Get Better Measurement of China's GDP grwoth

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Why GDP

- One of the most fundamental concepts of Macroeconomics
- Indicator of the economy
- Policy Making

Why China's GDP

- Second largest GDP of the World
- Account for 15% of the world's GDP
- Business condition: Barclays, Bloomberg, Capital Economics, Lombard Street Research, Nomura and Oxford Economics

What Problem

- a long debate of the reliability of China's GDP statistics
- Adams and Chen (1996), Rawski (2001), Maddison and Wu (2007): Official growth rate considerably overstates actual growth.
- Perkins and Rawski (2008), Holz (2013): Chinese data are generally accurate.

Three Methods

- A penny expended = A Penny earned = A Penny Produced
- Expenditure account, income account, production account
- Ideally three accounts should give same numbers
- Often diverge numbers

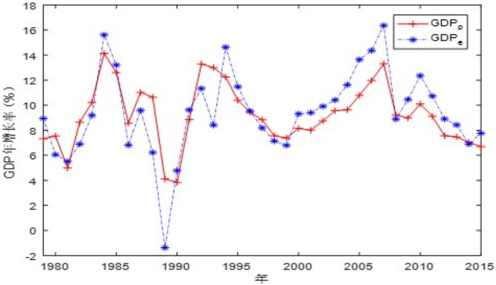
China's Reality

- Official GDP: production account
- Most advanced economy: expenditure account
- Historical reason

Information Content

- Nalewaik (2010): US, expenditure and income account may have different information content. GDI better reflects the business cycle fluctuations.
- What about China?

China's two accounts



China's two accounts

表1、生产法和支出法GDP年增长率的统计特征

	最小值	最大值	均值	方差
GDP_p (%)	3.84	14.14	9.22	2.50
GDP_e (%)	-1.38	16.36	9.41	3.37

Forecast of Two

表2、两种GDP增长之间的相互预测

	GDP_p(t)	GDP_p(t)	GDP_e(t)	GDP_e(t)
Constant	5.36^{***}	3.99^{**}	4.55^{**}	4.84^{*}
	(1.02)	(1.37)	(1.48)	(2.14)
GDP_e(t-1)	0.41^{***}		0.51^{**}	
	(0.10)		(0.15)	
GDP_p(t-1)		0.57^{***}		0.49^{*}
		(0.14)		(0.22)
R^2	0.33	0.32	0.26	0.13
Adj. R^2	0.31	0.30	0.24	0.10
Num. obs.	36	36	36	36

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Forecast Error

Let y_t^T, y_t^E and y_t^P be the true GDP growth, expenditure account GDP growth, production account GDP growth. We assume the model

$$y_t^P = y_t^T + \epsilon_t^P \tag{1a}$$

$$y_t^E = y_t^T + \epsilon_t^E \tag{1b}$$

$$E(\epsilon_t^P) = E(\epsilon_t^E) = 0 \tag{2}$$

Forecast Combination

From the forecast combination literature, consider a convex combination:

$$y_t^C = \lambda_P y_t^P + \lambda_E y_t^E \tag{3}$$

This forecast should minimize the loss function

$$(\lambda_P^*, \lambda_E^*) = \arg\min_{\lambda_P, \lambda_E} E[(y_t^T - \lambda_P y_t^P - \lambda_E y_t^E)^2] \tag{4}$$

subject to the unbiased constrain

$$E[y_t^C] = E[\lambda_P y_t^P + \lambda_E y_t^E | y_t^T] = y_t^T \tag{5}$$

This will lead to

$$\lambda_P + \lambda_E = 1 \tag{6}$$

Forecast Combination

To solve the minimization problem, we will get

$$\lambda_P^* = \arg\min_{\lambda_P}[\lambda_P^2 var(\epsilon_t^P) + 2\lambda_P(1-\lambda_P)cov(\epsilon_t^P, \epsilon_t^E) + (1-\lambda_P)^2 var(\epsilon_t^E)] \quad (7)$$

We can use first order condition to solve this problem:

$$\lambda_P^* = \frac{var(\epsilon_t^E) - cov(\epsilon_t^P, \epsilon_t^E)}{var(\epsilon_t^P) + var(\epsilon_t^E) - 2cov(\epsilon_t^P, \epsilon_t^E)} \quad (8)$$

To get the optimal weight λ_P^*, we have to know the variance and covariance of the error term ϵ_t^P and ϵ_t^E.

A Third Measurement

- Aruoba et al. (2012) use a quasi-bayesian method.
- Pinkovskiy and Sala-i Martin (2016a), Pinkovskiy and Sala-i Martin (2016b) and Clark et al. (2017) suggest using a third independent measurment: the light data
- light data are correlated with economic activity: Elvidge et al. (1997) Ghosh et al. (2010), Chen and Nordhaus (2011), Henderson, Storeygard, and Weil (2012), Michalopoulos and Papaioannou (2013, 2014)

A Third Measurement

Let Y_t^S be the GDP growth rate by light data.

$$y_t^S = y_t^T + \epsilon_t^S \tag{9}$$

$$E(\epsilon_t^S \epsilon_t^P) = E(\epsilon_t^S \epsilon_t^E) = 0 \tag{10}$$

Some Math

Consider the population regression

$$y_t^S = \alpha_0 + \alpha_P y_t^P + \alpha_E y_t^E \tag{11}$$

The formula for the above regression coefficient is

$$\alpha_P = \frac{var(y_t^E)cov(y_t^P, y_t^S) - cov(y_t^P, y_t^E)cov(y_t^E, y_t^S)}{var(y_t^P)var(y_t^E) - (cov(y_t^P, y_t^E))^2} \tag{12}$$

we can get

$$var(y_t^P) = var(y_t^T) + var(\epsilon_t^P) \tag{13}$$

$$var(y_t^E) = var(y_t^T) + var(\epsilon_t^E) \tag{14}$$

$$cov(y_t^P, y_t^S) = var(y_t^T) \tag{15}$$

$$cov(y_t^E, y_t^S) = var(y_t^T) \tag{16}$$

$$cov(y_t^E, y_t^P) = var(y_t^T) + cov(\epsilon_t^E, \epsilon_t^P) \tag{17}$$

Solution

$$\alpha_P = \frac{var(y_t^T)[var(\epsilon_t^E) - cov(\epsilon_t^E, \epsilon_t^P)]}{var(y_t^T)[var(\epsilon_t^E - \epsilon_t^P)] + var(\epsilon_t^E)var(\epsilon_t^P) - (cov(\epsilon_t^E, \epsilon_t^P))^2} \quad (18)$$

We can exchange E and P to get

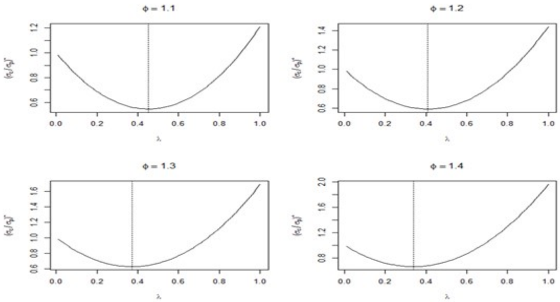
$$\alpha_E = \frac{var(y_t^T)[var(\epsilon_t^P) - cov(\epsilon_t^E, \epsilon_t^P)]}{var(y_t^T)[var(\epsilon_t^E - \epsilon_t^P)] + var(\epsilon_t^E)var(\epsilon_t^P) - (cov(\epsilon_t^E, \epsilon_t^P))^2} \quad (19)$$

Finally

$$\frac{\alpha_P}{\alpha_P + \alpha_E} = \frac{var(\epsilon_t^E) - cov(\epsilon_t^E, \epsilon_t^P)}{var(\epsilon_t^E) + var(\epsilon_t^P) - 2cov(\epsilon_t^E, \epsilon_t^P)} \tag{20}$$

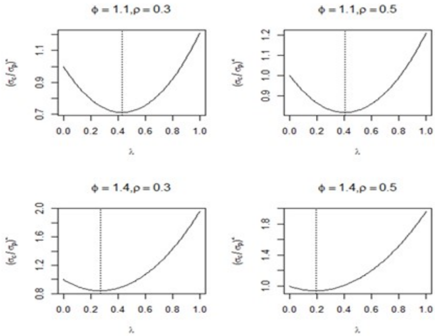
we see

$$\lambda_P^* = \frac{\alpha_P}{\alpha_P + \alpha_E} \tag{21}$$



where $\phi = \sigma_E / \sigma_P$

Why Combination



where $\phi = \sigma_E/\sigma_P$ and $\rho = corr(\epsilon_E, \epsilon_P)$

Empirical Result

Sorry, we haven't got empirical result yet!

Further Research

- Yang and Chen (2017)：Business Cycle
- Yang and Chen (2017): Confidence Interval of GDP growth
- Chen, Xu and Zou (2017): Mix frequency VAR
- Chen, He (2017): Mix Frequency dynamic Factor Model
- Chen and Luo (2017): Long Run Growth of China
- Yang and Chen (2017): Growth Rate of New Normal State