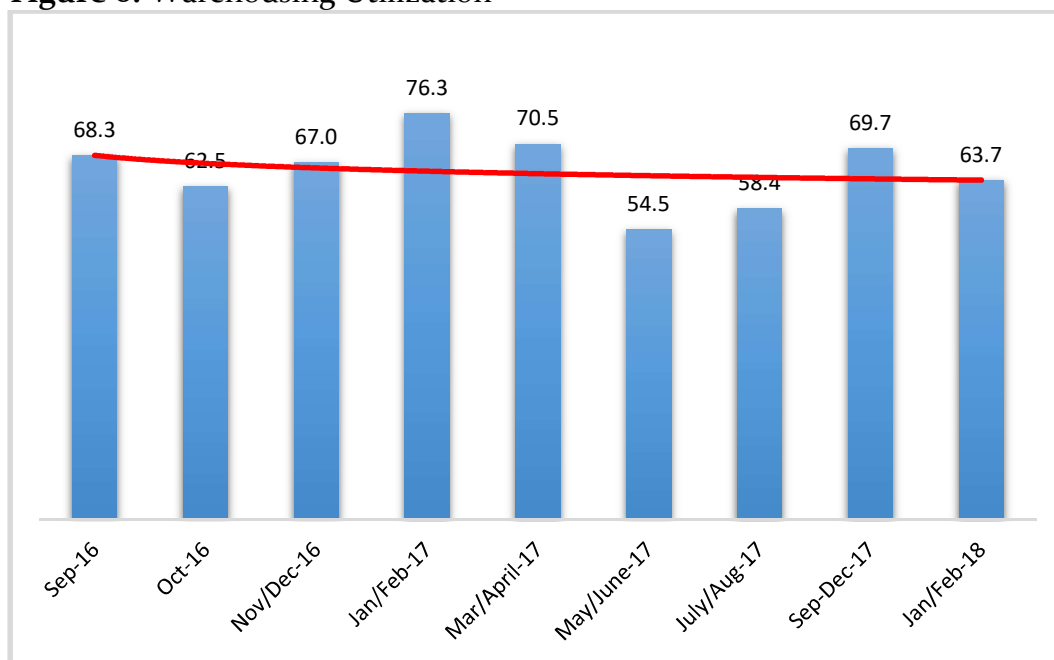**Figure 5.** Warehousing Capacity

Future Warehouse Capacity

As discussed above, to meet changes in expectations of overall service levels, firms are increasing the footprint of their distribution network by building more capacity. To test logistics components associated with expected changes in warehouse capacity, a regression analysis was utilized to determine the predictors of future movement in warehouse capacity. Strong, positive relationships between future warehouse capacity with future transportation utilization future transportation capacity, and future warehouse utilization were found. This indicates that warehouse capacity will increase as firms push to meet heightened consumer expectations. Available transportation capacity may increase as well as supply chains are built out to satisfy this demand. Interestingly, no statistically significant relationship exists between future warehouse price and future warehouse capacity. Perhaps the expectation is that by increasing capacity, prices will remain at a steady-state (although not enough capacity will be built to actually decrease prices). Finally, a moderate positive relationship between future inventory levels and future warehouse capacity was found. As inventory levels continue to rise, more space will be required to store it.

Warehouse Utilization

Changes in warehousing utilization over the 18 months of the LMI is displayed in Figure 6 below. The warehousing utilization index registered 63.7 in January/February, this is down from 69.7 percent in September-December. Utilization has displayed some level of growth in every period over the 18 months of the LMI, the only change is in the rate of growth reading-to-reading. The variance of the rate of growth has been fairly consistent, with the trend line displaying a nicely-fitted curve over the course of this index.
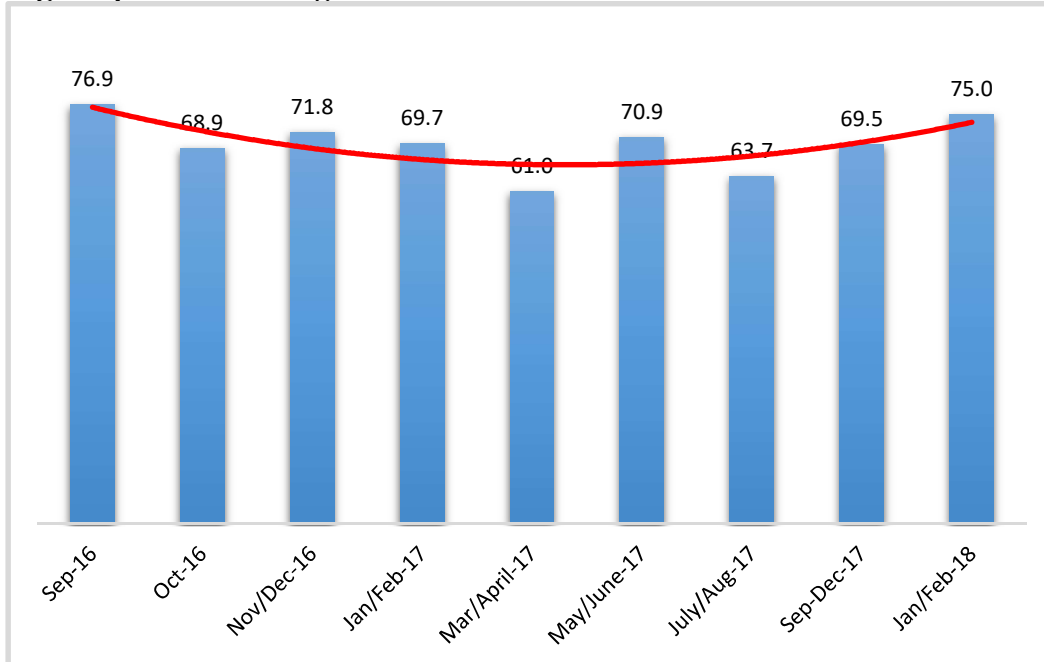
Figure 6. Warehousing Utilization

Warehousing Prices

Changes in warehousing pries over the 18 months of the LMI are presented in Figure 7 below. The Warehousing Prices Index registered 75.0 in January/February 2018, which is this metric's highest score since September 2016. This metric has been over 50.0, and therefore growing, in every reading of the LMI. The u-shaped trend line indicates that, while the rate of growth had slowed in the early part of 2017, the growth rate has been increasing over the last several periods. The increase in Prices corresponds with our readings on the growth in both Inventory Levels and Warehouse Utilization.
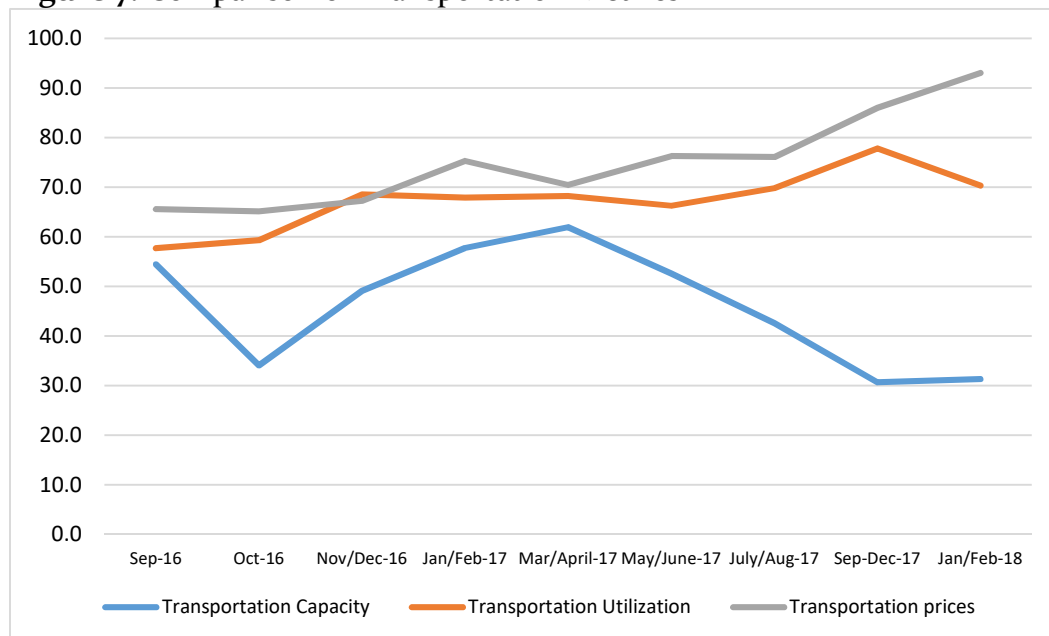
Figure 7. Warehousing Prices

To understand the growth of warehousing prices, regression analysis was conducted to determine the relationships between warehouse price and some of the other elements of the LMI. A statistically significant and strong positive relationship was found between warehouse and transportation prices. As firms spend more capital to store inventory, they also spend more to transport it. A strong, statistically significant negative relationship exists between warehouse capacity and warehouse price. As warehouse space becomes tighter due to the desire to locate inventory closer to consumers to decrease shipping times, the cost of warehouses increases. Movements in warehouse price are also associated with movements in warehouse utilization. As firms are using more of the space available to them, prices are going up. Finally, a statistically significant strong positive relationship exists between the cost of inventory and warehouse price, but no relationship exists between warehouse price and inventory levels. This indicates that the price of warehousing is associated more with the value of the inventory being stored than it is with the quantity of that inventory.

Transportation
Transportation has been considered a leading indicator of economic growth. The logic being that as more goods are moved from their point of origin towards customers, more transportation is needed. This is exasperated by the shift from traditional brick and mortar retail towards online retail

which is necessarily more transportation-intensive. The three transportation metrics tracked in the LMI are transportation capacity, cost, and price. Figure 7 below displays the movement in these three metrics over the first 18 months of the LMI. This figure suggests a fairly positive, consistent relationship exists between movements in transportation utilization and transportation price. This is in contrast to the inverse relationship displayed between movements in transportation price and transportation capacity. Transportation capacity has consistently measured as the lowest metric in this index, with an average reading of 46.1, indicating contraction. In comparison, transportation price has been the highest scoring metric. It's average index score of 75.0 over the first 18 months of the LMI indicates significant levels of growth.
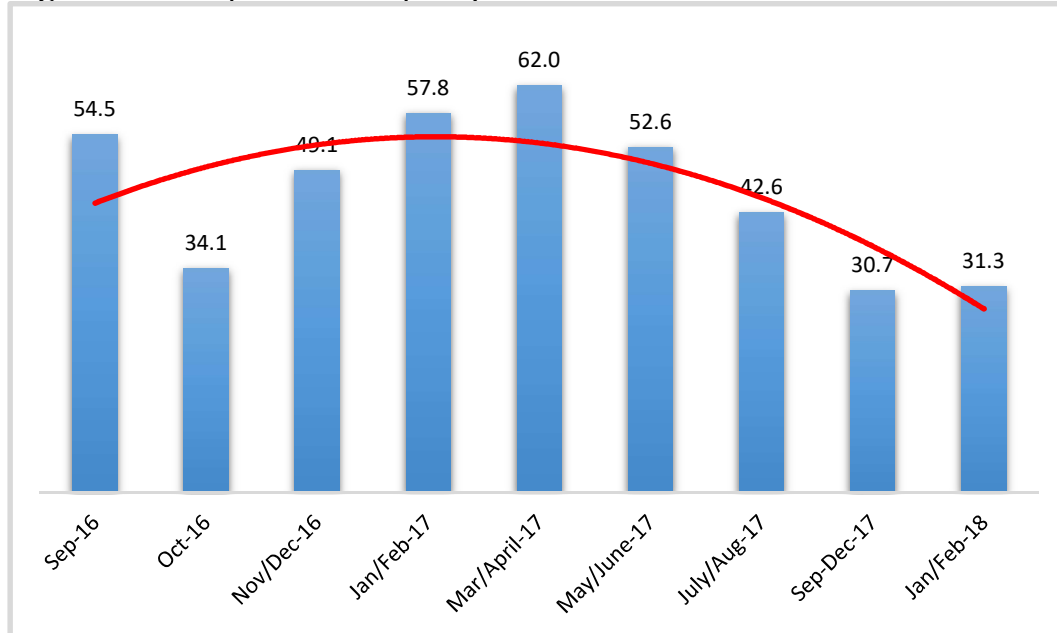
Figure 7. Comparison of Transportation Metrics

Transportation Capacity

Changes in transportation capacity over the 18 months of the LMI are presented in Figure 8 below. Transportation capacity registered at 31.3 in January/February 2018. This is a continuation of the downward sloping trend in transportation capacity since March/April of 2017, and contraction in transportation capacity since July/August 2017. The trend line in Figure 8 is shaped differently than the trend lines for any other metric in the LMI. The trend line for transportation capacity peaked in early 2017 and has sloped consistently downward since that time.

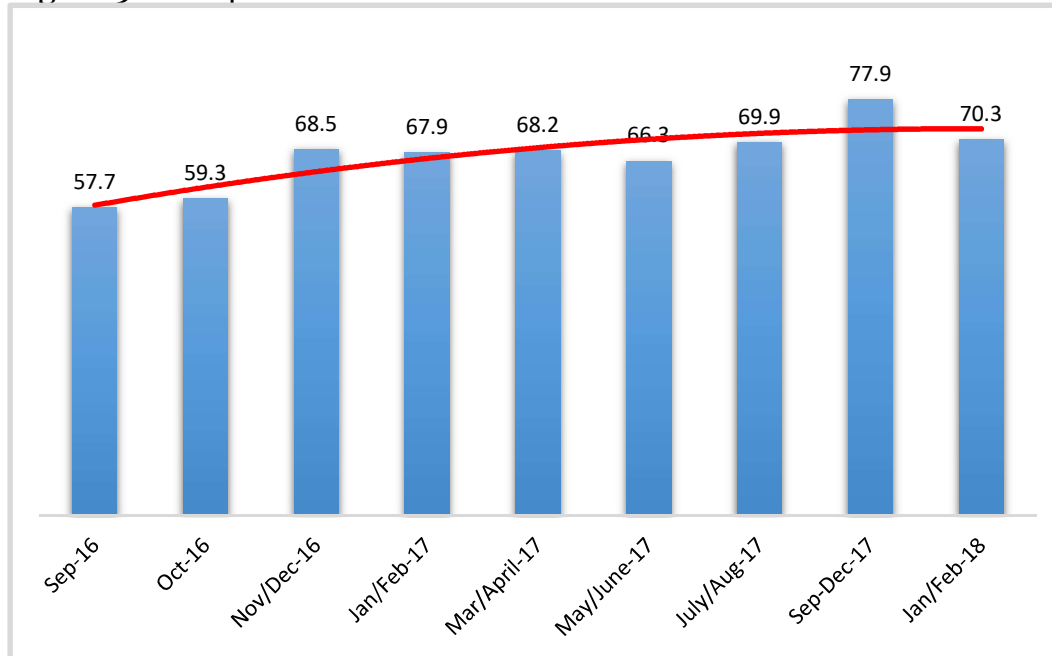**Figure 8.** Transportation Capacity

The tightening capacity is reflected in the explosive growth we have observed in transportation costs. In the course of our research we have found correlations on the ways transportation metrics grow together. Transportation capacity and prices have a sharp, inverse relationship. Meaning that in periods where capacity increases, prices go decrease and vice-versa. True to form, with transportation capacity at an all-time LMI lows in the last two readings of the LMI, transportation prices were reaching an all-time high over the same time frame.

Transportation Utilization
Movement in transportation utilization over the life of the LMI is presented in Figure 9 below. The transportation utilization index score for January/February 2018 is 70.3. This is down from the all-time high of 77.9 in the fourth quarter of 2017. Transportation utilization has been steadily increasing since the inception of this index in September 2016. The first two readings yielded index scores in the 50's, the next five readings were in the 60's, and the most recent two readings have been in the 70's. This suggests that as the availability of transportation has continued to tighten, the usage of that available transportation has continuously increased.
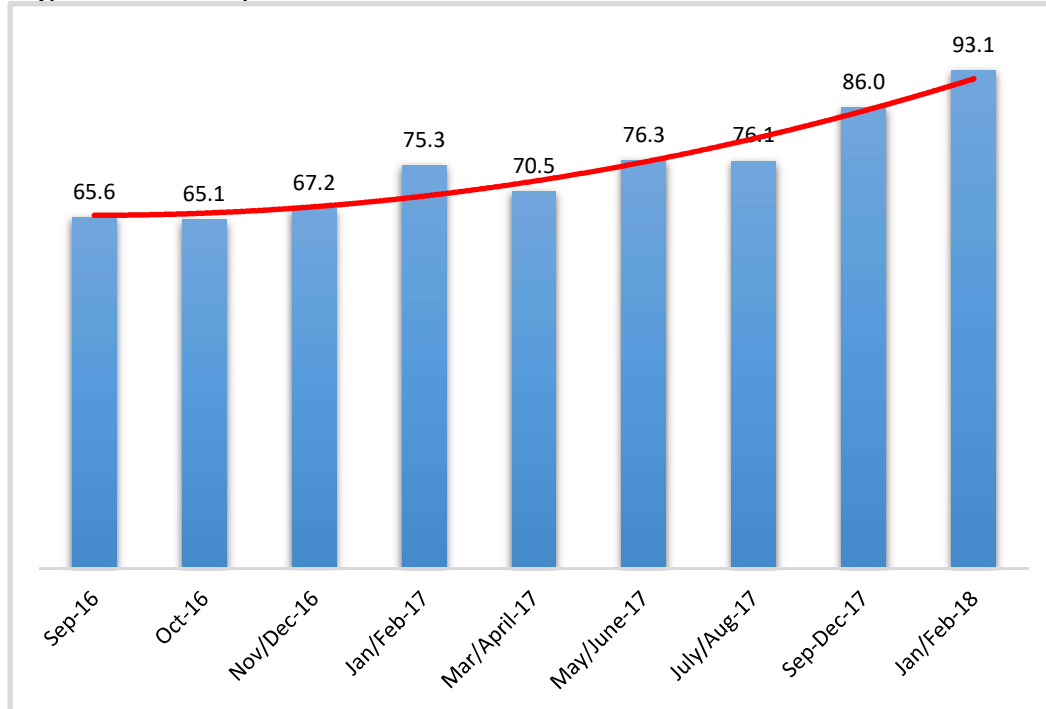
Figure 9. Transportation Utilization

While the increases in transportation utilization have been significant, they are much less then Transportation Price.

Transportation Price

Changes in transportation price over the course of the LMI are presented in figure 10 below. Transportation price reached an all-time index high of 93.1 in January/February 2018; breaking the record of 86.0 it set in the previous period. The increased rate of growth over the last four periods mirror the rates of contraction in transportation capacity over the same time period. Similar to transportation capacity, the shape of the trend line for transportation price, displayed in Figure 10 below, is unlike any of the other seven metrics in the LMI. Where the trend line for transportation capacity is sloped down, the trend line for transportation price climbs prodigiously upwards.

Figure 10. Transportation Prices

To better understand the explosive growth in transportation prices, a regression analysis was carried out to determine the relationship between transportation price and select elements of the LMI. Transportation cost has a statistically significant strong negative relationship with transportation capacity. As increasing demand for transportation restricts available capacity, the price of shipping will continue to increase. We find no direct link between transportation utilization and transportation price. However, when transportation utilization and capacity both increase, we see an increase in the cost of transportation. Similar to the prediction of warehouse prices above, we find a strong, positive correlation between transportation price and warehouse price. Once again, if firms are spending more money to hold inventory, they are likely spending more money to move it. Finally, we find a strong, statistically significant and positive relationship between transportation prices and inventory levels, but no relationship at all between transportation prices and the cost of inventory. This indicates that what really matters is how much inventory is being moved, and not the value of the inventory transported. This is a reversal of our findings for warehouse costs.

Conclusions

Research suggests that transportation functions as a leading economic indicator.[7] Holiday retail sales in 2017 were up 5.5% from 2016, exceeding projections.[8] This seems to be reflected in the overall LMI scores, but especially in the jump in transportation prices. With only 18 months of the LMI completed, more observations are needed to unequivocally state the precise ability of the LMI to act as a leading indicator for the economy. However, early returns, and preliminary analysis are promising, with the LMI growing along-side, and at times in advance of, the overall economy.

While we cannot yet unequivocally state the relationship between the LMI and future economic movement, the first 18 months of this index does clearly establish relationships between the components of the LMI. Perhaps the most clear of these relationships are those between warehouse and transportation price and warehouse and transportation capacity. All price metrics measured in this index have increased over time. Transportation prices in particular have grown an increasing rate. This is likely a function of strains on capacity wrought by changing consumer expectations for wider inventory selection and shorter delivery times.

This is borne out by the positive relationships between transportation prices, warehouse prices, and inventory levels. Carrying high levels of inventory is among the factors that over-extends and strains both transportation and warehouse capacity. The LMI does not track promised service levels, but extant research indicates that firms promising higher levels of service to their customers, service primarily based around cheap, fast delivery also experience similar pressures.[9]

Thus far, the LMI has shown relatively consistent, positive movement over the life of the index. It is clear that the logistics industry, and its components, continue to increase in importance as we both accelerate the movement of product, while at the same time attempting to tighten inventories. Some of these dramatic changes are driven by shifts towards e-commerce and direct-to-consumer fulfillment that require more transportation and additional storage capacity.

While the researchers feel strongly that warehousing, transportation, and inventory trends are key economic indicators, the exact relationship between the LMI and the overall economy as indicated by GDP has yet to be established empirically. However, as more data is gathered for the index we will be able to more confidently check for the predictive capabilities of the LMI.

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Authors

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Endnotes

1. Rogers, D.S. & Rabinovich, E. (2017) Warehouse of the Future (pp.1-24). Tempe, AZ: JDA. Retrieved from https://research.wpcarey.asu.edu/wp-content/uploads/2017/06/Warehouses-of-the-future.pdf
2. Dotcom Distribution. (2016). Study: Delivery Time Influences 87 Percent of Online Shoppers' Purchase Decisions. *Dotcom Distribution*.
3. Smith, J. (2018, January 25). A Shortage of Trucks Is Forcing Companies to Cut Shipments or Pay Up. *The Wall Street Journal*.
4. Berman, J. (2017, October 5). Report says Amazon is focusing on in-house delivery service. *Logistics Management*.
5. Swink, M., Melnyk, S.A., Hartley, J.L., & Cooper, M.B. (2017). *Managing operations across the supply chain*. McGraw-Hill Education.
6. Stock, J.H., & Watson, M.W. (2002). Macroeconomic Forecasting Using Diffusion Indexes. *Journal of Business & Economic Statistics*, 20(2), 147–162
7. Bureau of Transportation Statistics. (2014, December 8). Research Confirms Transportation Index as Leading Indicator. Retrieved February 2, 2018, from https://www.bts.gov/newsroom/research-confirms-transportation-index-leading-indicator
8. Shearman, J.C., & Smith, A.S. (2018, January 12). Holiday Retail Sales Increased 5.5 Percent in 2017, Exceeding NRF Forecast and Showing Strongest Gain Since Great Recession. Retrieved February 2, 2018, from https://nrf.com/media/press-releases/holiday-retail-sales-increased-55-percent-2017-exceeding-nrf-forecast-and
9. Rogers, D.S. & Rabinovich, E. (2017) Warehouse of the Future (pp.1-24). Tempe, AZ: JDA. Retrieved from https://research.wpcarey.asu.edu/wp-content/uploads/2017/06/Warehouses-of-the-future.pdf