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## The application of zero-inflated model to the determinants of international direct investment outflow direction - evidence from Chinese acquiring technology overseas merger and acquisition

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### ABSTRACT

Zero-inflated model belong to the compound counting model used to process discrete or discrete data with too much zero value of Poisson distribution or negative binomial distribution. This study select the sample of Chinese enterprises 'seeking technology overseas merger and acquisition, through analyzing the influential factors of capital outflow direction, try to prove that zero expansion models is a appropriate tool when data contains a large number of zero values. According to the research results, we find that the total trade volume and the gap of the corrupting level between the host country and China have a significant positive impact on cross-border merger and acquisition, Meanwhile, The cultural gap and the Gap of the income tax rates have a significant negative impact to the direction of capital outflow. However, the distance, the degree of financial deepening and Technical level of labors are not significant in the ZINB regression.

### KEYWORDS

Overseas M&A; Zero-inflated model; Capital outflow.



### INTRODUCTION

Zero-inflated model belongs to the counting model. It is often found that the number of occurrence of observed events contain a large number of zero values in the field of social science, i.e. many observed individuals do not occur the random events in the unit of observation time, space and area correspondingly. This is a special kind of discrete limited dependent variable data that can not be analyzed through the Poisson / negative binomial model. In most cases, though the zero values are the same, but they reflect the different circumstances. The zero-inflated phenomenon of enumeration data has been given wide attention from academia. Lambert (1992) proposed zero-inflated Poisson (ZIP) model to deal with the zero-inflated phenomenon<sup>[1]</sup>. By the introduction of co-variables, he established mixed probability distribution of zero and nonzero counts to derive the zero-inflated Poisson model. Greene (1994) extended the Poisson model to the zero-inflated negative binomial (ZINB)<sup>[2]</sup>. ZINB model is the development and supplementary for the ZIP model. It makes up for the deficiencies of the Poisson model in the analysis of zero-inflated structural data, provides the possibility to identify the true value of zero, and then obtains unbiased and consistent parameter estimation. The character of the zero-inflated model is to divide the zero value into two subpopulation of different character, i.e. a group of individuals would not have the corresponding event occurring while the other group may have some events assumed to follow the Poisson / negative binomial distribution. When we take data zeros as "too much zero" and "true zero", the former is from the first process and the latter is from the second process. It is should be noted sometimes we can not explicitly determine that this individual data with an observed zero comes from which process.

The zero-inflation model has a certain degree of universality to deal with more zero value of count data. The model is consistent with the logit / Probit regression and Poisson Processes / negative binomial model. The logit / Probit regression answers whether the explanatory variables influences the events to happen or the probability of occurrence, while the general count models answers the affected number of the explanatory variables.

### METHOD

For the zero-inflated model, the probability distribution mixed with zero and non-zero is as follows:

$$y_i \sim \begin{cases} 0, p_i \\ g(y_i), 1 - p_i \end{cases}$$

$P_i$  Indicates the probability of the individual coming from the Bernoulli distribution, and the probability of "excessive zero" data;  $g(y_i)$  indicates the individual that comes from another process meeting the Poisson distribution or negative binomial distribution. Zero data is divided into two parts, part of which comes from the individual of the impossible events, whose probability is  $P_i$ , and the other part comes from the individual events not happening in the Poisson distribution or negative binomial distribution, whose probability is  $1 - P_i$ . The probability density of  $Y = y_i$  is as follows:

$$\begin{cases} P(y_i = 0 | x_i) = p_i + (1 - p_i) g(0) \\ P(y_i | x_i) = p_i + (1 - p_i) g(y_i), y_i > 0 \end{cases}$$

If the value of  $P_i$  is affected by individuals' explanatory variables, then  $p_i = F(w_i' \gamma)$ .  $F(\cdot)$  is zero-inflated link function, the logit function or the probit function can be used.

When  $g(y_i) = \frac{e^{-\mu_i} \mu_i^{y_i}}{y_i!}$ , it is the model of zero-inflated Poisson (ZIP). When the probability that the number of individual events are zero is not subject to the individual itself in the first process of the ZIP model, i.e. When explanatory variables of zero-inflated only contains one constant term, ZIP model estimates one more parameter than the Poisson model.

In accordance with the same thought, the zero-inflated Poisson models can extend into the zero-inflated negative binomial model (ZINB).

When  $g(y_i) = \frac{\Gamma(y_i + \alpha^{-1})}{y_i! \Gamma(\alpha^{-1})} (\frac{\alpha^{-1}}{\alpha^{-1} + \mu_i})^\alpha (\frac{\mu_i}{\alpha^{-1} + \mu_i})^{y_i}$ , it is the zero-inflated negative binomial (ZINB).

The basic idea of zero-inflation model is as follows: Firstly, it is initially determined whether there is zero expansion in count data by the percentage of zero to total count of samples. Secondly, by comparing the values of average and variance and the alpha test, it is determined whether there was discretion in the count data. If the Alpha test is not significant ( $p > 0.05$ ) and the average and the variance are basically the same, it is equal discretion, subject to Poisson distribution, we should adopt the zero-inflated Poisson model. If the Alpha test is significant ( $p < 0.05$ ) and the variance is more than average, it is excessive discretion, subject to negative binomial distribution, we should adopt the model of zero-inflated negative binomial.

And then we do the test of Vuong value to determine the choice of the final model between zero-inflated negative binomial and the general negative binomial model.

## THE APPLICATION OF ZERO-INFLATED MODEL TO THE DETERMINANTS OF CAPITAL OUTFLOW DIRECTION

Acquiring and absorbing advanced technologies, improving have great sense to enhance international competitiveness of Chinese corporations under the trend that science and technology competition has appeared as the indication of national comprehensive competitiveness. Overseas technology-acquiring merger and acquisition (M&A) is an effective approach to realize those above goals. By overseas technology-acquiring M&As to take over R&D from hi-tech companies and transnational companies in industrialized countries, companies acquire essential knowledge about advanced technologies and organizing abilities to improve their international competitiveness. Especially, China's overseas M&A experience a steady increase after the 2008 world financial crises, Currently, there are some researches about the Chinese corporations' performance transitions from overseas technology-acquiring M&As, but domestic relevant researches are rare about the Chinese corporations' capital direction from overseas technology-acquiring M&As. This article samples the listed companies in Shanghai and Shenzhen Stock Exchange in 2000 to 2009 to analyze this issue.

As the biggest emerging countries, the direction of capital outflow is affected by many factors which different from developed countries<sup>[3]</sup>, when we choose the number of mergers and acquisitions cases as interpreted variables, it contains a large number of zero values. But the real reasons for these zero values are not uniform. Some may be caused due to statistical loss called "too much (non-real) zero", and others may be caused by no existing mergers and acquisitions called "real zero", the zero inflation model is applicable to these fields where the count data exists zero expansion. Existing research on the inter-related domains of the international investment provide valuable insights about the factors of M&A flow direction.

### Dependent variable

The dependent variable M&A includes the numbers of China's all overseas M&A during 2002 to 2009. The samples have excluded the host country from tax shelter islands like British Virgin Islands, the Cayman Islands, whose economic significance for overseas M&A is not consistent with the purpose of our analysis. The cross-section samples involve 39 countries and regions, which come from the Thomson onebanker database. The time of events is selected by the effective date, Thomson Group is an international authoritative information services institution providing professional information on businesses and professionals, whose M & A database covers almost all of the M & A transactions that can be recorded.

### Independent variables

Nine representative variables are selected as interpreting variables. Respective explanations are given as follows:

(1)  $GDP_{i,t} \cdot GDP_{j,t}$  - the gross scale of the market of the two countries, presented by the product term of two countries' GDP<sup>[4]</sup>. It come from the World Bank database (<http://data.worldbank.org/>).

(2)  $DIS_{ij}$  - the central distance between the major economic sea shipping centers of China and the host country. It comes from the distance measurement device on the web-side (indo.)<sup>[5-6]</sup>. When estimating, Shanghai is the starting point and the host country capital is the endpoint of the distance, the unit is kilometer.

(3)  $TRADE_{ij,t}$  - the total bilateral trade between the host country and China, the sum including both import and export. It comes from the National Bureau of Statistics database, the unit is million dollars<sup>[7-8]</sup>.

(4)  $FD_{ij,t}$  - Financial deepening, measured by the  $\frac{STC_{i,t} \cdot STC_{j,t}}{GDP_{i,t} \cdot GDP_{j,t}}$ , where the STC represent the total value of the security market<sup>[9]</sup>, the data is also from the World Bank database (<http://data.worldbank.org/>), Taiwan's data is from the website ([www.tse.com.tw](http://www.tse.com.tw)).

(5)  $CORR_{ij,t}$  - the level of corruption, reflecting the gap of the corrupting level between the host country and China. There are lots of indicators to measure corruption, among which the more authoritative one is the Corruption Perceptions Index (CPI) published annually by Transparency International<sup>[10]</sup>. CPI uses 10-point scale, where 10 are the highest score meaning the least corrupt and 0 stands for the most corrupt. This indicator is defined as the CPI values of the Host Country minus the CPI value of China, so the higher the index is, the more corrupt is to our country than the host country. Data is from [www.transparency.org](http://www.transparency.org).

(6)  $Skill_{ij}$  - technical level of labors where the human capital is used to represent the technical level and dummy variables is set to measure the relative skill levels. This data is measured by using the adult (15 years of age and above) Literacy rate (the ratio of the total population) published by the World Bank database (<http://data.worldbank.org/>)<sup>[11-12]</sup>. The value is 1 if the data of host country is greater than that of China, and otherwise the value is 0. Since the data is published every five years, it is often a fixed value.

(7)  $Tax_{ij,t}$  - Gap of the income tax rates, reflecting the difference of income tax rates between the host country enterprises and Chinese enterprises<sup>[13]</sup>. This indicator is defined as the tax rate of China minus the tax rate of the host country, the greater the gap is, the tax burden of the host country is lighter. Data is from the World Bank database (<http://data.worldbank.org/>).

(8)  $C D_{ij}$  - cultural gap. Knout, Singh (1988) proposes the formula to calculate the cultural gap index between the two countries according to Hofstede' four dimensional model. The formula is as follow<sup>[14]</sup>:

$$C D_{ij} = \sum_{k=1}^4 [(I_{kj} - I_{ki})^2 / V_k] / 4$$

Where  $I_{kj}$  represents the k-th index of the cultural dimensions in j country;  $V_k$  represents the variance of the k-th cultural dimension, i represents the host country,  $C D_{ij}$  represents the cultural gap between the host country i and country j, the higher value means the greater cultural gap<sup>[14-15]</sup>. The entire cultural dimension index is from <http://www.geert-hofstede.com>.

(9)  $T A_{ij,t}$  - Avoidance of double taxation agreements. If the agreements have put into effect (rather than signed between China and the host country), dummy variables is set to 1, otherwise is set to 0. The data is from the State Administration of Taxation website (<http://www.chinatax.gov.cn>)<sup>[15-16]</sup>.

The below analysis is about whether the zero-inflated Poisson model or the ZIPB should be adopted.

(1) There are 175 zero value in the sample data, which take up 56.1% of the total sample data, this is the zero-inflated phenomenon, we can initially identify that is suitable to adopt zero-inflation model.

(2) The average of dependent variables is 1.92 and variance is 24.91, apparently the variance is more than average. Then, the alpha test is conducted. The result shows that  $L\alpha = -1.77$ ,  $\alpha = 0.17$ , LR test of  $\alpha = 0$ ,  $P = 0.000$ , which indicates that alpha is significant and the data is excessive discretion, subject to binomial distribution and suitable to adopt zero-inflated negative binomial.

The Vuong test is conducted. The result is significant ( $P = 0.000 < 0.05$ ), which indicates that the model of the zero-inflated negative binomial is better than the negative binomial model.

## RESULTS

The zero-inflated negative binomial model is chosen for regression analysis, the results is as follows:

**TABLE 1 : The regression results of zero-inflated negative binomial model**

Zero obs : 175 Log likelihood : -281.02 LR chi2(10): 145.34			
Nonzero obs : 137 Inflation model = logit Prob > chi2: 0.0000			
Constant term	-6.808** (-2.18)	CORR	0.163*** (4.72)
GDP	0.047 (0.67)	SKILL	0.120 (0.64)
DIS	0.67 (1.17)	TAX	-0.024*** (-5.31)
TRADE	0.334*** (3.62)	CD	-0.349*** (-3.79)
FD	3.620 (0.38)	TA	0.353* (1.87)

Values in brackets are z values; \*\*\*, \*\*, \* represent the significant in 1%, 5% and 10% confident level respectively.

According to the regression results that  $LR\ chi2(10) = 145.34$ ,  $Prob > \chi^2 = 0.0000$ , regression is quite efficient as a whole, indicating that zero-inflation model is a better description of research purpose, and also the number of M&A in some year in some country is 0 which includes the real 0 and excessive 0, The following brief analysis is made based on regression results:

(1) GDP is not significant. TRADE factor itself also includes the consideration of economic scale, which may appear co linearity together with GDP.

(2) The effect of distance is also insignificant. As important variables of the gravity model, distance is usually the main consideration for scholars to study the influence to foreign direct investment. However, due to the development of the international shipping industry, the influence of distance is weakened, on the other hand, the culture distance caused from psychology, customs and other differences become more important to the international M&A, and is introduced in our model to explain the behavior of international M&A.

(3) The total trade volume of China and the host country show strong positive significance in the model in the 1% level, and its coefficient is positive. The trade volume containing the consideration of the economic scale and economic freedom, and a huge volume of trade also shows the large bilateral economic scale, as well as the high degree of economic freedom, these factors are important for Chinese enterprises to implement overseas M&A.

(4) The degree of financial deepening does not show significance, which means the financial market environment in both countries has no impact on M&A to occur. Chinese enterprises need not take into account the financial market environment when they choose target firms.

(5) The gap of the corrupting level between the host country and China has a significant positive impact on cross-border M&A, indicating that the greater the gap is, cross-border M&A are more likely to occur. The gap of corruption is calculated by the Corruption Perceptions Index of the host country minus that of China, the greater gap shows the lower level of corruption in the host country, it means that political environment of the host country play a positive role.

(6) Technical level of labors is not significant in the ZINB regression, indicating that technological variable often does not change in the time series.

(7) The Gap of the income tax rates has a significant negative impact on cross-border M&A. Some countries with low income tax will have great attractive to Chinese enterprises oversea M&A.

(8) The cultural gap has a significant impact. The negative coefficient shows that too large cultural gap will hinder the motivation of our cross-border M&A. The small cultural gap makes the probability of success increase in M&A, and also reduces the management costs of post-merger integration, which play a significant role in promoting the occurrence of M&A.

(9) The double taxation avoidance agreement has a significant positive impact on cross-border M&A. This shows that the effects of avoiding double taxation are very important, which will promote the occurrence of M&A.

## CONCLUSION

Zero-inflated model belong to the compound counting model used to process discrete (variance is equal to the average) or discrete (significantly greater than the mean variance) data with too much zero value of Poisson distribution or negative binomial distribution; it includes 0-1 logit model (to identify zero) and Poisson model/negative binomial model. This study take the Chinese enterprises' overseas merger and acquisition for example, through analyzing the capital outflow direction influential factors, try to prove that zero expansion models is a appropriate tool when data contains a large number of zero values. According to the research results, we find that the total trade volume and the gap of the corrupting level between the host country and China have a significant positive impact on cross-border M&A, Meanwhile, The cultural gap and the Gap of the income tax rates have a significant negative impact to the direction of capital outflow. However, the distance, the degree of financial deepening and Technical level of labors is not significant in the ZINB regression.

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