

Reply

Understanding Outliers in Foreign Direct Investment Data Analysis

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It appears that Li's (2009) response to my analysis of Li and Resnick's (2003) study overlooks several key points of my outlier diagnostics.

In response to my first method of controlling for outliers with a dummy variable for China during the years 1992–1995, Li argues that “[I fail] to note that even after controlling for these influential observations, the effect of democracy remains *statistically significant and negative*” (p. 169). This is correct, however, the change in the magnitude of the coefficient on democracy has implications for the overall explanatory power of his model that would have gone unnoticed if not for the inclusion of the dummy variable.

In response to my second method of robust regression, Li claims that “compared with the sample of 483 observations for 53 countries in Li and Resnick, [my] robust regression sample covers only 403 observations for 51 countries, excluding a total of 80 observations” (pp. 169–170). Actually my robust regression estimation uses the same 483 observations for 53 countries as Li and Resnick's models (see my Model 4 in Table 1 on p. 156 in the previous study and the Stata log file). Li states that he identifies “observations with Cook's *D* values greater than one” to divide Li and Resnick's data into two subgroups for robust estimation (p. 173). However, the largest Cook's *D* value in the data is 0.46 for China in 1995. Thus, Li's results in Columns 2 and 3 in Table 2 are based on the wrong criterion of Cook's *D* statistic.

Li suggests that “one other possible estimator that resists the influence of outliers is the median regression” (p. 171). While median regression may be an appropriate method if data are skewed, it should not be used when influential outliers, such as those in the FDI data, distort the results. This is why Li's results in Column 1 of Table 2 show that the coefficient of democracy is negative.

Li also asserts that Li and Resnick's Panel-Corrected Standard Error (PCSE) estimates may be superior to those of the robust regression because they take into consideration

heteroskedastic error variance and serial correlation (p. 171). I would counter that neglecting influential outliers causes more substantively confounding results than ignoring heteroskedasticity and autocorrelation. Even if we fit the FDI data with standard cross-sectional, time-series regression models with or without addressing the two violated assumptions, we obtain very similar estimates of the coefficients and the standard errors. For example, the coefficient and the standard error for democracy are -0.088 and 0.025 using Li and Resnick's preferred `xtpcse` command and -0.088 and 0.031 using the `xreg` command. Both statistical methods lead to the same erroneous conclusion that democracy is negatively associated with FDI inflows. However, as demonstrated in my previous study, failure to properly handle influential outliers can produce misleading results, such as a negative rather than a positive sign as in Li and Resnick's study.

Li also contends that "net FDI inflows in dollars and FDI/GDP measure two different concepts, i.e., they are not conceptually equivalent" (p. 174). However, I do not claim that the two measures are conceptually equivalent. Rather, I highlight the differences between the two measures with respect to outlier diagnostics and suggest that the latter is more appropriate because it accounts for the size of economy and makes itself comparable among heterogeneous countries.

Li correctly points out that "the appropriateness of a measure depends on the nature of the research question at hand, that is, the investigator's purpose" (p. 173). Unfortunately, many researchers fail to follow through. For example, some studies of FDI employ two different measures for economic globalization without obvious theoretical reasons: (1) the sum of the absolute values of inflows and outflows of FDI weighted by GDP (e.g., Gartzke and Li, 2003), and (2) the ratio of gross FDI to GDP in purchasing power parity (e.g., Gartzke *et al.*, 2001).

Finally, Li argues that, instead of FDI/GDP, scholars should use the log of FDI inflows as a measure of FDI. However, the use of logged FDI inflows drops all the observations that are negative or equal to zero. Although Li suggests that "one possible solution [to allow for the log of negative and zero values] is to add some constant value that is just large enough to turn the variable's negative and zero values into positive ones before log transforming the whole variable" (p. 177), this strategy does not lead to a true standardization because it does not take into account the economy of scale effects. More importantly, FDI theory says that the dependent variable of FDI inflows should be either positive, negative or zero, the latter two cases of which render logarithms inappropriate.

In summary, Li's response has fostered a constructive debate on what is the most appropriate way of dealing with outlying data. Although some disagreements are likely to remain, I adhere to my claim that avoiding erroneous inferences requires outlier diagnostics such as those suggested in my previous study.

REFERENCES

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