Does the inclusion of transport indicators enhance the performance of the CLIs?

The case of China

By

Michela Bello and Roberto Astolfi

Abstract

This paper investigates whether the addition of transport indicators enhances the leading performance of the OECD Composite Leading Indicator (CLI) for China. The study focuses on the comparative performance of freight and passengers transport indicators, and the combination thereof. Coupling classical NBER assessment measures of the CLI lead performance at peaks and troughs with the receiver operating characteristic (ROC) curves, we conclude that the use of passenger and freight transport sector indicators, as additional components of current CLI, improves our ability in anticipate turning points in the Chinese business growth cycle, on average, by two months.

JEL Classification: C40, C43, E32, E37.
Keywords: business cycles, composite indicators, CLIs components, turning points, ROC.
1. Introduction

1. This study investigates whether the addition of transport indicators might improve the leading performance of the OECD Composite Leading Indicator (CLI) for China. Attention to the leading properties of transport indicators is not new and indeed dates back to the early studies by Mitchell and Burns (1938) and Moore (1950) who had included transport indicators among the list of cyclical indicators. However, in spite of those findings, and of the importance the sector plays in the global economy, transport indicators have rarely been used in the construction of leading indicators.

2. The work by Lahiri and his colleagues aims at filling this gap in the business cycle literature. In a study conducted in 2003, for instance, Lahiri, Yao and Young used four coincident indicators representing different aspects of transport sector, including output, payroll, personal consumption and employment, and found evidence of the importance of these indicators in monitoring cyclical movements in economic activities.

3. In our study, we have opted for analysing the predicting performance of transport indicators in relation to the Chinese economy, as the transport sector represents an essential part of the latter. According to the International Transport Forum (2015 and 2017), China, together with the United States and India, accounts for nearly 80 percent of total estimated global rail freight. Similarly, China and India account for more than 70 percent of global rail passenger-kilometres. Furthermore, given the increasing involvement of China in the global value chain, the importance of this sector will, most likely, increase over time.

4. This paper differs from earlier studies focusing on the performance of the CLI for two reasons. Firstly, at the best of our knowledge, it represents the first attempt to use transport indicators in OECD CLIs. Secondly, following the studies by Berge and Jordà (2010), Lahiri and Wang (2013), and Lahiri and Yang (2015), the receiver operating characteristic (ROC) curves are adopted, for the first time, to evaluate the OECD-CLI leading performance. The latter is typically assessed by analysing mean and median lead time at turning points, the number of missed and extra turning points and the cross correlation between the CLI and the reference series. Competing CLI specifications are discriminated on the basis of a loss function that assigns scores to statistical indicators along with practical considerations on the extent to which each specification can actually be put in production. More recently, a few studies have explored the use of rolling-windows analysis, applied to the Granger causality, cross-correlation and concordance indices to assess the evolution of the CLI ability to anticipate business cycle fluctuations (Astolfi and Gamba 2018, Astolfi and Guidetti, 2018). The present study aims to bring further insights into this field.

5. Our findings suggest transport sector indicators, when used as additional components of the CLI for China, improve its ability in forecasting turning points in the Chinese growth cycle. Additionally, there is evidence that the leading properties of the new CLIs are stronger when the lead time horizon is lower than 9 months. Our analysis also points to the fact that a regular monitoring of the performance of newly introduced indicators is required as structural changes occurring in the economy may undermine their forecasting performance in the long term.

6. The paper is organized in 8 sections. After the introduction, section 2 reviews the related economic literature. Section 3 briefly describes the Chinese transport sector, while
section 4 illustrates the current OECD CLI for China. Methodology and data sources are described in sections 5 and 6, respectively. Section 7 illustrates the results. In section 8, we draw some conclusions.

2. Literature review

7. Lahiri, Yao and Young (2004) are among the precursors in exploring the macroeconomic forecasting potential of transport sector indicators. They utilize the U.S. transportation services index (TSI), developed in Lahiri et al. (2003) and now produced by the U.S. Department of Transportation, which combines eight series on freight and passenger movements from airlines, rail, waterborne, trucking, transit and pipelines (NAICS codes 481-486) covering around 90 percent of total for-hire transport. Their study found that business cycles in the transport sector are synchronized with that of the US economy, and that the transport sector leads on average of 6 months at peaks, and lags on average of nearly 2 months at troughs. Recessions in this sector are, therefore, longer by around 8 months than those of the overall economy.

8. In a successive work, Lahiri and Yao (2006) further explain this leading ability of the transport sector with respect to the aggregate economy through three factors. First, as derived input, transport demand also depends on the producers' expectations on future profits. Second, transport modes have significantly contributed to productivity improvements in the US economy. Third, as transport involves a high usage of capital equipment and fuel consumption, the sector is largely affected by monetary policy tightening and oil price shocks.

9. The attention to transport sector stems from the fact that this sector plays an essential role in facilitating economic activity between sectors and across regions (K. Lahiri and W. Yao, 2004). In a study on the importance of geographical and sectoral shocks in the U.S. business cycle, Ghosh and Wolf (1997) find that transport is one of the sectors that are highly correlated with intra-state and intra-sector shocks, and are essential in the propagation of business cycles. Similarly, Berman and Pfleeger (1997) use the US 1994-2005 projections of labour force, gross domestic product and its components, industry output, and industry and occupational employment, published by the Bureau of Labor Statistics, in order to examine the industries in which demand and employment are most sensitive to business cycle movements. They find that final demand is largely correlated with the business cycle in air, railroad and water transport.

10. The importance of the transport sector also derives from the fact that it contains information on the services sector, which is still underrepresented in the business cycle literature. Lahiri and Yao (2006) have developed a coincident indicator and a leading indicator for the transport sector, and have found that the business cycle of this sector is consistent with that of the general services sector, which tends to peak before peaks in economic activity, while the troughs are simultaneous (Layton and Moore, 1989). Given these results, and as a consequence of the increasing importance of the services sector in the global economy, data on transport should allow a more comprehensive and accurate analysis of business cycles.

Does the inclusion of transport indicators enhance the performance of the CLIs?
11. Transport-related indicators have been, recently, used in the calculation of various composite leading indicators, such as that of industrial activity in India, developed by J. Mohanty, B. Singh and R. Jain (2003), which includes data on freight loading of the railways, and cargo handled among its components. According to their results, these two transport indicators lead the Indian index of industrial production of 9 and 11 months, respectively.

12. Examples of economic indices for China that combine transport indicators with various other economic indicators include the index built by the China Economic Monitoring and Analysis Center (CEMAC), a branch of China’s National Bureau of Statistics, and that of the Center for Forecasting Science (CFS) at the Chinese Academy of Science, a private-sector think tank. CEMAC produces three types of index: a leading index, a coincident index, and a lagging index. These indices combine monthly year-on-year growth rates of time series data, and are used to identify China’s growth rate cycle. The volume of freight transported, and the volume of cargo shipped and received at coastal ports indicators are added to the components of the leading index. The CFS also produces a leading, coincident and lagging index. Volume of port cargo handled is one of the components of the leading index.

3. The transport sector in China

13. Given China’s size and proximity to many countries, transport is of great importance for the country and it plays an essential role in its economic and social development.

14. Since the reform and opening policies that began in 1978, and especially after 1990s, the Chinese government has implemented several measures aimed at the development of transport infrastructure, which involved, especially in the recent years, the creation of a modernized comprehensive transport system, the improvement of the management system, and the modernization of the management capacity in transport (The State Council Information Office of the People’s Republic of China, 2016). This development has concerned each mode of transport, and it has impacted on the size, capacity and quality of the transport lines.

15. By the end of 2015, China’s total transport route mileage was 4,951,230 km, almost 2 fold of the size in 1996. It includes 121,000 km railways, 4,577,730 km highways, 127,000 km inland waterways, 5,317,230 km civil aviation and 108,700 km pipeline (National Bureau of Statistics of China, 2017).

16. The quality of China’s transport line has also largely improved. In 2015, the length of double track railway was 64,700, a 3.5 fold increase since 1996. The length of expressway and class I to IV highways increased to 4,046,300 km, 4-fold increase compared to that in 1996. Its proportion to the total highway length augmented from 80 to 88 percent.

17. Over the period 2004-2015, the Chinese government has massively increased its investments in transport. In 2004 the investment in fixed assets of transport industries was...
23,257, which increased by 55 percent in 2014, and by 74 percent in 2015 reaching a level of 40,536 million yuan. Highway accounted for more than two thirds of the total fixed assets investment in the four major modes of transport, indicating the importance of road transport in the development of transport infrastructure in China. Compared to 2010, investment on railway has increased by the lowest rate (3.9 percent), followed by investment on waterways (21.1 percent).

18. China’s transport capacity has also improved substantially. In 2015, China’s passenger transport volume was 19.43 billion persons, and freight transport volume was 41 billion tons. In terms of railway transport, freight transport volume ranked first in the world. In terms of highway transport as well as waterway transport, passenger and freight transport volume ranked first in the world. In terms of port transport, cargo throughput and container throughput ranked first in the world (The State Council Information Office of the People’s Republic of China, 2016).

19. Figure 3.1 shows the growth of GDP, freight ton-kilometres and passenger-kilometres over the period from 1996 to 2015. Both freight ton-kilometres and passenger-kilometres grow roughly proportional to GDP until recent years, confirming findings of previous studies (Bannister and Stead, 2002) indicating a close statistical correlation between GDP and growth in passenger and freight transport. However, in the last years, there seems to be a slight decoupling of GDP, freight and passenger growth, most likely caused by changes in the Chinese economy. The greater fragmentation of production by China has highly contributed to the higher trade elasticity in the 1990s (ITF, 2017), and, as freight transport is directly tied to the supply chain, freight growth has largely increased as well. However, as the expansion of global supply chain has now slowed down (Constantinescu et al., 2015), and the focus of China’s economy is shifting to high-value added manufacturing and services, the actual tonnes shipped is reduced, and growth in freight transport has been more moderate. However, according to the International Transport Forum (ITF, 2015), the world growth of surface freight volume will be driven by non-OECD economies in the future, and Asia will account for over 50 percent of world surface freight transport.
Figure 3.1. The evolution of GDP, merchandise trade and transport volume in China

Sources: National Bureau of Statistics (NBS) of China; World Bank Development Indicators; The OECD National Accounts Statistics database

4. Data

4.1. Existing Composite Leading Indicator for China

20. The OECD composite leading indicator for China is calculated by aggregating the following time series: volume of chemical fertilizer production (tons); production of manufactured crude steel (tonnes); production of motor vehicles (number); production of total construction (m2); Shanghai stock exchange turnover (yuan); industrial enterprises diffusion index, overseas order level (%). With the exclusion of the industrial enterprises diffusion index, all components are released monthly, generally within 30 days after the end of the reference month. A notable exception, however, are the first two months of each year, when data are released with high delays due to the Chinese New year festivities. As most components date back to the early 1990s, the CLI estimates start in 1990.

21. In the absence of Quarterly estimates for GDP, the value added in industry (IVA) is instead used as a reference series. Over the period 1979-2017, China’s industrial value added has registered seven growth cycles measured from trough to trough (see Table 4.1). The average duration of the cycle is 58 months, although length of cycles ranged from as short as 30 months for the fifth cycle to as long as 111 months for the fourth cycle.
Table 4.1. Growth cycles in China industrial value added 1979-2017

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Trough</th>
<th>Peak</th>
<th>Trough</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle 1</td>
<td>1979-01</td>
<td>1980-02</td>
<td>1982-11</td>
</tr>
<tr>
<td>Cycle 3</td>
<td>1986-04</td>
<td>1988-09</td>
<td>1990-05</td>
</tr>
<tr>
<td>Cycle 4</td>
<td>1990-05</td>
<td>1994-09</td>
<td>1999-07</td>
</tr>
<tr>
<td>Cycle 5</td>
<td>1999-07</td>
<td>2000-07</td>
<td>2002-01</td>
</tr>
<tr>
<td>Cycle 6</td>
<td>2002-01</td>
<td>2007-12</td>
<td>2009-02</td>
</tr>
<tr>
<td>Cycle 7</td>
<td>2009-02</td>
<td>2011-08</td>
<td>2012-11</td>
</tr>
<tr>
<td>Cycle 8</td>
<td>2012-11</td>
<td>2013-12</td>
<td>2016-11</td>
</tr>
<tr>
<td>Not complete</td>
<td></td>
<td></td>
<td>2016-11</td>
</tr>
</tbody>
</table>

Source: OECD Main Economic Indicators (MEI) database. Authors’ calculation using the OECD Cyclical Analysis and Composite Indicators System (CACIS) program.

22. Figure 4.1 plots the CLI curve with the growth cycle of the reference series. The graph shows that the CLI is slightly more volatile than the latter with larger fluctuations and a few extra turning points.

Figure 4.1. China’s CLI and industrial value added growth cycle

Source: OECD Main Economic Indicators (MEI) database

23. Monthly observations of the Composite Leading Indicators (CLIs) and the cyclical components of the reference series are obtained from the OECD Main Economic Indicators database. Both reference and component series data are seasonally adjusted. In this study, we use the CLI in its amplitude-adjusted form, while for the reference series we opt for the deviation-from-trend form.

24. All series are the result of the smoothing and de-trending filtering process that the OECD performs to isolate the cyclical component of the series. The OECD employs a two-step approach based on the double application of the Hodrick-Prescott (HP) filter, which consists of setting up the frequency cut-off at frequencies lower than 120 months and higher than 12 months. The filtering procedure is applied to the reference series as well as to the CLI components. The latter are then normalised (by subtracting their mean and
dividing by their mean absolute deviation) and aggregated into the raw CLIs. To match the amplitudes of the business growth cycle of the reference series, raw CLIs are also adjusted by a simple rescaling (see also Gyomai et al., 2017).

25. Turning points are identified using the Bry-Boschan algorithm. Based on the turning points identified, a recession is defined in this study as the period between a peak and a trough, including the peak months.

4.2. Three new specifications for the Chinese CLI

26. We identify three new CLIs specification by adding, first separately and then simultaneously, indicators on traffic volume for freight and passenger to the current CLI.

27. Data on freight traffic volume and passenger traffic volume are from the National Bureau of Statistics (NBS) of China. These indicators are published on a monthly basis and are usually available around 30 days after the end of the month.

28. Error! Reference source not found. plots the new and current CLIs together with the IVA growth cycle. New CLI−Freight refers to the new version of the CLI that includes the freight transport indicator among its components, whereas New CLI−Passengers refers to the version of the CLI, to which the passenger transport indicator is used as additional component. In the version New CLI−Both, both transport indicators are added to the CLI components. For any given period, a CLI is only calculated if data for 60 percent or more of the component series are available in that period. Given the availability of historical data on passenger and freight transport for the period 1989 - 2017, the new CLIs have slightly more data than the current one. The new CLIs cover the period 1989 - 2017, whereas the current CLI has data for the period 1992 - 2017. As the chart shows, all versions of CLI register larger fluctuations than those of the IVA growth cycle.

Figure 4.2. The current and new CLIs

Source: our elaboration
5. Methodology

29. Our analysis includes two steps. First, we assess the performance of newly added indicators in relation to the cyclical turning points of the reference series by looking at the following statistics: mean and median lead time at turning points, number of missed and extra turning points, and cross correlation between the CLI and the reference series. Second, we analyse the leading performance of the new CLIs, in comparison with the current CLI, by studying their receiver operating characteristic (ROC) curves. Our empirical strategy in the last step is similar to that adopted in a study by Lahiri and Yang (2015).

5.1. The receiver operating characteristic

30. The ROC curve was initially developed by electrical and radar engineers for detecting electromagnetic signals during World War II, and it was later applied to the field of psychology by Peterson and Birdsall in 1953. The ROC curve has now become a common standard of evaluation of medical and psychological tests, whereas its use in economics is quite recent. Recent applications of the ROC curve to economics include the studies by Berge and Jorda (2010 and 2011), Lahiri and Wang (2013), and Lahiri and Yang (2015). The benefit of adopting the ROC curve in place of the more conventional inferential methods in the field of leading indicators is twofold. Firstly, the use of the ROC curve can potentially overcome the issue of an arbitrary choice of the penalties associated with the inputs of the loss function. Second, in evaluating rare event probabilities, the impact of correctly identifying the frequent event should be minimized. In these cases, it is more appropriate to concentrate on the hit rate and the false alarm rate for the infrequent event, instead of looking at the percentage correctly predicted (Lahiri and Wang, 2013). The hit rate is the proportion of times an event occurred when it was forecast, and the false alarm rate (F) is the proportion of times the event was forecast but it did not occur.

31. ROC graphs are a technique for quantifying the accuracy of a classifier used to discriminate between two states or conditions. They are represented as two-dimensional graphs in which the hit rate is plotted on the Y axis and the false alarm rate is plotted on the X axis, and depict relative trade-offs between hit rates and false alarm rates. Depending on the type of classifier, the nature of the graph varies. A classifier can be a discrete classifier, such as decision trees or rule sets, which produces only a class decision, such as Yes or No; or it can represent a probability or score, which is a numeric value indicating the degree to which an instance is a member of a class, and whose boundary between classes are determined by a threshold value. The former classifier produces only a single point in the ROC space, whereas the latter generates a ROC curve, where each point represents a different threshold value.

32. Define $Y_t$ as a continuous classifier. Given a threshold $c$, the instance is classified as positive whenever $Y_t \geq c$, and negative whenever $Y_t < c$. Consequently, the hit rate and the false alarm rate can be defined by the following conditional probabilities, respectively:

\[
TP(c) = P[Y_t \geq c \text{ when the instance actually belongs to class 'positive'}]
\]

\[
FP(c) = P[Y_t \geq c \text{ when the instance does not belong to class 'positive'}]
\]

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The ROC curve plots the entire set of possible combination of \( TP(c) \) and \( FP(c) \) for \( c \in \mathbb{R} \). Figure 5.1 shows the construction of a ROC curve for a continuous classifier.

**Figure 5.1. Construction of a ROC curve for a continuous classifier**

![ROC curve construction](image)

*Source: Wikipedia*

The diagonal \( TP(c) = FP(c) \) represents zero skill, indicating that the forecasts are completely uninformative. On the other hand, a ROC curve that leans on the north-west border of the positive unit quadrant indicates a perfect discrimination.

33. The area under the curve (AUC) is commonly used as a measure of overall classification ability:

\[
AUC = \int_0^1 ROC(r) \, dr; \tag{1}
\]

Where \( AUC = 1 \) indicates perfect discrimination, whereas forecasts with \( AUC = 0.5 \) are completely non-discriminatory. AUC with a value lower than 0.5 indicates that the forecasts are mislabelled, and a forecast of non-occurrence should be taken as an occurrence, and vice versa. By reversing the interpretation of the forecasts, the AUC would become larger than 0.5.

34. In our study, we evaluate the predictive ability of the current and new versions of the CLI taking recessions in industrial value added growth cycle (See Section 6) as the true classification of industry growth cycle. Following Lahiri and Yang’s study, we define \( p_t \) as the one-month-ahead probabilistic forecast with the following form:

\[
p_t \equiv \phi(c + \delta_1 CLI_{t-1} + \delta_2 CLI_{t-2}), \tag{2}\]

where \( CLI_{t-i} \) is the value of the CLI in period \( t - i \) for \( i = 1,2 \) and \( \phi(\cdot) \) is the standard normal distribution function. The 2-month-ahead forecast is similar to Equation (1), except that \( CLI_{t-2} \) and \( CLI_{t-3} \) are used as independent variables; and so on for the 3, 6 and 9 month-ahead forecast. Given these continuous probability forecasts, the forecast for
the occurrence of a recession is based on a cut-off value that converts probability forecasts into binary decisions. The recession is thus predicted when \( p_t > c \). Consequently, defining \( Z_t = 1 \) as the binary recession indicator, the hit rate is \( TP(c) \equiv P(p_t > c \mid Z_t = 1) \), while the false alarm rate is \( FP(c) \equiv P(p_t > c \mid Z_t = 0) \). Both \( TP(c) \) and \( FP(c) \) are functions of \( c \). As mentioned above, the ROC is represented as a graph plotting the hit rate against the false alarm rate as \( c \) varies. For a given \( FP(c) \), a higher \( TP(c) \) implies a larger discrimination. Hence, the higher the ROC curve the better are the results.

6. Results

35. Table 6.1 reports the results of the turning point statistical analysis. Overall, new CLIs seem to perform better than the current CLI. Both New CLI – Freight and New CLI – Both have longer lead in detecting turning points of the reference series. The mean lead increases from 8.4 month recorded by the current CLI to 9.4 in the case of the New CLI – Passengers and to 10.1 for the other two new CLIs. Similar improvements are confirmed by the median lead which moves from 6 months for the current CLI to 8 month recorded by all new CLIs. Moreover, over the period taken into consideration, whereas the current CLI have missed one turning point, the new CLIs have not missed any turning points. Finally, all CLIs have reported four extra turning points.

36. The table also provides the results of the cross-correlation analysis between the CLIs and the reference series, which gives information about the extent to which the cyclical profiles of the reference series and CLIs resemble each other. Looking at the cross-correlation is important if the cyclical indicators are to give information about the likely rate and amplitude of movements in the reference, and it provide information on “the general fit” of the indicators in relation to the reference series (OECD, 2006). The number of months lag at which the correlation has the highest value is an additional guide to the average lead of the indicator over the reference series. However, this analysis has limitations as, first, it only considers linear correlation among the two series, and second, it is influenced by the presence of extreme values in the series (OECD, 2006).

37. New CLI – Passengers performs the best in terms of cross-correlation analysis. It reports the highest value of correlation (0.78), followed by New CLI – Freight (0.74), the current CLI (0.71). New CLI – Both registers the lowest value of cross-correlation (0.63). The number of months lag at which the correlation reaches its highest value is 4 for all CLIs, with the exclusion of New CLI – Freight. In case of the latter CLI, highest correlation is reached at three months lag.
Table 6.1. Turning points analysis

<table>
<thead>
<tr>
<th>CLI version</th>
<th>Targeted</th>
<th>Missed</th>
<th>Extra</th>
<th>Av. Lead</th>
<th>St. Dev.</th>
<th>Median</th>
<th>Peak</th>
<th>Correl.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current CLI</td>
<td>10</td>
<td>1</td>
<td>4</td>
<td>8.4</td>
<td>6.6</td>
<td>6</td>
<td>4</td>
<td>0.76</td>
</tr>
<tr>
<td>New CLI – Freight</td>
<td>11</td>
<td>0</td>
<td>4</td>
<td>10.1</td>
<td>8.13</td>
<td>8</td>
<td>3</td>
<td>0.74</td>
</tr>
<tr>
<td>New CLI – Passengers</td>
<td>11</td>
<td>0</td>
<td>4</td>
<td>9.4</td>
<td>7.09</td>
<td>8</td>
<td>4</td>
<td>0.78</td>
</tr>
<tr>
<td>New CLI – Both</td>
<td>11</td>
<td>0</td>
<td>4</td>
<td>10.1</td>
<td>8.03</td>
<td>8</td>
<td>4</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Source: our calculation

6.1. Predictive probabilities of the new CLIs

38. Figure 6.1, Figure 6.2 and Figure 6.3 plot the probability forecasts of the new CLIs, calculated using Equation (2), in comparison with the current one. The shaded bars mark the months of economic recessions as identified by the Bry-Boschan routine. High probabilities of recession during these months suggest a better performance of the index.

39. The current CLI have issued higher probabilities of recession than New CLI – Freight, especially when longer forecast horizons are considered. However, it is noteworthy that the current CLI has generally issued higher probabilities of recession in expansionary phases.

40. New CLI – Passengers and New CLI – Both have performed better than their counterparts in the last recession issuing higher probabilities of recession in these months, whereas the current CLI has issued higher probabilities during the recessions before. Again, these results are more evident when longer forecast horizons are considered.

41. Interestingly, New CLI – Freight, New CLI – Both and current CLI have reported high probabilities of recession in only two of the five recessions that took place in the period between 1995 and 2017. On the contrary, New CLI – Passengers has issued high probabilities in three out of five recessions in the same period.

42. Finally, all CLIs have issued higher probabilities for 3 and 6 month-ahead forecasts than for the 9 month-ahead forecasts.
Figure 6.1. Probabilistic forecasts: current CLI and *New CLI* – *Freight*

![Graph showing probabilistic forecasts for freight](image)

Figure 6.2. Probabilistic forecasts: current CLI and *New CLI* – *Passengers*

![Graph showing probabilistic forecasts for passengers](image)

Figure 6.3. Probabilistic forecasts: current CLI and *New CLI* – *Both*

![Graph showing probabilistic forecasts for both](image)

*Note: The shaded bars mark the months of economic recessions*

Does the inclusion of transport indicators enhance the performance of the CLIs?
6.2. The ROC curves

43. Figure 6.4. ROC curves: current CLI and New CLI – Freight, Figure 6.5. ROC curves: current CLI and New CLI – Passengers and Figure 6.6. ROC curves: current CLI and New CLI – Both display six ROC curves corresponding to 3, 6 and 9-month-ahead forecasts associated with the new CLIs and the current one. The new CLIs generally show a higher discriminatory power than its current counterpart. The curves indicate that, given a threshold value of \( c \), the new CLIs often generate higher hit rates and lower false alarm rates than the current one, especially when both – passenger and freight – transport indicators are included in the CLI. However, it is interesting to note that a very low (high) and high (low) level of false alarm rate (specificity), the current CLI report slightly higher level of hit rates for the same false alarm rates.

44. Table 6.2 reports the area under the ROC curves (AUC). The area is calculated for the full sample as well as by splitting the sample in various time intervals. This division of the sample enables us to study the discriminatory power of the new and current CLIs over the years, and assess how changes in the structure of the Chinese economy may have impacted on their predictive performance. Standard errors are reported in parenthesis, and indicate that all results as well as the differences between AUC values are statistically significant.

45. When the full sample is considered, the new CLIs perform better than the current one for each forecast horizon. New CLI – Freight reports the highest values of AUC, confirming the results found in Section Error! Reference source not found.. Interestingly, both current and new CLIs achieve a higher level of AUC at the 3-month horizon.

46. Results also indicate that the performance of all four CLIs has improved over the years. The AUCs of all CLIs have jumped from a level between 0.6 and 0.7 to a value between 0.8 and 0.9, depending on the forecast horizon. It is also noteworthy that, in the years after the 2008 – 2009 crisis, the performance of New CLI – Both and New CLI – Passengers are higher than that of the other versions for the 3 month horizon, whereas the current CLI as well as New CLI – Freight register a higher discrimination power in case of 9 month forecasts. After the crisis, all versions seem to perform similarly in case of 6 month forecasts.

47. Finally, it is worth to note that all CLIs reach their highest level of AUC in the period 1999-2008 for 3 month forecasts.

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<table>
<thead>
<tr>
<th>Samples</th>
<th>Current CLI</th>
<th>New CLI - Both</th>
<th>New CLI – Freight</th>
<th>New CLI – Passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>h = 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole sample</td>
<td>1989 - 2017</td>
<td>0.73</td>
<td>0.75</td>
<td>0.77</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0004)</td>
<td>(0.0004)</td>
<td>(0.0003)</td>
</tr>
<tr>
<td>Two sub-periods</td>
<td>1989 - 2000</td>
<td>0.62</td>
<td>0.67</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td></td>
<td>2001 - 2017</td>
<td>0.86</td>
<td>0.83</td>
<td>0.86</td>
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<tr>
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<td>0.87</td>
<td>0.83</td>
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<td>(0.0011)</td>
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<td>0.72</td>
<td>0.73</td>
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<tr>
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<td>(0.001)</td>
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<tr>
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<td>0.71</td>
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<td>2001 - 2017</td>
<td>0.75</td>
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Note: Standard errors reported in parenthesis.
Source: our elaborations.
7. Conclusions

48. This paper studies whether the inclusion of transport indicators among the components of the CLI for China improves the predictive ability of the latter. We have considered two transport indicators, including a passenger transport indicator and a freight transport indicator, and have added them as additional components of China’s CLI separately, as well as, together. The performance of the new versions of the CLI was then studied by looking at the traditional statistics used in turning points analysis, including mean and median lead time at turning points, the number of missed and extra turning points, and the cross correlation between the CLI and the reference series; and studying their receiver operating characteristic (ROC) curves. Our empirical strategy in the last step is similar to that adopted in a study by Lahiri and Yang (2015).

49. Our results point to the following conclusions:

- Both freight and passenger transport indicators, when added as components of the CLI, improve its ability in forecasting the peaks and troughs of the Chinese economy.
- The forecast performance of the CLI is stronger when the freight transport indicator is used as additional component. When this indicator is added in the calculation of the CLI, the ability of the latter in anticipate turning points in the Chinese business growth cycle increases, on average, by two months.
- The leading properties of all CLI versions are stronger when the lead time horizon is lower than 9 months.

8. Implications for future research

50. The predictive performance of the freight transport indicator may derive from the fact that it reflects changes in inventories. Economists have long suggested that inventory investment is strongly pro-cyclical. Since firms target a relatively fixed ratio of inventory to sales, when sales rise they adjust their stocks upward, whereas when sales decrease, they reduce the level of their stocks. Since sales movements roughly correspond to movements in business cycle, inventory investment has proved to have a pro-cyclical nature (J. A. Kahn and M. M. McConnell, 2002). However, various studies have showed that improved inventory management, and production techniques may reduce this pro-cyclical feature of inventory investment (Kahn, McConnell, and Perez-Quiros, 2002). Better information have made demand more forecastable, and, consequently, reduced the accumulation of undesired stocks. Given the close relationship between the transport sector and changes in inventory investment, we may expect that the forecast performance of transport indicators will also be affected.
51. Although the adoption of new technologies and techniques, such as just-in-time delivery and flexible automation, is not yet a widespread phenomenon in China due to the shortage of experience and skills among the Chinese labour force (K. Eloot et al., 2013; L.S. Phen and G. Shang, 2011; R. Anjoran, 2017), we may assume that these changes will soon occur in China as well. Chinese enterprises have recently invested more and more on R&D. China’s gross expenditures on R&D has more than doubled in the period from 2005 to 2010, with the business sector accounting for the largest share (OECD, 2012). Likewise, since 2000, Chinese exports of ICT goods have almost doubled (ILO, 2017). Additionally, the new “China Manufacturing 2025” initiative, developed by the Ministry of Industry and Information Technology, aims to accelerate the innovative development of the manufacturing industry. If production techniques will soon change in China, the leading performance of the Chinese freight transport sector may change as well.

52. An important result of our study is also the leading performance of passenger transport indicator. This result is quite new to the economic literature on leading indicators, which has mainly focused on goods transport. In his 2010 work, Lahiri has studied the leading ability of the two transport indicators separately, and he has concluded that the growth cycle movements of transport output are mainly due to its freight component, whereas its passenger component does not show a lead or lag relationship with the economy reference cycle.

53. Our results seem to point to a different conclusion. According to our findings, the inclusion of the passenger transport indicator improves the forecast performance of China’s CLI. The leading ability of this indicator can be explained by three reasons. First, as in the case of goods circulation, movements in passenger transport are influenced by oil prices. Second, the indicator provides additional information on the status of the transport sector, which represents an important aspect of the global economy, and of the Chinese economy, in particular. Third, given the rise of the services sector, as well as, as a consequence of the changes in the supply chain, and the stronger co-movements among the various sectors, compared to the past (Irvine and Schuh, 2002), information on passenger movements may reflect the performance of those industries that do not belong to the industrial sector, but that are linked to the latter, as, for instance, is the business services sector.

54. In conclusion, our study suggests that there is evidence of a leading ability of the transport sector. However, additional research is necessary in order to further investigate the performance of transport-related indicators, and that of the CLI as the structural changes occurring in the Chinese economy may be affecting their performance.
Bibliography


Does the inclusion of transport indicators enhance the performance of the CLIs?
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http://dx.doi.org/10.1787/9789282107782-en

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