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Does the Cross-Sectional Equation $EPS_{t+1} = a^*P_t + b^*EPS_t + u_{t+1}$ Differ between China and the US?*

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Abstract

This paper compares Chinese (CH) and US firms in an earnings per share (EPS) forecasting setting. Next year's EPS depend on (i) current price and (ii) current EPS. A comparison gives rise to the following question: what will the two financial markets have in common and what will most likely be different? The evidence presented suggests that on a very basic level, China does not differ from the US. For both economies, the data show that the right hand side of the equation can be conceptualised as a weighted average of the two variables when rescaled. This scaling procedure depends on the earnings rate in the capital markets. However, the weights differ: For CH firms, the second right hand side (RHS) variable, current EPS, is relatively more important than the first, price; this finding stands in contrast to the US, where the two RHS variables are of about equal importance. The paper also elaborates on a methodological subject: the conclusions are not available if one uses ordinary least squares (OLS). It shows that a robust estimation method due to Theil (1950) and Sen (1968) leads to two empirical conclusions. More generally, the paper contends that it makes no sense to compare CH and US financial market data unless the issue at hand is specific, straightforward, and relies on robust estimation.

I. Introduction

Many researchers addressing issues related to the Chinese (CH) economy proceed from the pleasing adage "China is different". This opens the door to making all sorts of striking claims/findings that can be juxtaposed to, in particular, the US. A researcher focusing on China is thereby given certain leeway as well as marketing muscle which potentially aids his/her publication endeavours. A more reflective perspective recognises

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that there are many aspects of the CH and US economies that ought to be similar insofar as the "laws of economics" do not depend on the country/economy. The challenge, therefore, becomes one of first showing that some central aspects of the two financial markets are indeed similar. Following that, one can then take a closer look, hypothesising that in some specific respects, there are also differences. The former aspect now turns out to be where the critical issue of "statistical methodology" rears its head. A sloppy methodology tends to lead to "rejection of the null" and the suggestion that on a very basic level, CH financial markets differ from US financial markets. These epistemological observations lead to the following conclusion: research comparing China and the US can benefit from starting out by showing that under the appropriate methodology, *basic* aspects of the CH and US financial markets are similar. This should be viewed as a necessary condition before moving on to aspects that make the two economies different. A major purpose of this paper is to show that this objective can be achieved for the equation to be estimated.

The equation subject to scrutiny specifies that one can view a firm's forthcoming earnings per share (EPS) (those of the next year) as being conditioned by the current EPS and the current stock price. Common sense suggests that both of the variables' coefficients should load positively (or at least, cannot be negative). But naturally one looks for reasonable, relatively weak assumptions that produce a more restrictive class of admissible relations. If this class satisfies certain characteristics meaningful in the US, then these characteristics ought to apply in China too. As the paper discusses in greater detail in the next section, for both economies, the right hand side (RHS) of the equation can be conceptualised as the weighted average of the two variables when rescaled. In other words, the magnitude on the coefficient related to current price should be connected with the one related to current EPS; there ought to be some kind of trade-off that common sense economics can model. The principles applied do not refer to a particular country. The idea simply exploits the fact that there are two benchmark models, one based on price and one based on EPS, and these can be combined into an average. However, the weighting scheme will not be the same in the two countries; in China, the second RHS variable is much more important than the first, which stands in contrast to the US. The paper will explain why this is so.

The model estimated is of interest quite aside from the practical aspects of earnings forecasting. On a more basic level, it reflects that in all financial markets, investors focus on expected earnings as the primary determinant of value: As the colloquial saying goes, "investing is easy as long as a firm's future earnings have been purchased cheaply". Thus, the model reflects that price and current earnings pick up on the next period's earnings and the growth in expected earnings. The principle should be viewed as universal – it applies in China no less than it does in the US – but it can of course be implemented with some differences. Hence, the paper addresses both similarities and differences, US vs. China.

The paper also addresses a methodological point. It demonstrates that a robust estimation method can, due to the development of the Theil-Sen (TS) estimator, provide the reliable estimates needed to find out in what ways the US and China are similar and yet different. The statistical method put to use accordingly demonstrates that the above conclusions depend on the TS estimation method: ordinary least squares (OLS) does not work at all, as the subsequent estimations show. This issue illustrates the importance of outliers and the role of heteroscedasticity, both of which disrupt the effectiveness of OLS estimation. TS estimations, by contrast, deal with these problems in an effective manner.

A recent working paper by this author and Seil Kim (2014) discusses OLS as compared to TS. On a more introductory level, to appreciate TS, the reader may consult Wikipedia, which provides a brief elementary exposition. Both of these references point out that the statistical efficiency inherent in TS compared with OLS works in TS's favour. The Ohlson-Kim paper demonstrates this efficiency empirically in cross-sectional valuation settings. TS-based estimates tend to be stable across years, and at the same time, TS-estimated equations dominate OLS-estimated equations in terms of goodness-of-fit. This paper will demonstrate these aspects yet again.

II. The Forecasting Equation: The Hypotheses

A vast literature on EPS forecasting studies various predictors and their performance. We do not need to review such research here. For the purposes of this paper, it suffices to note that there are two very natural starting points. First, as is suggested by virtually all elementary valuation models and even more so by the capital markets' received wisdom, current price anticipates future earnings. The idea is that investors try to buy future earnings as cheaply as possible. Second, a long standing tradition in accounting research, and yet again received wisdom, suggests that current EPS provides a plausible first-cut variable in the forecasting of next year's EPS. Researchers often refer to the so-called random walk hypothesis, or martingale hypothesis, of the time-series behaviour of earnings. More precisely, EPS is expected to grow over time due to the EPS increments attributable to retained earnings. (The concept can be sharpened by introducing dividends.) Thus, the idea is that the bottom line in the income statement provides the centrepiece in financial reporting. This hypothesis combined with the one related to price provides "organising first principles" when one tries to forecast earnings.

What about adding more variables on the right hand side of the equations as predictors? This may appeal, but one should expect decreasing incremental forecasting power, and so it may not be worthwhile. Nonetheless, it is of conceptual interest to consider book values as an additional predictor since these variables act as bottom line numbers in balance sheets. We will revisit this matter at the end of the paper.

By introducing an earnings rate, referred to as $r = R-1$, one can express two benchmark models as:

(i) $EPS_{t+1} = r*P_t$ + mean zero noise, and
(ii) $EPS_{t+1} = R*EPS_t$ + mean zero noise.

A more general forecasting scheme combines (i) and (ii) to yield the equation in the paper's title:

$$EPS_{t+1} = (a/r)*(r*P_t) + (b/R)*(R*EPS_t) + \text{mean zero noise.}$$

The model can be sharpened up if one further assumes that there can be no "double-counting"; in such a case, (a/r) and (b/R) must satisfy the weighted average condition:

$$(a/r) + (b/R) = 1.$$

Given the last condition, note next that with the parameters a and b in place, via estimation, one can solve for the implied r: that is, it leads to an estimate $r = f(a,b)$ (A quadratic equation solves for r as a function of a and b).

Later, the paper provides estimates of a and b for both China and the US and across a five-year period for each year. Thus, no less than 10 estimates of r will be inferred from the underlying estimated equations (actually, 20 if one keeps in mind that both OLS and TS will be applied). So what should be expected? Roughly speaking, a certain degree of success can be declared if the estimated r falls within the range of say 5 to 12 per cent. These numbers should subsume a crude estimate of the average CH and US cost of equity capital. To expect a more narrow range would seem to be overly ambitious given the presence of estimation errors and the inherent uncertainty as to the "true" earnings rate.

The two main hypotheses compare the US and CH financial markets, the first one stating a similarity – the broad weighted average hypothesis – and the second a difference – the weights are different.

H1: Both CH and US generally lead to estimates of r, as a function of the estimates of (a,b), that are within a reasonable range.

Admittedly, this hypothesis is unlikely to hold unless the estimations are relatively efficient. *Accordingly, we expect that the application of TS leads to materially more plausible estimates of r as compared to OLS.* Thus, implicit in the first hypothesis is the use of the TS estimation method; the same is true for the second hypothesis.

H2: Estimates of the parameter a are generally lower for China as compared to the US. As to b, the opposite is true.

This hypothesis reflects the fact that consistent with their respective country's GNP growth, CH firms have experienced much higher growth than US firms. It suggests that to a corresponding degree, the current price connects less to expected earnings; accordingly, current earnings have to pick up as a predictor of expected earnings for the forthcoming year. In other words, growth shifts the forecast to current earnings as a variable picking up on future earnings in relative terms.

One could of course also hypothesise that r should generally be larger in China than in the US simply because, as a matter of hypothesis, firms in China are, on average, riskier. When the estimation results are presented in subsequent sections, such a comparison will be made and commented on. However, it should be noted that the estimation errors, not to mention the confounding variables, work against the possibility of obtaining a clear-cut result to that effect; the "real" spread between r(CH) and r(US) is most likely quite small compared to the estimation (and specification) errors.

III. Basic Statistics

To avoid problems associated with small firms and related outliers, the analysis focuses only on relatively large firms in each of the two economies. For the US, the sample refers to the S&P 500, and for China, to the Shanghai & Shenzhen 300. Both sets exclude financial firms. The period covered is 2007-2011: a five-year period suffices given the objective of the paper. It should be noted that 2007 was a watershed year for China: it was the year that followed substantial reforms in the financial markets, so earlier years would be of less interest.

The equation estimated normalises all variables using the current stock price. Thus, the dependent variable equals the realised forward earnings yield EPS_{t+1} / P_t and the RHS comprises (i) an intercept (i.e. a) and (ii) one data-dependent variable, namely, EPS_t / P_t with slope-coefficient b. This procedure, while somewhat arbitrary, is standard in OLS applications to deal with heteroscedasticity. When it comes to TS, the estimates of a and b remain the same even in the absence of normalisation (Ohlson and Kim discuss this issue).

Table 1 presents the statistics of the dependent variable, one panel for the US and one for China. The realised (forward) EPS yields centre around 6% in the US sample and 3.7% in the CH sample. It should indeed be lower in the CH sample because China's economy has been, and is expected to remain, a growth economy in terms of both earnings and GNP. The greater the growth, the less the current and expected earnings yield. The table also provides a sense of the forecasting error in the absence of any specific forecasting information. It measures the forecast dispersion which defines a variability measure centred on the median earnings yield, or "median absolute error" for short. The US sample shows a dispersion in absolute value terms of, as a rough average across years, 1.8%, whereas in the CH sample, it is higher (2.1%). Given the variations across years, the numbers are not all that different for the two countries.

Table 1 Descriptive Statistics

$E_1P = EPS_{t+1} / P_t$

Panel A: US Standard & Poor's 500

	2007	2008	2009	2010	2011
Median	**0.050**	**0.060**	**0.069**	**0.066**	**0.061**
25th	0.028	0.032	0.049	0.048	0.046
75th	0.065	0.080	0.087	0.083	0.079
Min	-2.142	-0.772	-0.607	-0.972	-0.615
Max	0.149	79.216	0.429	0.317	0.333
N	378	394	392	396	398
Dispersion = med.Abs.Value $\left[\left(E_{1j}/P_j\right) - \underset{j}{\text{med}}\left(E_{1j}/P_j\right)\right]$					
	0.018	**0.024**	**0.019**	**0.018**	**0.017**

Remember:

- **median E_1P = 6.1%**
- **median dispersion = 1.8%**

Panel B: China Shanghai & Shenzhen 300

	2007	2008	2009	2010	2011
Median	**0.017**	**0.053**	**0.034**	**0.037**	**0.047**
25th	0.007	0.029	0.020	0.019	0.020
75th	0.026	0.083	0.054	0.062	0.076
Min	-0.100	-3.856	-0.151	-0.300	-0.245
Max	0.519	0.315	1.305	0.168	0.183
N	283	273	273	268	267
Dispersion = med.Abs.Value $\left[\left(E_{1j}/P_j\right) - \underset{j}{\text{med}}\left(E_{1j}/P_j\right)\right]$					
	0.009	**0.026**	**0.017**	**0.021**	**0.028**

Remember:

- **median E_1P = 3.7%**
- **median dispersion = 2.1%**

A closer look at the table shows that at least some observations ought to be categorised as outliers for both countries. Observations of earnings yield in excess of one (or even 0.5) in absolute value are totally unreasonable and potentially due to outright data errors. Such data points occur for both countries (though not in all years). In the table, the “max” and “min” can be very large – too large – in absolute value terms, and they rarely make sense except as real exceptions to the overwhelming majority of data points. This suggests the need for robust estimation techniques, a matter to be discussed later.

IV. Estimating the Forecasting Equation: Results

The initial results reported in Table 2 relate to OLS, starting with the US sample. These results are obviously “disappointing” insofar as the estimated b in 2008 is absurdly negative and the estimated r for 2007 is negative, as is the estimate of a, neither of which makes economic sense. Perhaps most strikingly, overall, the median across year forecast error has now *increased* from 1.8% to 1.9%. In other words, it is virtually impossible to argue that the model estimated has added anything of substance; the inclusion of a forecasting variable has made things worse, not better as one might have expected, in terms of the error metric.

Table 2 Results of OLS Regression

$$\mathbf{EPS_{t+1} / P_t = a + b^*(EPS_t / P_t) + u'_{t+1}}$$

Panel A: US Standard & Poor’s 500

	2007	2008	2009	2010	2011
a	-0.017	0.041	0.061	0.038	0.020
b	0.68	-4.01	0.11	0.39	0.49
abs. error	0.038	0.333	0.018	0.016	0.019
r	-0.062	0.008	0.068	0.060	0.038

Remember:

- median a = 3.8%, median b = 0.39
- **median r = 3.8%**
- **median abs. error = 1.9%**

Panel B: China Shanghai & Shenzhen 300

	2007	2008	2009	2010	2011
a	0.010	-0.015	0.029	0.003	-0.007
b	0.33	0.94	0.49	0.96	0.94
abs. error	0.008	0.032	0.014	0.010	0.016
r	0.015	N.S.	0.054	0.039	N.S.

N.S.: No solution

Remember:

- median a = 0.3%, median b = 0.94
- **median r = 3.9%**
- **median abs. error = 1.4%**

Why such a disappointing outcome? The answer is fairly obvious: the data include outliers and the OLS estimation responds too much to outliers. Indeed, a plot of the data for the years 2007 and 2008 for the US reveals the distortion due to the outliers. But the point is too obvious to be worth examining in any detail. Suffice to say, the *rank* correlation between the dependent and independent variable is always positive and ranges from a low of .40 to a high of .76; this result alone speaks volumes about the outlier problem. (These correlations are not reported on in any of the tables.)

The OLS results for China are just as unappealing, if not more so. Two of the five years show negative estimates of a, which makes no sense whatsoever, and in these years, there is no (non-imaginary) solution for r. Outliers therefore lead to inaccurate estimates of a, which in turn lead to inaccurate r. But there is some improvement in the forecasting error, from 2.1% to 1.4%, so it is clear that the relatively large load factors on current EPS build in forecasting power. The rank correlations support the conclusion: these are relatively high, ranging from .40 to .76.

Again, with regard to China, the table shows that the estimated slope coefficients vary considerably across years. These coefficients have two relatively low values (.33 and .49) and three relatively large values (.94, .96, and .94). This cluster of results in two groups may or may not be due to estimation errors and the presence of outliers. To get a better feel for this issue, it helps to check on what happens if one estimates the equations using a so-called robust estimation method. The rest of this section reports on such results.

As an alternative way to estimate the coefficients a and b (thereby r as well), consider the TS method. This method will not be described in any detail here. As noted earlier, Wikipedia provides a clear and easy to understand exposition of the method which stresses that it deals efficiently with outliers, skewness, and heteroscedacticity. Broadly speaking, this estimation method is robust. The following phrase from Wikipedia suggests that TS actually dominates OLS: "it competes well against non-robust least squares, even for normally distributed data, in terms of statistical power."

Table 3 provides the estimation results for the US and CH samples. The results for the US sample are nothing if not impressive. The two coefficients always end up positive, meeting a minimum requirement. Moreover, the range of estimates over the five years is reasonably narrow. The coefficient on price ranges from .021 to .04, with a median of .028; for b, the range is .34 to .67, with a median of .54. This range is of course much tighter compared with what happens if one uses OLS.

TS estimations deliver the same reasonableness when it comes to the estimate of r, which for the US sample runs from a low of 4.4% to a high of 7.6%, with a median of 5.8%. The range/median is somewhat on the low side yet is not unreasonable given the intrinsic difficulty in trying to estimate an earnings rate in an economy. The narrow range shows the power of the TS method. Given these reasonable estimates of r, it follows that the forecasting puts approximately a 50-50 weight on the two rescaled independent variables. This finding is noteworthy.

In sharp contrast to OLS, the TS method also improves the goodness-of-fit materially. The unconditional forecast error (dispersion), which serves as a benchmark, equals 1.8% (median; see Table 1); OLS yielded the larger error of 1.9%. As Table 3 shows, the TS method results in a much reduced error of 1.4%. Such an improvement is precisely what one should expect under a reasonable estimation method since the dependent and independent variables rank correlate, as was noted earlier. Looking at the results in their totality, it is obvious that OLS simply does not work.

Next, consider the TS results related to China. The first parameter (a) is positive in all years except the last (2011). In terms of magnitude, the values are all quite small, less than .01, except for 2008, when the value equals .02. The range of values for the earnings coefficient (b) runs from 0.53 to 1.17. These numbers are much larger than those for the US. This finding is consistent with (i) the much larger rank correlations for the CH sample and (ii) the forecasting equation putting close to all of the weight on the second variable (though there is a non-trivial variation across years).

Goodness-of-fit also improves: the median absolute error equals 1.0% compared with 1.4% if one uses OLS (Table 2) and 2.1% using “no” information (Table 1). Such a significant goodness-of-fit improvement reflects the relatively high rank correlation between the two variables. Compared with OLS, the TS method can better exploit this aspect.

Finally, as to the estimated earnings rate r, it has a median of 4.8%, which is too low, but (in the author’s view) not unreasonably so. Setting aside this aspect, the results could have been more appealing because r has no solution in one year (the one with a negative estimate of a). The results for China accordingly do not impress to the same extent that those for the US do.

Table 3 Results of TS Regression

$$EPS_{t+1} / P_t = a + b*(EPS_t / P_t) + u'_{t+1}$$

Panel A: US Standard & Poor’s 500

	2007	2008	2009	2010	2011
a	0.021	0.031	0.040	0.028	0.022
b	0.54	0.34	0.47	0.67	0.66
abs. error	0.014	0.023	0.016	0.012	0.013
r	0.044	0.046	0.071	0.076	0.058

Remember:
- median a = 2.8%, median b = 0.54
- **median r = 5.8%**
- **median abs. error = 1.4%**

Panel B: China Shanghai & Shenzhen 300

	2007	2008	2009	2010	2011
a	0.006	0.020	0.002	0.003	-0.002
b	0.53	0.67	1.17	0.97	0.99
abs. error	0.007	0.020	0.007	0.010	0.015
r	0.013	0.055	0.178	0.042	N.S.

N.S.: No solution

Remember:
- median a = 0.3%, median b = 0.97
- **median r = 4.8%**
- **median abs. error = 1.0%**

V. Adding Book-to-Market (BTM) as a Forecasting Variable

It appeals to add book-to-market as yet another variable on the forecasting equation’s right-hand side. Book values act as bottom lines in the balance sheet, and future earnings should, on average, relate to current earnings via an earnings rate. Thus, one can identify a triple-weighted average of three benchmark models and thus, with appropriate weighting, potentially improve on the forecasting accuracy. (However, the weighting may no longer have all positive coefficients.) This matter was investigated using both OLS and the TS method for the two countries.

The findings are unambiguous: the absolute forecasting error does not get reduced whether one applies OLS or TS as the estimation method. The results related to OLS show that, for the US sample, the forecast errors are greater in two years, the same in two years, and a tie in one year if one adds the variable. Improvement occurs in the years when the error is very large initially (when there are two variables). For China, the results are very similar, except that there are now three years with ties. Again, much of this negative result can be attributed to outliers. For TS, the absolute forecasting errors remain virtually unchanged for all years in both the US and CH samples. The reason for the latter finding is easily explained: The estimated coefficients related to BTM are typically sufficiently close to zero, and there is no material impact on the estimates of the first two coefficients. For the US sample, the coefficient related to BTM is negative in three out of five years, with a median of -.01; for the CH sample, it is negative in four out of the five years and the range is extremely narrow: a low of -.02 and a high of .00.

VI. Summary of Findings

How can we best summarise the findings related to the two hypotheses stated in section II?

With respect to the first hypothesis, it can be accepted, except for the single year in the CH data that yielded no r because of the negative estimate of a. If we replace the negative b with a zero, then r equals zero, and this scheme allows the claim that the weighted average hypothesis holds, approximately, for all years and that it holds for both countries, though of course more so for the US than for China: US implied earnings rates would seem to be closer to the implied cost of capital guesstimates.

With respect to the second hypothesis, the US weights approximate to 50-50 across the years, though of course, the range is more like 33-66 at one end and 66-33 at the other. As for China, for three of the years (the last three), the weights correspond to a "very small weight on price" and "a weight on current EPS very close to 100". For the remaining two years, the weights are more like 40-60, the 60 being the weight on current earnings. Clearly, the forecasting depends much more on current EPS than price in the case of China.

The difference in weightings in the two economies is not surprising. CH firms do business in a growth economy, more so than US firms of course, and the earnings yields should reflect this. As the data show, earnings yields are much lower in China and this in turn implies a lower weight on price compared with current earnings.

Admittedly, as noted a few times earlier, the summary comments above depend on using a TS estimation method rather than OLS. A comparison between the two methods clearly shows that OLS is far too inefficient to even come close to the findings one should expect on the basis of priori reasoning.

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