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PMIs as tools for nowcasting and providing early signals to Mainland economic performance: an empirical investigation

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Abstract

This article examines the statistical relationship between the Purchasing Managers Indices (PMIs) and major macroeconomic variables in the Mainland context, with an aim to explore their usefulness as tools for economic monitoring. We find that the manufacturing PMI can help gauge the near-term movement of industrial value-added and export growth. On the other hand, the non-manufacturing PMI is also found to be a useful indicator for assessing the development of the services sector, indicating the unique value of the index in monitoring the Mainland economy.

有關利用採購經理指數預判內地經濟表現之實證研究

摘要

本文分析內地採購經理指數與宏觀經濟變量之間的統計關聯，以探討指數作為經濟監察工具的功能。我們發現製造業採購經理指數有助預判規模以上工業增加值以及出口增長的短期走勢，而非製造業商務活動指數則有助評估服務業的發展。

I. INTRODUCTION

1. Purchasing Managers Indices (PMIs) are widely considered useful indicators for gauging the near-term outlook for an economy. In the context of the Mainland, monthly PMIs are published at least a week earlier than other major economic indicators, and their movements may possibly aid economists in nowcasting as well as assessing the future movements of growth rates of key macroeconomic variables.

2. This article investigates the statistical relationship between PMIs and economic variables in accordance with their sectoral coverage. Specifically, we study if the **manufacturing PMI** and its key sub-indices can shed light on the performance of industry-related indicators such as industrial value-added, goods exports, and industry sector growth. On the other hand, we also examine whether the **non-manufacturing PMI**[1] can help in gauging the development of the services sector of the Mainland.

II. AN OVERVIEW OF PMIs AND THEIR COMPILATIONS IN THE MAINLAND

3. Monthly PMIs are compiled based on survey responses of purchasing executives of enterprises. Respondents are asked to compare their business situations in different aspects with the previous month, and their responses are then summarised in the form of diffusion indices. ***Table 1*** provides further details on the compilation methodology.

4. For the manufacturing PMI, the constituent sub-indices can help gauge the situation at different stages of the manufacturing process. For example, the new orders index is often considered a leading indicator as a rise in new orders is typically seen as the first sign of increasing production activity in the future. The production index should serve as a concurrent indicator, attempting to directly assess the production activity of the month concerned. Meanwhile, the employed person index could be a concurrent or lagging indicator as firms are expected to step up hiring alongside increased production after exhausting short-term options available (e.g. overtime). On the other hand, the non-manufacturing PMI directly links to the business activities of the concurrent month and is often perceived as a concurrent indicator.

[1] The index is formally known as the non-manufacturing business activity index (非製造業商務活動指數), although "non-manufacturing PMI" is more commonly used in order to correspond to its manufacturing counterpart.

Table 1: Compilation of manufacturing and non-manufacturing PMIs

	Manufacturing PMI	Non-manufacturing PMI
Respondents	Manufacturing firms	Non-manufacturing firms
Compilation methodology	Composite index: Weighted average of *five* diffusion sub-indices[2] (see below)	*One* diffusion index to assess enterprises' concurrent-month business activities
Key sub-indices	Sub-indices used in compiling the composite index (weightings) (i) New orders (30%); (ii) Production (25%); (iii) Employed person (20%); (iv) Supplier delivery time (15%); and (v) Main raw materials inventory (10%).	
	Other key sub-indices compiled in the survey - New export orders - Production and business activities expectation	

III. EXAMINING THE MANUFACTURING PMI AS A CONCURRENT AND LEADING INDICATOR FOR INDUSTRIAL VALUE-ADDED AND EXPORT PERFORMANCE

5. In this section, we will empirically examine whether the manufacturing PMI and its sub-indices can offer useful insights on the latest (i.e. "nowcasting") as well as future performance of industrial value-added (規模以上工業增加值) and the value of goods exports, which are two of the most important economic indicators for the Mainland's industry sector. These two indicators are published on a monthly basis, but they are released after the monthly PMI.[3]

6. First, we explore if the manufacturing PMI can leverage its timeliness and serve as a useful concurrent indicator. Consider the following simple nowcasting equation:

$$y_t = \beta_0 + \beta_1 x_t + \varepsilon_t \quad (1)$$

where y_t denotes the year-on-year growth rate of the macroeconomic variable (i.e.

[2] The index is computed according to the formula: *Index* = *P**100+*Q**50+(1-*P*-*Q*)*0, where *P* denotes the proportion of responses that reported a month-to-month improvement, and *Q* denotes the proportion of responses that reported no change. Hence, a reading of 50 or above is interpreted as a general month-to-month improvement, and vice versa.

[3] In 2018, the PMIs of a particular month are published on the last day of that month, while the monthly performance of industrial value-added and goods exports are released in the month after.

industrial value-added or goods exports) at month t, and x_t denotes the index value at month t.[4] The goal is to examine whether the estimates of the slope coefficient β_1 are positive and statistically significant. First differencing is applied to the variables before estimation in order to ensure stationarity.

7. ***Table 2*** reports regression estimates of the coefficients. Consistent with intuition, the **manufacturing PMI appears to be a good concurrent indicator for nowcasting industrial value-added growth.** Of the five component sub-indices of the manufacturing PMI, the production, employed person and main raw materials inventory indices are also found to hold significant explanatory power on the industrial value-added growth of the same month. Overall, our findings suggest that the manufacturing PMI and many of its sub-indices can effectively reflect the concurrent situation of the industry sector.

8. In contrast to the findings for industrial value-added, **the nowcasting power of the manufacturing PMI and its sub-indices on goods exports growth appears to be very limited.** As shown in ***Table 2***, the slope estimates are statistically insignificant, with many of them being wrong signed.

Table 2: Summary of findings of the nowcasting model (Equation (1): $y_t = \beta_0 + \beta_1 x_t + \varepsilon_t$)

Indices (x)		**Macroeconomic variables (y)**	
		Industrial value-added	Goods exports
Manufacturing PMI		**0.22***	-0.36
Constituent sub-indices	New orders	0.09	-0.22
	Production	**0.15****	-0.20
	Employed person	**0.28***	-0.86
	Supplier delivery time	0.10	0.26
	Main raw materials inventory	**0.20***	0.43
Other sub-indices	New export orders	**0.19****	-0.34
	Production and business activities expectation	-0.04	-0.88

Note: ** and * indicate the estimate is statistically significant at the 1% and 5% level respectively.

9. The weak statistical relationship between export performance and the manufacturing PMI could be due to the time lag between production and exports. To

[4] Data sources: National Bureau of Statistics (for PMIs and related sub-indices, industrial value-added) and China Customs (for goods exports).

further examine this issue, we consider the following model:

$$\bar{y}_{t+3,3} = \beta_0 + \beta_1 \bar{x}_{t,3} + \varepsilon_t \qquad (2)$$

where $\bar{y}_{t+3,3}$ denotes the 3-month moving average of the year-on-year growth rate of the macroeconomic variable over months $t+1$ to $t+3$, and $\bar{x}_{t,3}$ denotes the 3-month moving average of the index over months $t-2$ to t. In essence, the model examines whether the average PMI value over the past 3 months can help give early indications of the average growth rates of selected economic variables over the next 3 months. As with the previous case, first differencing is applied to ensure stationarity.

10. The findings are summarised in ***Table 3***. The results for industrial value-added are broadly similar to those reported in the nowcasting setting. This indicates that **the manufacturing PMI and various related sub-indices are also useful for gauging the near-term performance of industrial value-added**.

11. Meanwhile, the statistical relationship between the manufacturing PMI and exports has become notably stronger in the forecasting setting as described in equation (2). **The manufacturing PMI appears to be a decent leading indicator for growth of goods exports.** Among the constituents of the manufacturing PMI, the new orders and main raw materials inventory indices are found to be useful leading indicators as well. Furthermore, **the new export orders index holds significant explanatory power for future export growth**, which is also reasonably intuitive.

Table 3: Summary of findings of the forecasting model
(Equation (2): $\bar{y}_{t+3,3} = \beta_0 + \beta_1 \bar{x}_{t,3} + \varepsilon_t$)

Indices (x)		**Macroeconomic variables (y)**	
		Industrial value-added	Goods exports
Manufacturing PMI		**0.25****	**0.82***
Constituent sub-indices	New orders	**0.16****	**0.50***
	Production	**0.13****	0.37
	Employed person	**0.23***	1.26
	Supplier delivery time	-0.11	-0.78
	Main raw materials inventory	**0.30****	**1.21***
Other Sub-indices (manufacturing PMI)	New export orders	**0.12****	**0.69****
	Production and business activities expectation	0.04	0.43

Note: ** and * indicate the estimate is statistically significant at the 1% and 5% level respectively.

IV. ASSESSING THE MARGINAL NOWCASTING POWER OF PMIs FOR SECTORAL ECONOMIC GROWTH

12. This section further explores if PMIs can help nowcast the performance of the broader economy, i.e. quarterly economic growth. Specifically, manufacturing and non-manufacturing PMIs, given their sectoral coverage, are expected to be closely linked with growth of the industry and services sectors respectively. We begin our investigation with the following linear models.

$$y_{i,t} = \alpha_i + \beta_{i,1}x_{M,t,1} + \beta_{i,2}x_{M,t,2} + \beta_{i,3}x_{M,t,3} + \varepsilon_{i,t} \quad (3)$$
$$y_{s,t} = \alpha_s + \beta_{s,1}x_{NM,t,1} + \beta_{s,2}x_{NM,t,2} + \beta_{s,3}x_{NM,t,3} + \varepsilon_{s,t} \quad (4)$$

where $y_{i,t}$ and $y_{s,t}$ denote the growth of the industry and services sectors[5] at quarter t, while $x_{t,1}$, $x_{t,2}$ and $x_{t,3}$ denote the PMI value of the first, second and third month of quarter t (the subscripts *M* and *NM* indicate whether the variable is the manufacturing or non-manufacturing PMI). If PMIs can help provide an early signal of sectoral growth in the concurrent quarter, the estimates of coefficients β's are expected to be statistically significant. As in the previous analysis, first differencing is applied here to ensure stationarity.

13. The first two columns of ***Table 4*** report the key results of the above regressions. F-tests are conducted to reject the null hypothesis that all β's are zero, implying that **the three monthly PMIs of the quarter indeed offer a certain degree of nowcasting power for sectoral growth.** Further tests confirmed that both $\beta_i \equiv \beta_{i,1} + \beta_{i,2} + \beta_{i,3}$ and $\beta_s \equiv \beta_{s,1} + \beta_{s,2} + \beta_{s,3}$ are significantly positive.

14. Yet, considering the fact that monthly indicators (e.g. growth of industrial value-added, goods exports, retail sales and fixed asset investment) for the first two months of the quarter concerned would have been publicly available beforehand, one may wonder whether PMIs can offer any marginal predictive power on top of these indicators. To examine this issue, the models are further extended as follows:

$$y_{i,t} = \alpha_i + \beta_{i,1}x_{M,t,1} + \beta_{i,2}x_{M,t,2} + \beta_{i,3}x_{M,t,3} + \boldsymbol{\gamma_i}'\boldsymbol{z} + \varepsilon_{i,t} \quad (3')$$
$$y_{s,t} = \alpha_s + \beta_{s,1}x_{NM,t,1} + \beta_{s,2}x_{NM,t,2} + \beta_{s,3}x_{NM,t,3} + \boldsymbol{\gamma_s}'\boldsymbol{z} + \varepsilon_{s,t} \quad (4')$$

where $\boldsymbol{z}$ is a vector of control variables, including the growth rates of industrial value-added, goods exports, retail sales and fixed asset investment of the first two months in the quarter concerned. Our goal is to examine whether the estimates of coefficients β's are statistically significant after controlling for $\boldsymbol{z}$.

[5] Data source: National Bureau of Statistics

Table 4: Marginal nowcasting power of PMIs to sectoral growth (Equations (3), (4) and their variations)

Models	**Industry vs. mfg. PMI**	**Services vs. non-mfg. PMI**	**Industry vs. mfg. PMI**	**Services vs. non-mfg. PMI**
Control variables	No		Yes	
Sector	Industry	Services	Industry	Services
PMI	Manufacturing	Non-manufacturing	Manufacturing	Non-manufacturing
Joint significance of all β's (at 5% level)	F-test rejects all β's are jointly insignificant	F-test rejects all β's are jointly insignificant	*F-test **cannot** reject all β's are jointly insignificant*	F-test rejects all β's are jointly insignificant
Sum of β's	**0.44***	**0.45***	0.13	**0.65***

Note: * indicates the estimate is statistically significant at the 5% level.
Control variables include the growth rates of industrial value-added, goods exports, retail sales and fixed asset investment in the first two months of the quarter.

15. The findings are reported in the last two columns of ***Table 4***. **After controlling for indicators that supposedly have already been released, the predictive power of the manufacturing PMI for industry sector growth subsides visibly.** It indicates that the information value of the manufacturing PMI has been largely reflected in the control variables, particularly in monthly industrial value-added growth.

16. On the other hand, **the findings for the non-manufacturing PMI remain largely intact despite the introduction of control variables. This suggests that the non-manufacturing PMI can offer significant marginal predictive power for gauging services sector value-added growth even after controlling for the data made available for other monthly indicators.** Indeed, the majority of monthly economic indicators in the Mainland are more related to the industry sector, while the coverage on services sector is relatively thin. The non-manufacturing PMI helps fill this gap, and its importance as an economic indicator for macroeconomic monitoring is expected to increase further amid the Mainland's gradual transition towards a services-oriented economy.

V. CONCLUDING REMARKS

17. In this article, we analysed the statistical relationship between the manufacturing PMI and industrial value-added, and found that the former can help nowcast industrial value-added growth in the concurrent month, as well as shed light on its near-term growth. As for the relationship with exports, the manufacturing PMI and the new export orders sub-index are found to hold statistically significant explanatory power for export performance in the near future. This suggests that the manufacturing PMI (and the new export orders sub-index) can provide valuable information for gauging the outlook of the export sector.

18. The non-manufacturing PMI is also found to be a useful indicator for assessing the development of the services sector of the Mainland. Empirical evidence suggests that the non-manufacturing PMI can offer marginal nowcasting power for predicting the quarterly growth of the services sector. This indicates the unique value of the non-manufacturing PMI in monitoring the Mainland economy.