Is PMI a good leading indicator of industrial production?: Evidence from India

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Abstract

The manufacturing Purchasing Managers' Index is often used by policy makers to gauge the 'nerve' of the real economy and as lead indicator of industrial activity. This paper makes an effort to evaluate whether the PMI is indeed a good lead indicator of IIP or whether by relying on PMI the policy makers are making a systematic error. Using ARDL technique, this paper largely support the claim that the PMI is a good lead indicator of industrial activity, albeit only in the short run.

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Introduction

The manufacturing Purchasing Managers Index (PMI), is based on five major counts, which include new orders, inventory levels, production, supplier deliveries and the employment environment. It is based on a monthly survey of purchasing managers, who are in the 'core' of the activity in the sector and can be expected to gauge first impulse of changes in direction and activity levels in an economy. PMI value above 50 indicate expansion in the manufacturing sector, while value below 50 indicates contraction. The survey based results are aggregated and presented in the form of a diffusion index at the beginning of every month, which derives its value from the fact that it is released around one and half months before the release of Index of Industrial Production for the same period. Therefore PMI is commonly used as one of the leading indicators for tracking the IIP and alternately real economy activity by policy makers (including central banks), and financial market analysts.

Notwithstanding its widespread reputation as a leading indicator, no study so far has addressed the issue relating to how good a proxy / leading indicator PMI is for the IIP. In other words, the question we attempt to address is whether the survey based PMI captures the magnitude and direction of the changes in IIP, or policy makers get into a systematic bias by depending on PMI for their expectation formation.

To get a deeper insight into its predictive power and relevance in policy making, we analyze PMI and its components alongwith IIP and its components The paper is organised in five sections; Section II concentrates on recent literature, Section III describes the data and descriptive statistics, Section IV reports the empirical findings and Section V concludes our findings and their policy implications.

II. Literature

There is a large body of literature on forecasting and now-casting of GDP, using various macro-variables and surveys. The literature about use of PMI as a forecasting tool is mixed with few studies alluding its usefulness as a timely and efficient predictor of economic trends, other studies

have not found conclusive evidence to back this claim. The literature can be tracked back to Harris (1991), who reported mixed results suggesting that the index sends too many false signals and is erratic in capturing the cyclical swings. However he also highlighted that when used in conjunction with other indicators, the PMI is useful as it improves the explanatory power of simple econometric models and consensus forecasts. Later studies also highlighted the usefulness of PMI as good indicator of macroeconomic health of a country (Dasgupata and Lahiri, 1992, 1993; Kauffman, 1999; Lindsey and Pavur, 2005). Recently however, Tsuchiya (2014) showed that while these indices are useful predictors of industrial production and employment, they are not useful predictors of real GDP or hours worked. A detailed study on PMI and its effectiveness as an index to assess macroeconomic situation was attempted by Koenig (2002) that found a mixed result for the US.

In the Indian context, Bhattacharya *et. al* (2011) evaluated the usefulness of PMI surveys in predicting the GDP growth rates, but found that despite its timeliness, it does not improve the nowcasting of GDP forecasts over the benchmark models. They note that this finding is in contrast with those in the developed economies where survey dynamics are largely consistent with the official GDP growth rates. They suggest that this peculiarity may arise from a marked difference in coverage in the reference sample of firms underlying the GDP data and the ones considered by PMI.

In contrast, Bose (2015) found PMI to be a reliable indicator of economic activity. In particular, PMI was found to provide some additional information on current economic growth over that is embedded in its own past values and other available high frequency official indicators.

Coondoo and Das (2016) also find that notwithstanding the shortcomings of the PMI surveys, the aggregate PMI and many of its components correlate well with the GDP growth rate and services GDP. However the PMI's predictive power for manufacturing GDP is seen to be much less.

In a different vein, however, Khundrakpam and George (2013) concentrated on a sub-indices of information provided by PMI on industrial input and output prices and found that these indices are good indicators and have significant predictive powers of the WPI-All and WPI-Non-food manufactured products.

Notwithstanding earlier research, it is difficult to find any systematic study relating PMI and its sub-components to IIP and its components in the Indian context. From the perspective of an economist, however, it is necessary to systematically validate the leading indicator property of the PMI. This paper takes forward the literature in this regard by analysing the leading indicator property of PMI with reference to IIP and we expect that our study will bridge this gap in the literature.

III. Data sources

The main data source is the monthly data on IIP and its components made available by Ministry of Statistics and Programme Implementation (*MOSPI*).

The monthly data on PMI manufacturing, services as well as composite is available from Markit Economics through a press release, however the time series as well as disaggregated data on specific PMI constituents is taken from Bloomberg.

Manufacturing PMI is a composite indicator, constituted as a weighted average of output, new orders, employment, suppliers' delivery, stocks of purchase, input prices, quantity of purchases, stocks of finished goods, new export orders, output prices and backlog of work. It is a survey based, seasonally adjusted diffusion index, meaning that the index summarises the common tendency of the group. Thus the index value above 50 indicates expansion, below 50 indicates contraction while a value at 50 is considered neutral or no change.

We also propose to use several other macro variable as proxy, exogenous and / or control variables. The source of these macro variables will be the Database on Indian Economics (DBIE) and Handbook of Statistics on the Indian Economy, published by the Reserve Bank of India. Summary Statistics of the primary set of variables considered are reported in the Table-1. The Chart-1 also reports broad path of these variables with associated distributional histograms. These charts indicates a) variables are of different statistical properties, IIP and its sub-groups are mostly I(1) series with strong seasonal patterns observed in them. PMI and its classifications on the other hand are stationary in nature as they hover around 50 mark, and are broadly found to be I(0) in nature. This has been confirmed by the ADF statistics. It is therefore difficult to apply conventional statistical analysis to these variables to evaluate long or short run relationship among them or their

forecasting power. In the next section we attempt to address this problem and analyze inherent relationship among these variables.

IV. Methodology and Empirical Analysis

The objectives of our empirical analysis are of two folds. First, to establish whether there exists a long term relationship between market expectations, as captured by the PMI index, and industrial production activity; and second, how the short term dynamics manifests itself. We intend to start our analysis with seasonally adjusted differenced IIP index, PMI and PMI disaggregates. The latter, which is by construction differenced in nature (as it evaluates change in business conditions as compared to previous month) may not be further differenced for this analysis. In a time series framework, this is best done by cointegration analysis for two or more non-stationary variables. However, these variables may not be of the same order of integration, which may prevent us from using cointegration analysis. In such a framework, Pesaran and Shin (1999) have suggested use of Autoregressive Distributed Lag Modelling (ARDL) Approach of cointegration to quantify long run relationship among these variables. The short term dynamics, on the other hand, could be captured by the error correction term as indicated in the equation (2) below:

$$Y_t = a_0 + \sum_{i=1}^{m} b_1 Y_{t-i} + \sum_{i=0}^{n} b_2 X_{t-i} + \varepsilon_t \qquad \text{.....(1)}$$

$$\Delta Y_t = a_S + \sum_{i=1}^{m} b_1 \Delta Y_{t-i} + \sum_{i=0}^{n} b_2 \Delta X_{t-i} + ECT_{t-1} + \varepsilon_t \qquad \text{.....(2)}$$

We also intend to take up each component of PMI and attempt to evaluate their inter-relationship with components of IIP to get a better understanding of surveyed index and real activity movements.

In this vein, we estimate both equation (1) and then equation (2) to estimate short run relationship between these variable. In the base model we start with IIP general and its classification (at levels) and evaluate the long run relationship using the ARDL methodology. Table- 2 reports the estimated coefficients of the short (ECT or the CointEq(-1)) and long run coefficients. As it is evident from the above discussion and from the results reported in the Table -2, the IIP in levels

and its classifications (i.e. manufacturing, mining and electricity) did not report any statistically significant evidence of any long-term or short-term associations with the PMI.

In view of the severe seasonality in the IIP data as evident from the Chart-1, we test for seasonality using X12 methodology. Statistical tests confirm evidence of strong seasonality in the IIP series. The deseasonalized set variables (Variable_SA) were then used to evaluate relationship with PMI using ARDL methodology. These set of results were, however, very different from the previous, as reported in Table-3. The most noticeable results in this set of regression were that the error correction term were negative and statically significant at conventional levels for seasonally adjusted IIP, Manufacturing IIP and for Mining and Quarrying subsector. The only exception in this regard was seasonally adjusted electricity, which had very low error correction coefficient and it was statistically insignificant indicating lack of short term equilibrating behavior between electricity and PMI. However, the empirical findings didn't find any long run equilibrating relations between these variables.

To have a deeper insight, we followed the differenced technique used in George and Kundrapan (2007) and use the first difference of the seasonally adjusted IIP variables instead of their levels. The results obtained are reported in the Table -3(b) which indicate (a) a negative and significant error correction term, implying a stable short term relationship (b) positive and significant value of lagged PMI terms which indicate increase in differenced IIP general and differenced IIP manufacturing with increase in PMI and vice-versa. These results support the leading indicator properly of the PMI series and (c) significant long term coefficients for these two series. These relationship were also found credence in the Bound test and suggested by Preseran. However, this modified relationship was not found to be statistically significant for Mining and Electricity sectors of IIP.

To evaluate whether the sub-classifications have better predictive power as compared with the general PMI we used manufacturing IIP (seassonally adjusted) and the sub-classification of PMI, and the regression result again noted the short term equilibrating relationship between these variables. Among these the most significant were found to be *stock of purchases* and *stock of finished goods* that have observed a) stable short term relationship b) positive coefficient indicating predictive power and c) significant long term coefficient.

These results were found to be even stronger when difference seasonally adjusted manufacturing IIP was used as one of the variable and its predictive power was analyzed on a long run basis. Even these results found support for the conventional bound test.

We than turned to the user based classification and tried to evaluate whether stock purchase could provide leading indicator for the components. However, the present specification was not found to be extremely significant in explaining these classifications. Prediction of user based classification remains a challenge and the role of PMI indicators may be an interesting area of research going forward.

V. Concluding observations

One of the major concerns of policy makers is to obtain reliable data about macroeconomic trends with a minimum time lag to facilitate appropriate policy actions. The purchasing managers' index is an ideal contender for the post of 'lead indicator' of real economic activity, including industrial production, as the data is available quickly, the methodology is consistent and dissemination of data is wide. Indeed, policy makers, most notably central bankers, make regular references to, inter alia, PMI in their communications. Nevertheless, it is important to verify whether the PMI does a reasonably good job as reliable predictor of the underlying trends. In absence of such ratification, it is difficult to judge whether or not the lead indicator is emitting erroneous signals that may prove costly from policy perspective. The present paper makes an effort to de-mystify use of PMI and its sub-classifications for policy makers and help expectation formations. This paper finds evidence that the manufacturing PMI is a good lead indicator of IIP and manufacturing IIP, atleast in the short run. This is not surprising as the PMI manufacturing is representative of the manufacturing sector and not the mining and quarrying or electricity sector, which are governed by different sectoral dynamics. This good short run indicator property is valuable from policy makers' perspective and suggests that by using PMI as a lead indicator, the policy makers are not making any systematic mistake.

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Table 1: Descriptive Statistics

VARIABLE	FULL DESCRIPTION	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability	Sum	Sum Sq. Dev.	Observations
MIN	Mining & Quarrying	121	121	151	91	13	0	3	1	1	15932	23258	132
MNF	Manufacturing	164	172	210	98	27	-1	3	11	0	21600	94831	132
ELE	Electricity	142	137	202	100	27	0	2	8	0	18797	93099	132
GEN	General Index	155	162	198	99	24	-1	3	9	0	20508	76861	132
BASIC	Basic Goods	141	142	188	100	22	0	2	4	0	18647	60643	132
CAPITAL	Capital Goods	228	236	392	85	58	0	3	5	0	30155	437775	132
INTERMEDIATE	Intermediate Goods	138	142	171	98	16	-1	3	7	0	18178	34203	132
CONS	Consumer Goods	165	168	208	102	28	-1	3	8	0	21731	103185	132
CONS_D	Consumer Durables	233	247	336	103	60	-1	2	11	0	30706	476345	132
CONS_ND	Consumer Non-durables	138	138	186	98	21	0	3	2	0	18174	58435	132
PMI	PMI Index	54	55	62	44	3	0	3	2	0	7186	1487	132
OUTPUT	Output	57	57	67	41	5	0	3	4	0	7491	3513	132
NEWORDER	New Orders	58	58	72	41	6	0	3	1	1	7626	4560	132
EMP	Employment	51	51	54	47	1	0	3	0	1	6691	179	132
S_DEL	Suppliers' Delivery Times	50	50	54	47	1	0	4	3	0	6591	155	132
PUR	Stocks of Purchases	53	52	60	45	3	0	3	1	1	6953	918	132
INP_PRI	Input Prices	57	57	69	41	5	0	3	3	0	7524	3753	132
Q_PUR	Quantity of Purchases	56	56	70	44	5	0	3	1	1	7429	3006	132
FIN_GOOD	Stocks of Finished Goods	50	50	54	45	2	-1	4	17	0	6601	372	132
N_EXP	New Export Orders	54	54	61	41	4	-1	4	23	0	7102	1635	132
OUT_PRI	Output Prices	53	52	60	44	3	0	3	1	1	6972	1121	132
BLOG_WORK	Backlogs of Work	51	51	57	44	2	0	4	9	0	6777	564	132

Chart 1: Variables Plot

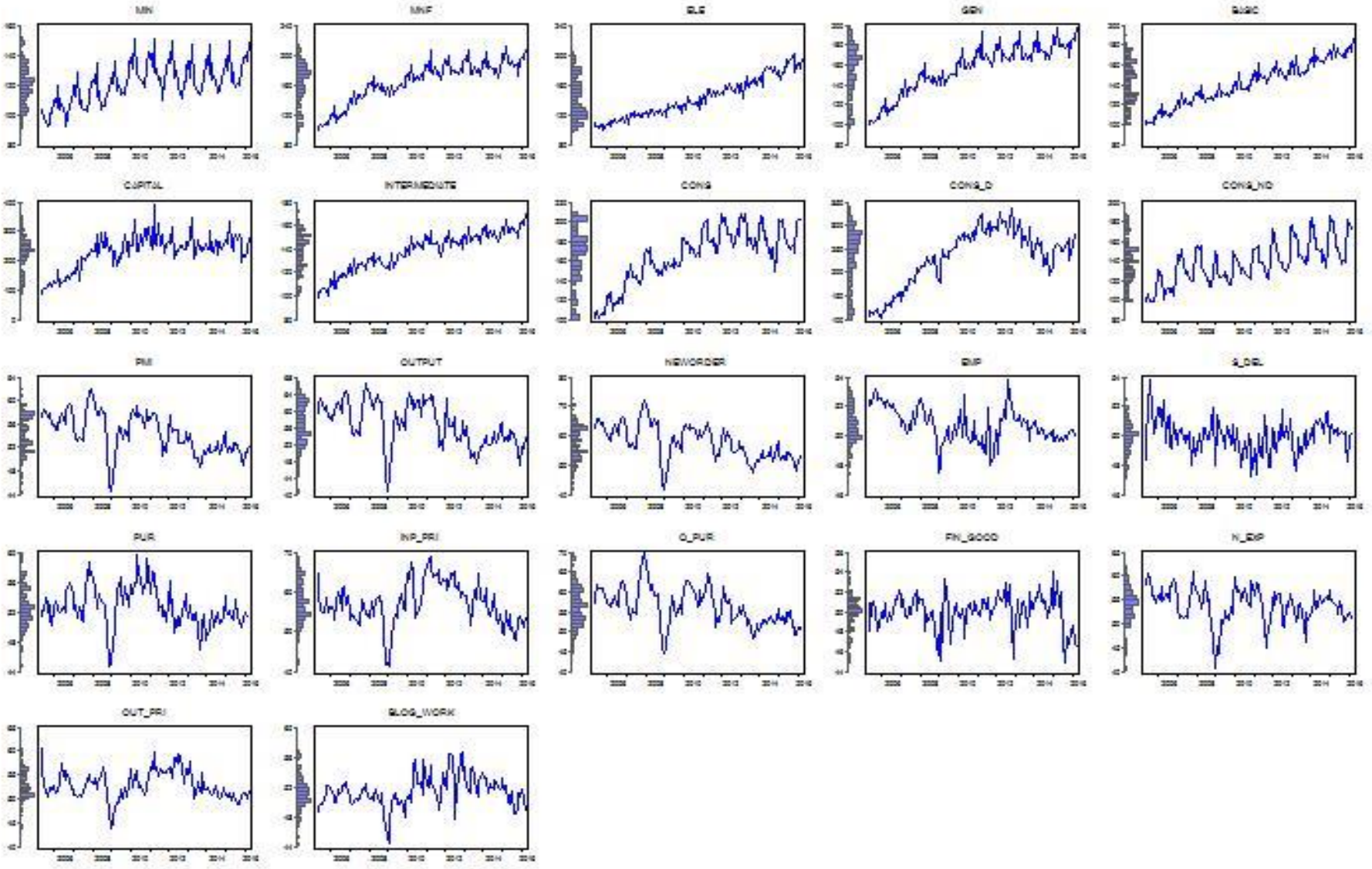

Table 2: Short and Long-term Relationship between IIP Classifications and PMI

Cointegrating Form

General Index			Mining & Quarrying			Manufacturing			Electricity		
Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
D(GEN(-1))	-0.62	0.00	D(MIN(-1))	-0.29	0.00	D(MNF(-1))	-0.57	0.00	D(ELE(-1))	-0.82	0.00
D(GEN(-2))	-0.12	0.27	D(MIN(-2))	0.38	0.00	D(MNF(-2))	-0.18	0.08	D(ELE(-2))	-0.29	0.00
D(GEN(-3))	0.21	0.02	D(MIN(-3))	0.37	0.00	D(MNF(-3))	0.18	0.05	D(PMI)	0.03	0.88
D(PMI)	0.07	0.75	D(PMI)	-0.31	0.14	D(PMI)	0.14	0.59	CointEq(-1)	0.00	0.96
CointEq(-1)	-0.05	0.14	CointEq(-1)	-0.29	0.00	CointEq(-1)	-0.05	0.12			

Long Run Coefficients

Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
PMI	1.48	0.77	PMI	-1.05	0.13	PMI	2.60	0.65	PMI	23.04	0.97
C	97.49	0.72	C	179.09	0.00	C	46.26	0.88	C	-36.66	1.00

Table 3 (a): Short and Long-term Relationship between IIP Classifications Seasonally Adjusted (SA) and PMI

Cointegrating Form

General Index SA			Mining & Quarrying SA			Manufacturing SA			Electricity SA		
Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
D(GEN_SA(-1))	-0.60	0.00	D(MNF_SA(-1))	-0.61	0.00	D(MIN_SA(-1))	-0.50	0.00	D(ELE_SA(-1))	-0.53	0.00
D(GEN_SA(-2))	-0.30	0.00	D(MNF_SA(-2))	-0.30	0.00	D(MIN_SA(-2))	-0.33	0.00	D(ELE_SA(-2))	-0.36	0.00
D(GEN_SA(-3))	-0.07	0.45	D(MNF_SA(-3))	-0.04	0.62	D(MIN_SA(-3))	-0.08	0.37	D(ELE_SA(-3))	-0.34	0.00
D(PMI)	0.05	0.78	D(PMI)	0.10	0.69	D(PMI)	-0.12	0.37	D(PMI)	-0.15	0.47
D(PMI(-1))	0.01	0.96	D(PMI(-1))	0.00	1.00	D(PMI(-1))	0.21	0.32	D(PMI(-1))	-0.27	0.37
D(PMI(-2))	0.28	0.34	D(PMI(-2))	0.33	0.36	D(PMI(-2))	-0.04	0.86	D(PMI(-2))	0.40	0.19
D(PMI(-3))	0.17	0.40	D(PMI(-3))	0.17	0.50	D(PMI(-3))	0.21	0.14	D(PMI(-3))	0.05	0.83
CointEq(-1)	-0.03	0.03	CointEq(-1)	-0.04	0.03	CointEq(-1)	-0.05	0.05	CointEq(-1)	0.00	0.96

Long Run Coefficients

Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
PMI	3.38	0.46	PMI	4.75	0.38	PMI	-1.17	0.45	PMI	164.97	0.96
C	10.71	0.96	C	-56.61	0.84	C	193.68	0.02	C	-10994.07	0.96

Table 3 (b): Short and Long-term Relationship between IIP Classifications Seasonally Adjusted (SA) and PMI-Differenced Specifications

Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
D(General Index SA)			**D(Mining & Quarrying SA)**			**D(Manufacturing SA)**			**D(Electricity SA)**		
D(GEN_SA(-1), 2)	0.25	0.01	D(MIN_SA(-1), 2)	0.27	0.00	D(MNF_SA(-1), 2)	0.26	0.00	D(ELE_SA(-1), 2)	0.69	0.00
D(PMI)	0.15	0.45	D(PMI)	-0.06	0.67	D(PMI)	0.20	0.40	D(ELE_SA(-2), 2)	0.34	0.00
D(PMI(-1))	0.03	0.92	D(PMI(-1))	0.36	0.01	D(PMI(-1))	0.01	0.97	D(PMI)	-0.16	0.45
D(PMI(-2))	0.38	0.05	CointEq(-1)	-1.73	0.00	D(PMI(-2))	0.43	0.08	D(PMI(-1))	-0.28	0.35
CointEq(-1)	-1.83	0.00				CointEq(-1)	-1.87	0.00	D(PMI(-2))	0.46	0.03
									CointEq(-1)	-2.22	0.00
Long Run Coefficients											
Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
PMI	0.12	0.03	PMI	0.02	0.53	PMI	0.16	0.01	PMI	-0.05	0.24
C	-5.70	0.04	C	-1.05	0.60	C	-8.05	0.02	C	3.59	0.15

Table 4 (a): Short and Long-term Relationship between PMI Classifications and IIP Manufacturing

Cointegrating Form

Output			New Orders			Employment			Stocks of Purchases		
Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
D(MNF_SA(-1))	-0.59	0.00	D(MNF_SA(-1))	-0.59	0.00	D(MNF_SA(-1))	-0.48	0.00	D(MNF_SA(-1))	-0.58	0.00
D(MNF_SA(-2))	-0.26	0.00	D(MNF_SA(-2))	-0.25	0.00	D(MNF_SA(-2))	-0.16	0.08	D(MNF_SA(-2))	-0.27	0.00
D(OUTPUT)	0.12	0.42	D(NEWORDER)	0.05	0.71	D(EMP)	0.71	0.15	D(PUR)	0.13	0.55
D(OUTPUT(-1))	0.04	0.84	D(NEWORDER(-1))	0.03	0.88	D(EMP(-1))	-1.22	0.03	CointEq(-1)	-0.04	0.01
D(OUTPUT(-2))	0.27	0.07	D(NEWORDER(-2))	0.27	0.05	D(EMP(-2))	1.33	0.01			
CointEq(-1)	-0.03	0.04	CointEq(-1)	-0.03	0.06	CointEq(-1)	-0.05	0.01			
Long Run Coefficients											
Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
OUTPUT	3.74	0.34	NEWORDER	3.14	0.39	EMP	-3.98	0.65	**PUR**	**14.58**	**0.05**
C	-8.64	0.97	C	23.20	0.91	C	390.08	0.37	C	-570.65	0.14

Table 4 (b): Short and Long-term Relationship between PMI Classifications and IIP Manufacturing

Cointegrating Form

Quantity of Purchases			Stocks of Finished Goods			New Export Orders			Output Prices		
Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
D(MNF_SA(-1))	-0.57	0.00	D(MNF_SA(-1))	-0.55	0.00	D(MNF_SA(-1))	-0.61	0.00	D(MNF_SA(-1))	-0.53	0.00
D(MNF_SA(-2))	-0.24	0.01	D(MNF_SA(-2))	-0.22	0.01	D(MNF_SA(-2))	-0.28	0.00	D(MNF_SA(-2))	-0.20	0.02
D(Q_PUR)	0.03	0.85	D(FIN_GOOD)	0.19	0.43	D(N_EXP)	0.00	0.98	D(OUT_PRI)	0.35	0.11
D(Q_PUR(-1))	0.06	0.80	CointEq(-1)	-0.04	0.00	D(N_EXP(-1))	-0.03	0.88	D(OUT_PRI(-1))	-0.01	0.97
D(Q_PUR(-2))	0.30	0.08				D(N_EXP(-2))	-0.05	0.80	D(OUT_PRI(-2))	-0.26	0.33
CointEq(-1)	-0.03	0.03				D(N_EXP(-3))	0.46	0.00	D(OUT_PRI(-3))	0.54	0.01
Long Run Coefficients											
Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
Q_PUR	2.49	0.45	**FIN_GOOD**	**16.73**	**0.03**	N_EXP	2.12	0.49	OUT_PRI	0.44	0.89
C	59.31	0.73	C	-646.63	0.09	C	78.84	0.62	C	166.48	0.32

Table 5: Short and Long-term Relationship between Finished Good PMI and IIP User Based Classifications

Cointegrating Form

Capital Goods			Capital Goods			Intermediate Goods			Consumer Durables			Consumer Non-durables		
Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
D(BASIC(-1))	-0.79	0.00	D(CAPITAL(-1))	-0.62	0.00	D(INTERMEDIATE(-1))	-0.82	0.00	D(CONS_D(-1))	-0.29	0.00	D(CONS_ND(-1))	0.16	0.07
D(BASIC(-2))	0.05	0.64	D(CAPITAL(-2))	-0.48	0.00	D(INTERMEDIATE(-2))	-0.34	0.00	D(CONS_D(-2))	-0.27	0.00	D(FIN_GOOD)	0.95	0.17
D(BASIC(-3))	0.34	0.00	D(FIN_GOOD)	0.63	0.71	D(FIN_GOOD)	0.05	0.85	D(CONS_D(-3))	-0.30	0.00	CointEq(-1)	-0.19	0.00
D(FIN_GOOD)	-0.07	0.78	CointEq(-1)	-0.14	0.01	CointEq(-1)	-0.05	0.12	D(FIN_GOOD)	0.97	0.29			
CointEq(-1)	-0.02	0.32							CointEq(-1)	-0.05	0.04			

Long Run Coefficients

Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.	Variable	Coefficient	Prob.
FIN_GOOD	-3.30	0.79	FIN_GOOD	4.35	0.71	FIN_GOOD	1.04	0.85	FIN_GOOD	17.97	0.33	FIN_GOOD	-1.05	0.78
C	346.42	0.59	C	29.67	0.96	C	109.36	0.70	C	-620.74	0.50	C	192.65	0.30

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