

Granger Causality Tests of Ai Group Performance Indices

Introduction

This note supplements the Ai Group Economics Research Note that assesses the correlations of the Ai Group performance indices with official economic data. This note uses econometric tests (Granger causality tests) to further assess the predictive ability of Ai Group's indices in relation to economic activity, measured by quarterly and annual growth rates of GDP(P), and sectoral performance as measured by quarterly and annual growth rates of GDP(P) (manufacturing, services and construction) as well as employment (manufacturing, services and construction).¹

Granger causality overview

What is Granger causality?

Bivariate Granger causality tests involve using regression analysis to provide an indication of whether lagged values of one variable x can help predict current values of another variable y . The approach involves seeing how much of the current value of y can be explained by past values of y and then to see whether adding lagged values of x can improve the explanation of y . Hence variable y is said to be Granger-caused by x if x helps in the prediction of y , or equivalently if the coefficients on the lagged x 's are statistically significant.

There are four different potential results from a bivariate Granger causality test:

- Lagged x terms (in a regression of y on lagged values of y and x) may be statistically different from zero as a group and the lagged y terms are not statistically different from zero. Hence here we have x Granger causing y .
- Lagged y terms (in a regression of x on lagged values of y and x) may be statistically different from zero as a group and the lagged x terms are not statistically different from zero. Hence here we have y Granger causing x .
- Both sets of x and y terms are statistically different from zero (in the two regressions outlined above) and so we have bi-directional causality.
- Both sets of x and y terms are not statistically different from zero (in the two regressions outlined above) and so x and y are independent of each other.

In the case of assessing the predictive capabilities of the Ai Group performance indices, we can think of either the Performance of Manufacturing Index (PMI), the Performance of Services Index (PSI) or the Performance of Construction Index (PCI) as the x variable and the official data series (whether GDP, GVA, employment or some other economic variable) as the y variable. We want to assess

¹ Granger, C. W. J. (1969). 'Investigating Causal Relations by Econometric Models and Cross-Spectral Methods', *Econometrica*, vol. 37, pp. 424–438.

whether the Ai Group performance indices contain information which helps predict the official data. In this way we are assessing the usefulness of the indices as leading indicators of economic activity.

Regression equations

The Granger causality tests for the case of two stationary variables y and x involves estimating the following time series regressions:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \dots + \alpha_l y_{t-l} + \beta_1 x_{t-1} + \dots + \beta_l x_{t-l} + \epsilon_t$$

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \dots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \dots + \beta_l y_{t-l} + u_t$$

where ϵ_t and u_t are uncorrelated error terms and involves testing $\beta_1 = \beta_2 = \dots = \beta_l = 0$ in each regression equation (i.e. testing the null hypothesis that x does not Granger cause y in the first regression and that y does not Granger cause x in the second regression).

Test results

The PMI

Table 1 provides the Granger causality test results for the PMI with the growth rates of GDP(P), GVA, GDP(P) - manufacturing and manufacturing employment, respectively.² The period tested covers 1992Q(3) to 2009Q(4).

Table 1 (a)	Obs.	PMI lags	y variable lags	F-stat	p-value	Granger causality? (b)
Tests of PMI and GDP(P):						
Null hypothesis:						
GDP(P) (agr) does not Granger Cause PMI	65	5	5	0.36	0.86	No
PMI does not Granger Cause GDP(P) (agr)	65	5	5	2.66	0.03*	Yes
GDP(P) (qgr) does not Granger Cause PMI						
PMI does not Granger Cause GDP(P) (qgr)	63	7	7	2.48	0.02*	Yes
	63	7	7	0.98	0.45	No
Tests of PMI and GVA:						
Null hypothesis:						
GVA (agr) does not Granger Cause PMI	65	5	5	2.23	0.06	No
PMI does not Granger Cause GVA (agr)	65	5	5	2.31	0.05*	Yes
GVA (qgr) does not Granger Cause PMI						
PMI does not Granger Cause GVA (qgr)	68	2	2	4.46	0.01*	Yes
	68	2	2	1.29	0.28	No
Tests of PMI and GDP(P) – manufacturing:						
Null hypothesis:						
GDP(P) - man (agr) does not Granger Cause PMI	59	11	11	1.61	0.13	No
PMI does not Granger Cause GDP(P) - man (agr)	59	11	11	3.02	0.00*	Yes
GDP(P) - man (qgr) does not Granger Cause PMI						
PMI does not Granger Cause GDP(P) - man (qgr)	68	2	2	2.27	0.11	No
	68	2	2	6.43	0.00*	Yes

² The variables are: the 3-month moving average PMI net balance and the year on year annual or quarterly growth rates of the official economic activity variables, seasonally adjusted. Unit root tests were performed on each series to confirm stationarity before Granger causality tests were applied.

Table 1 (a)	Obs.	PMI lags	y variable lags	F-stat	p-value	Granger causality? (b)
Tests of PMI and manufacturing employment:						
Null hypothesis:						
Manufacturing employment (agr) does not Granger Cause PMI	63	3	3	2.04	0.11	No
PMI does not Granger Cause Manufacturing employment (agr)	63	3	3	1.90	0.13	No
Manufacturing employment (qgr) does not Granger Cause PMI	66	3	3	3.49	0.02*	Yes
PMI does not Granger Cause Manufacturing employment (qgr)	66	3	3	2.88	0.04*	Yes

* Statistically significant at 5% level of significance.

(a) Lag length selection based on LR tests. LM autocorrelation tests for the residuals were also conducted up to lag length 12 and no statistically significant autocorrelation was detected. (b) Decision rule: Do not reject null hypothesis if probability (p-value) is above level of significance (such as 0.05 at the 5% level of significance). agr = annual growth rate; qgr = quarterly growth rate.

Implications of PMI results

The Granger causality tests for the PMI are the most promising in terms of the predictive ability of the indices with respect to economic activity, both economy-wide and in the manufacturing industry itself. On all four aspects of economic activity tested (GDP(P), GVA, GDP(P) for manufacturing, and manufacturing employment) there was evidence of the PMI Granger causing the official economic data (either annually or quarterly). Hence the PMI contains some information which helps predict the official data.

With respect to the PMI and gross domestic product, the PMI Granger causes the annual GDP(P) growth rate. However there is some feedback mechanism from quarterly GDP(P) growth Granger causing the PMI, which suggests that respondents to the PMI are taking into consideration the last quarter overall economic conditions and in turn influencing their responses to the PMI survey over the current quarter. A similar conclusion emerges when we consider the PMI and gross value added.

With regard to the PMI and gross domestic product of the manufacturing industry, both the annual and quarterly test results indicate one-way Granger causality from the PMI to the growth rate of GDP(P) of the manufacturing industry.

The PMI also provides some predictive ability with respect to manufacturing employment. This is evident from the granger causality test result for the PMI and the quarterly growth rate of manufacturing employment.

The PSI

Table 2 provides the Granger causality test results for the PSI with the growth rates of GDP(P), GVA, GDP(P) - services and services employment, respectively.³ The period tested covers 2003Q(4) to 2009Q(4).

³ The variables are: the 3-month moving average PMI net balance and the year on year annual or quarterly growth rates of the official economic activity variables, seasonally adjusted. The services industries include those reflected in the PSI i.e. all the ABS services industries less utilities, administrative

Table 2 (a)	Obs.	PSI lags	y variable lags	F-stat	p-value	Granger causality? (b)
Tests of PSI and GDP(P):						
Null hypothesis:						
GDP(P) (agr) does not Granger Cause PSI	24	3	3	0.48	0.69	No
PSI does not Granger Cause GDP(P) (agr)	24	3	3	2.90	0.06	No
GDP(P) (qgr) does not Granger Cause PSI	24	3	3	0.30	0.81	No
PSI does not Granger Cause GDP(P) (qgr)	24	3	3	0.89	0.46	No
Tests of PSI and GVA:						
Null hypothesis:						
GVA (agr) does not Granger Cause PSI	24	3	3	1.52	0.24	No
PSI does not Granger Cause GVA (agr)	24	3	3	5.25	0.00*	Yes
GVA (qgr) does not Granger Cause PSI	21	6	6	2.72	0.09	No
PSI does not Granger Cause GVA (qgr)	21	6	6	1.86	0.20	No
Tests of PSI and GDP(P) – services:						
Null hypothesis:						
GDP(P) - serv (agr) does not Granger Cause PSI	24	3	3	3.66	0.03*	Yes
PSI does not Granger Cause GDP(P) - serv (agr)	24	3	3	2.39	0.10	No
GDP(P) - serv (qgr) does not Granger Cause PSI	25	2	2	3.48	0.05*	Yes
PSI does not Granger Cause GDP(P) - serv (qgr)	25	2	2	1.09	0.35	No
Tests of PSI and services employment:						
Null hypothesis:						
Services employment (agr) does not Granger Cause PSI	25	2	2	0.05	0.95	No
PSI does not Granger Cause services employment (agr)	25	2	2	1.02	0.37	No
Services employment (qgr) does not Granger Cause PSI	23	4	4	1.32	0.30	No
PSI does not Granger Cause services employment (qgr)	23	4	4	1.11	0.38	No

* Statistically significant at 5% level of significance.

(a) Lag length selection based on LR tests. LM autocorrelation tests for the residuals were also conducted up to lag length 12 and no statistically significant autocorrelation was detected. (b) Decision rule: Do not reject null hypothesis if probability (p-value) is above level of significance (such as 0.05 at the 5% level of significance). agr = annual growth rate; qgr = quarterly growth rate.

Implications of PSI results

The PSI provides limited predictive ability of economy-wide economic activity and no predictive ability with respect to services industry activity (gross domestic product or employment). There is some evidence that the PSI Granger causes the quarterly growth rate of GVA but no evidence of Granger causality with respect to the annual growth rate of GVA or with respect to GDP(P). Moreover, when considering GDP(P) for services industries the direction of causality runs from the growth rate of GDP(P) for services industries to the PSI. Given the predominance of services in the

and support services, public administration and safety, and education and training. Unit root tests were performed on each series to confirm stationarity before Granger causality tests were applied.

economy when compared to the manufacturing industry, it is surprising that the PSI is less relevant to predicting economic activity than the PMI. This suggests there is a need to examine the coverage and construction of the PSI survey (noting the results may also be influenced by the smaller sample size).

The PCI

Table 3 provides the Granger causality test results for the PCI with the growth rates of GDP(P), GVA, GDP(P) – construction and construction employment, respectively.⁴ The period tested covers 2005Q(4) to 2009Q(4).

Table 3 (a)	Obs.	PCI lags	y variable lags	F-stat	p-value	Granger causality? (b)
Tests of PCI and GDP(P):						
Null hypothesis:						
GDP(P) (agr) does not Granger Cause PCI	14	3	3	0.34	0.79	No
PCI does not Granger Cause GDP(P) (agr)	14	3	3	3.05	0.10	No
GDP(P) (qgr) does not Granger Cause PCI	13	4	4	0.38	0.80	No
PCI does not Granger Cause GDP(P) (qgr)	13	4	4	0.87	0.55	No
Tests of PCI and GVA:						
Null hypothesis:						
GVA (agr) does not Granger Cause PCI	15	2	2	0.13	0.87	No
PCI does not Granger Cause GVA (agr)	15	2	2	2.47	0.13	No
GVA (qgr) does not Granger Cause PCI	14	3	3	0.47	0.71	No
PCI does not Granger Cause GVA (qgr)	14	3	3	3.51	0.07	No
Tests of PCI and GDP(P) – construction:						
Null hypothesis:						
GDP(P) - constr (agr) does not Granger Cause PCI	14	3	3	0.88	0.49	No
PCI does not Granger Cause GDP(P) - constr (agr)	14	3	3	8.71	0.00*	Yes
GDP(P) - constr (qgr) does not Granger Cause PCI	13	4	4	0.98	0.50	No
PCI does not Granger Cause GDP(P) - constr (qgr)	13	4	4	4.02	0.10	No
Tests of PCI and construction employment:						
Null hypothesis:						
Construction employment (agr) does not Granger Cause PCI	14	3	3	0.67	0.59	No
PCI does not Granger Cause construction employment (agr)	14	3	3	1.79	0.23	No
Construction employment (qgr) does not Granger Cause PCI	13	4	4	0.55	0.70	No
PCI does not Granger Cause construction employment (qgr)	13	4	4	0.57	0.69	No

* Statistically significant at 5% level of significance.

(a) Lag length selection based on LR tests. LM autocorrelation tests for the residuals were also conducted up to lag length 12 and no statistically significant autocorrelation was detected. (b) Decision rule: Do not reject null hypothesis if probability (p-value) is above level of significance (such as 0.05 at the 5% level of significance). agr = annual growth rate; qgr = quarterly growth rate.

⁴ The variables are: the 3-month moving average PMI net balance and the year on year annual or quarterly growth rates of the official economic activity variables, seasonally adjusted. Unit root tests were performed on each series to confirm stationarity before Granger causality tests were applied.

Implications of PCI results

There is limited usefulness of the PCI as a leading indicator of activity in the economy and the only Granger causality evident relates to the PCI Granger causing the annual growth rate in GDP(P) for the construction industry (although Granger causality is statically significant at the 10% level in relation to gross value added). Again these test results may be influenced by the small sample size but it also suggests a need to examine the coverage of the PCI survey and whether elements of both the PCI and PSI should be combined with the PMI into a composite index of economic activity.

Conclusion

This note supports the findings of the research note regarding the correlations of the Ai Group performance indices with economic data, which suggests that there is some correlation between the indices and official data (mainly with respect to annual growth rates). The analysis in this note finds that the PMI is the most relevant leading indicator of activity in the economy and in the manufacturing industry itself. On all four aspects of economic activity tested (GDP(P), GVA, GDP(P) for manufacturing, and manufacturing employment) Granger causality from the PMI to the official data was found.

Statistically, the PSI and PCI are less valuable as leading indicators of economic activity, the PSI test results suggesting evidence of Granger causality from the official data to the PSI and the PCI test results indicating limited causality in either direction. The coverage and size of the PSI and PCI surveys should be examined and refined and there is some basis for considering the development of an economy-wide composite index.

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