

SOURCES OF ASIAN CURRENCY CRISIS

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ABSTRACT

This study examines the sources of currency crises in ASEAN. The empirical findings indicate that reserve inadequacy, increase of bank's claims on private sector, deteriorating trade balance and misalignment of real exchange rate increase the probability of a speculative attack on a currency. The results also suggest that the currency crises could be contagious. The significant variables are closely related to the external factors and thus, indicate the openness of the ASEAN-4 economy. Hence, we could conclude that there is a linkage between the economic fundamentals and currency crises in ASEAN.

Keywords: currency crises, contagion effects, ASEAN-4, fundamental variables

INTRODUCTION

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Four waves of financial crises have hit international capital markets during the 1990s; the European Monetary System (ERM) crisis in 1992-1993, the collapse of Mexican peso with 'tequilla effects' in 1994-1995, the Asian flu of 1997-1998 and the Russia virus in 1998. These financial crises stimulated the theoretical and empirical literature on the economics of the crises in several ways, among other things on the determinants of a crisis (Kaminsky and Reinhart, 1999), its impact on domestic output (Aghion, Bacchetta and Banerjee, 2001) and policy implications (Rogoff, 1999).

The East Asian financial crises have been one of the most serious and challenging economic events of the 1990s. The macroeconomic conditions of these countries namely Malaysia, Thailand, Indonesia and the Philippines are shown in Tables 1. These newly emerging economies, which had succeeded in sustaining rapid growth through export promotion had strong economic fundamentals before the onset of the financial crisis, but also shared some disturbing similarities.

[Table 1 here]

First, they all experienced slowdowns in economic growth in 1996 except the Philippines. Second, all four countries saw their current account deficits rose substantially due to sluggish growth in export earnings. As a percentage of Gross Domestic Product (GDP), Indonesia, Malaysia, the Philippines and Thailand saw their current account deficits deteriorate from 2.0%, 3.8%, 1.9%, and 5.7% percent in 1992 respectively; to 3.4%, 4.9%, 4.7% and 4.7% in 1996 respectively. Third, the four countries accumulated large external debts. In 1996, Indonesia, the Philippines and Thailand had external debts amounting to US\$102.2 billion, US\$39.0 billion and US\$78.5 billion respectively; which increased to US\$137.1 billion, US\$50.6 billion and

Malaysia, Serdang, Malaysia.

US\$93.0 billion respectively, in 1997. Fourth, the real exchange rates in all four countries appreciated markedly. Finally, the levels of international reserves as a percentage of yearly imports were falling in Malaysia, the Philippines, and Thailand from 1995 to 1996.

The economists were divided as to which models are relevant to the East Asian currency crises as they are uncertain whether a currency crisis is due to fundamental imbalances or contagious events. Systematic empirical research on these issues is only just emerging and the evidence is mixed. Eichengreen, Rose and Wyplosz (1995) and Kaminsky and Reinhart (1999) show that currency crises are frequently preceded by fundamental macroeconomic imbalances and early warning signs. On the other hand, Jeanne (1995) and Jeanne and Masson (1996) demonstrate empirically that French crisis of 1992-93 had strong self-fulfilling characteristics.

This study examines the determinants of currency crises in ASEAN-4 countries: Malaysia, Thailand, Indonesia, and the Philippines. We develop a formal empirical model to analyse the determinants of currency crises. In addition, we would like to determine whether there exists contagion in foreign exchange markets, in which a speculative attack in one country may spread to the other countries. The currency crises of the 1997 have also raised questions about whether currency crises are predictable events with systematic early warning indicators or whether they are essentially unpredictable. This study will determine the ability of the model to predict the likelihood of currency crises in ASEAN-4 countries.

The paper is organised as follows. Section II summarises the literature on currency crises. Section III describes the definitions of crisis and contagion as well as the

methodology used in the analysis and the justification for the selection of variables. Section IV presents the results and interpretations of the findings. Finally, Section V summarises the findings of the study.

LITERATURE REVIEW

Currency crisis theories go back to the Salant and Henderson (1978) model of speculative attack on the gold market, which Krugman (1979) applied to the foreign exchange market. In the model the government runs a budget deficit, which is financed through additional money creation. The private sector will exchange this additional money creation for foreign currency and so reserves are steadily lost until reserves reach the threshold level. At that time, the demand for money falls, reserves fall to zero and a currency crisis occurs. This speculative attack is driven by the natural outcome of investors' maximization and forward-looking behaviour.

The first-generation models share the basic assumption of weak country fundamentals, which are known to be unsustainable in the context of a fixed exchange rate regime. This then establishes a unique relationship between fundamentals and timing of the crisis. The strength of the models is that a sudden speculative attack and loss of reserves occur even though all the behavioural functions are continuous and the fundamentals develop predictably.

The limitations of first generation theories became evident at latest after the EMS crisis in 1992-1993 since these models allowed only for an exchange rate peg, which either is or is not sustainable under the given fundamentals. The second-generation models take into account the possibility of self-fulfilling crises (Obstfeld, 1986, 1994, 1996 or Jeanne, 1997). An increase in devaluation expectations makes it more costly for

the authorities to maintain an exchange rate peg. These costs rise as higher interest rate lead to unemployment. The government weighs the costs of defending the exchange rate against the benefits. Investors anticipate the government's calculation and can raise the costs of defence even further and the crisis become self-fulfilling.

These second generation models introduce the possibility of multiple equilibria: one in which there are no attacks, no change in fundamentals and indefinite maintenance of the peg and another in which investor expect an attack. The new fundamentals in the second equilibrium are validated after the investors' expected change in the exchange rate actually occurs. The currency crisis is then modeled as a sudden jump from one equilibrium to another. And the timing of crisis is no longer uniquely determined.

There are several factors that can create a situation of multiple equilibria and may cause a self-fulfilling currency crisis. In Obstfeld (1994) market participants expect the currency to be devalued at a given rate and set nominal interest rate to a higher level. Because of high unemployment or a large debt burden, the higher interest rates make the peg too costly for the government to keep. Another source of multiple equilibria is the government's expected desire to offset a negative output shock. Authorities' behaviour as regards problems in the banking sector is another factor that can create a situation of multiple equilibria. As the central bank defends the peg, interest rate rise, which may cause losses to the banking sectors.

In emerging market countries willingness to decrease unemployment was not a key aspect of recent crises. Consequently, in a multiple equilibria model, Masson (1999) used a balance of payments approach to determine the country fundamentals. The cost benefits calculation is determined by expected value of foreign reserves and the model

does not include a direct escape clause for the government. The source of multiple equilibria is the higher debt service costs for the government due to depreciation expectations. The model is tested with recent crises in emerging markets and finds that the fundamentals of some crisis countries were inside the multiple equilibria region.

The recent crises in emerging markets have also inspired new theories, where the liberalization of the financial system and the weaknesses in the banking sector are the reason for crises. Diaz-Alejandro (1985) cited the liberalization of financial markets and bad banking supervision as reasons for the banking and currency crises in Latin America. In addition, the public expects the government to intervene and save most depositors when financial intermediaries run into trouble, whether or not deposits are explicitly insured. The model by Calvo and Vegh (1993, 1999) points out that a non-credible stabilization programme can be a reason why a consumption boom is followed by a drop in output and finally a currency crisis. Similarly, Kamin and Wood (1997) pointed out the boom and bust cycle of capital flows after the liberalization as the reason for currency crises.

Some progress in explaining recent crises and contagion effect has been made using models that contain financial diversification and the use of leverage by investors. These models are founded on the basic portfolio theory, where a representative investor weighs the effects of different portfolio management rules and margin calls. They find that diversification, together with leveraged investors, creates condition for the contagion effect. In the model by Calvo (1998) the contagion effect is caused by margin calls by informed investors, who are then mimicked by uninformed investors. Calvo and Mendoza (2000) discuss optimal diversification as the number of possible investment

countries grows. They show that costly information gathering might not be profitable when the number of countries grows. This might cause herding behaviour and contagion of currency crises.

Herding behaviour can be one reason for the large capital flows and contagion effect. Studies have found many theoretical reasons for this herding behaviour (Schafstein-Stein 1990, Banerjee 1992, and Devenow-Welch 1996). Krugman (1997) gives two reasons for the herding behaviour in Asian crises. First, there is a bandwagon effect driven by investors' awareness of expectations that other investors have private information. Secondly, much of the money invested in emerging markets is managed by agents rather than directly by principals. These agents are compensated in accord with comparisons with other money managers and so herding behaviour is quite rational.

MODEL SPECIFICATION

In this study, a currency crisis is defined following the definition by Frankel and Rose (1996), in which crisis is a nominal depreciation of at least 25% a year from the mean rate in the bilateral exchange rate *vis-a-vis* the U.S dollar. A currency crisis exists only when there is an abrupt change in the nominal exchange rate. The definition of crisis excluded the element of unsuccessful speculative attacks since it is very hard and subjective to define when a speculative attack has occurred then ascertain whether the countries, Malaysia, Indonesia, Thailand, and the Philippines, are under the condition of currency crises before proceeding to analyse the model of currency crises and contagion effects.

Following Eichengreen, Rose and Wyplosz (1996), and Kruger, Osakwe and Page (1998), the model is written as

$$Crisis_{j,t} = \eta X(L)_{i,t-1} + \varphi R(Crisis_{j,t}) + \varepsilon_{i,t} \quad (1)$$

where φ is the coefficient on the regional contagion variable $R(Crisis_{j,t})$; $X(L)_{i,t-1}$ is a vector of information set of lagged explanatory variables of economic fundamentals from country i in period $t-1$; η is the vector of coefficients on the lagged regressors and $\varepsilon_{i,t}$ is a normally distributed error term defined as,

$$\varepsilon_{i,t} = \alpha_i + v_{i,t} \quad (2)$$

where α_i is a random country specific effect and $v_{i,t}$ is normally distributed error term with zero mean and unit variance. The i subscript indexes the individuals countries of a cross-section and the t subscript indexes the time period in the available data. The variable *Crisis* takes a value of 1 if crisis and 0 otherwise. The regional contagion variables, $R(Crisis_{j,t})$, for country j take a value of 1 if and only if, there is a crisis in at least one country other than j and if this condition is not satisfied the contagion variable will take a value of 0 for the period.

The lagged values of the economic fundamentals are used to indicate that crises arise due to persistent deteriorations in economic fundamentals. This implies that it takes some time for deterioration in economic fundamentals to trigger a currency crisis. Besides, we do not expect a very brief and short-lived decline in fundamentals to result in a currency crisis. Using lagged economic fundamentals enable us to segregate the effects of economic fundamentals on currency crises, which also provide a simple test of the ability of the explanatory variables to predict future crises.

SOURCES OF DATA AND CHOICE OF VARIABLES

The data used in this empirical analysis were obtained from the International

Monetary Fund's (IMF) *International Financial Statistic*. The choice of variables used in the estimation is based on theoretical considerations and data availability, as suggested in previous studies, Eichengreen, Rose and Wyplosz (1996), Sachs, Tornell and Velasco (1996) and Kaminsky and Reinhart (1999). Using quarterly data for Malaysia, Thailand, Indonesia, and the Philippines spanning the ten-year period from 1987 to 1997, this paper hypothesizes that the macroeconomic variables: the ratio of M2 to reserve; the trade balance; the growth rate of domestic credit; the bank's claims on the private sector; the domestic inflation; the real exchange rate and regional contagion, cause the currency crises.

As in Sachs, Tornell and Velasco (1996), the ratio of M2 to international reserves was chosen as a measure of reserve adequacy. This variable worked well in previous empirical studies and has been identified as a leading indicator of currency crises by Kaminsky and Reinhart (1999). The use of a broad measure of money, as opposed to monetary base, in the definition of the reserve adequacy variable can be rationalised on the grounds that it measures the potential amount of liquid monetary assets that agents can try to convert into foreign exchange. To reduce dispersion in this variable and to facilitate the interpretation of its associated coefficient, the log form is used and it is expected that this variables to have a positive effect on the probability of crisis.

The trade balance and the real exchange rate are indicators of external competitiveness. Along with the misalignment of the real exchange rate, trade imbalance could cause currency crisis. There is a fair amount of evidence showing that some currency crises are preceded by negative trade balance and volatile exchange rate. We expect the negative association of the trade balance while the real exchange rate to have a

positive effect on the probability of crisis. The effects of monetary policies are captured by the growth rate of domestic credit and we expect to have a positive effect on currency crises.

The banks' claims on the private sector are a measure of the health of the domestic banking system and are known as a lending boom variable. Sachs, Tornell and Velasco (1996), argue that lending booms increase the ratio of bad loans to total assets thereby weakening the banking system. A weak banking system increases the probability of speculative attack because the investors know that the government will be reluctant to resist an attack by increasing interest rates since this would result in bankruptcies and a recession. In this case, the crisis is self-fulfilling. This variable is expected to have a positive effect on the probability of crisis.

Contagion effects are the most recent contribution of extended second-generation models or a third-generation model. There are several channels through which they may be transmitted across countries. Most explanations, however, imply that contagion effects tend to occur at the regional level. In order to capture the effects of contagion, we define a dichotomous variable that takes the value of 1 for countries where at least one other country has had one currency crisis in the quarter. We expect this variable to have a positive relationship on the probability of crisis.

ESTIMATION TECHNIQUE

Using pooled quarterly data for Malaysia, Thailand, Indonesia and the Philippines from 1987 to 1997, the study estimates explicitly the multiperiod probit model linking macroeconomic variables and a measure of contagion to the crisis index. Pooled quarterly data method is used to increase the number of observations and the number of crisis

episodes. Three episodes were found each for Malaysia, Indonesia and Thailand, and four for the Philippines. Furthermore, probit with random effects is an appropriate method to estimate a model that has dependent binary, repeated variables and repeated observations of the same group countries over time.

Let P_i be the cumulative normal distribution, called Probit, for the i -th observations, then

$$P_i = F(x_i \beta) = \int_{-\infty}^s \frac{1}{(2\pi)^{1/2}} \exp\left(-z^2 / 2\right) dz \quad (3)$$

where $s = x_i \beta$

The Probit Model is written as

$$\begin{aligned} y_i &= F^{-1}(P_i) + \varepsilon_i \\ &= x_i \beta + \varepsilon_i \end{aligned} \quad (4)$$

where $F^{-1}(P_i) = x_i \beta$ is the inverse of cumulative distribution $F(x_i \beta)$. The probit model is derived from a model involving the latent variable, say y_i^* such that

$$y_i^* = x_i \beta + \varepsilon_i \quad (5)$$

where $\varepsilon_i \sim \text{normal}(0, 1)$. The value of binary y_i depends on the value if y_i^* is greater than 25% devaluation (depreciation) and 0 otherwise.

Since the estimated coefficients in the probit model are difficult to interpret, the study reports the effects of one-unit changes in the regressors on the probability of crisis termed as marginal effects. The non-linear and the marginal contribution of each variable depends on the other explanatory variables in the models. In this study the marginal effect of x_i is calculated as

$$\delta E(y_i / x_i) / \delta x_i = [\delta F(x_i \beta) / \delta(x_i \beta)] \beta_i \quad (6)$$

where $\delta F(x_i \beta) / \delta(x_i \beta)$ is the density function associated with F (Greene, 1999). β_i is weighted by a factor, in this case a density function, which depends on all the values of X . As the density function is non-negative, therefore the direction of the effect of a change in β_i depends on the sign of β_i .

RESULTS AND DISCUSSION

The regression results on the determinants of currency crises are reported in Table 2. Insignificant variables are subsequently excluded in each of the regression equations. The probit model with random effects is estimated utilizing a maximum likelihood procedure. There are no specific overall goodness-of-fit measures for this methodology. Therefore, the pseudo R^2 and likelihood test ratio were used for the test of overall goodness-of-fit and the percentage of right prediction to predict the likelihood of currency crises.

Model 1 uses all explanatory variables as derived from the model formulation. The coefficients that are significant at 1% level are the ratio of M2 to reserve, real exchange rate, bank's claims on private sector, trade balance and regional contagion. These results support the findings by Kruger, Osakwe and Page (1998). But the growth rate of domestic credits and domestic inflation are insignificant at conventional levels. They all have the expected signs. The ratio of M2 to reserve has a positive coefficient and is significant at 1% level suggesting that countries with a low reserve relative to a broad measure of money are more likely to experience currency crises. The result is consistent with the view addressed in first-generation models of currency crises that

reserve inadequacy triggers a currency crisis. The result is also consistent with the findings of Caramazza, Rici and Salgado (2000) that reserve inadequacy triggers a currency crisis. The real exchange rate is significant at 1% level and has the expected sign indicating that misalignment of real exchange rate increases the probability of a currency crisis.

Domestic credit and domestic inflation are insignificant at conventional level. This is interesting given that these are important fundamental variables suggested in the theoretical literature. The result do not supports the notion that inconsistent in macroeconomic policies will lead to the countries having in a speculative situation suggesting that monetary expansion to finance the fiscal deficit do not increase the probability of currency crisis. On the other hand, trade balance variable is significant at 1% level and has a negative influence on the probability of a currency crisis suggesting that a deteriorating trade balance is a risk factor.

The regional contagion variable has a positive sign and is significant at the 1% level, supporting the findings for industrial countries by Eichengreen, Rose and Wyplosz (1996). A currency crisis in neighbouring country increases the probability of a speculative attack on the domestic currency. Two channels of international transmission of speculative attacks have been identified in the literature. The first channel is trade links in which a currency crisis in an economy forces the government to devalue the domestic currency and the second channel is information effects, hypothesising is that a currency crisis in one country sends a signal to speculators that pegs in countries with similar macroeconomic policies are unsustainable.

Bank's claims on private sector is significant at 1% level confirming the belief

that it is an important determinant of currency crises. These suggest that currency crises in Malaysia, Thailand, Indonesia and the Philippines are due to the weaknesses in the banking sector supporting the hypothesis that lending booms in these countries weaken the structure of the banking sector and increase the probability of speculative attacks on the domestic currency.

In order to find a more parsimonious model, insignificant variables are excluded from our benchmark equation denoted as Models 2 and 3. Model 2 excludes the growth rate of domestic credit. The M2 to reserve, bank's claims on private sector, trade balance, real exchange rate and regional contagion are all significant at conventional levels. The likelihood ratio test with one degree of freedom for exclusion of money growth is insignificant at the 5% level. Model 3 excludes both the growth of domestic credit and domestic inflation from the equation and the results show that the rest of the variables are significant. The likelihood ratio test with two degree of freedom, for exclusion of the two variables are not significant, suggesting that domestic credit and inflation can be excluded from model.

Model 4 shows the results of logit model in which the estimates have been divided by 1.81 to make them comparable to probit results. The results generated by simple logit are similar to the probit with random effects, in terms of sign and significance of variables. All variables are significant at 1% and 5% levels except the growth of domestic credit and domestic inflation suggesting that the results are not driven by specific method of estimation.

CONCLUSION

This study examines the determinants of currency crises in Malaysia, Thailand,

Indonesia and the Philippines in the period between 1987 to 1997, using quarterly panel data. The empirical findings indicate that reserve inadequacy, deteriorating trade balance, increases of bank's claims on private sector and misalignment of real exchange rate increase the probability of a speculative attack. The results also suggest that currency crises could be contagious.

The growth rate of domestic credit should capture the behaviour of monetary policies preceding the crises but the results do not support that lending booms in these countries weaken the structure of the banking sector and increase the probability of speculative attacks on the domestic currency. In addition domestic inflation is not an important macroeconomic variable in determining the probability of currency crisis. The result do not supports the notion that inconsistent in macroeconomic policies will lead to the countries having in a speculative situation suggesting that monetary expansion to finance the fiscal deficit do not increase the probability of currency crisis

It could be concluded that in the Asian currency crises, there is a linkage between the economic fundamentals and currency crises. The economic fundamentals are the M2 to international reserve, the trade balance, bank's claims on private sector and the misalignment of real exchange rate as well as the contagion effects. The contagion indicator suggests that the currency crises in Malaysia, Thailand, Indonesia and the Philippines were partly driven by the effect of economic disturbances in neighbouring countries. These results suggest that the central banks should closely monitor the changes in these fundamental variables to prevent the occurrence of currency crises.

Table 1

Macroeconomic Indicators

Year	Malaysia	Indonesia	Thailand	Philippines
1. Real GDP Growth Rate (%):				
1991	8.8	8.9	8.4	-0.2

1992	7.8	7.2	7.8	0.3
1993	8.4	7.2	8.3	2.1
1994	9.4	7.5	8.8	4.4
1995	9.4	8.1	8.6	4.8
1996	8.6	8.0	6.4	5.5
1997	8.0	4.7	0.5	5.1
1998	-7.4	-13.2	-10.2	-0.5
2. Current Account Deficits (% of GDP):				
1991	-8.9	-3.3	-7.7	-2.3
1992	-3.8	-2.0	-5.7	-1.9
1993	-4.5	-1.3	-5.1	-5.5
1994	-5.9	-1.6	-4.6	-4.6
1995	-9.9	-3.5	-2.7	-2.7
1996	-4.9	-3.4	-4.7	-4.7
1997	-4.8	-3.8	-4.0	-4.0
1998	13.7	4.2	11.2	2.3
3. Real Effective Exchange Rate (1990=100)				
1991	96.9	99.6	99.0	103.1
1992	109.7	100.8	99.7	107.1
1993	111.0	103.8	101.9	97.4
1994	107.1	101.0	98.3	111.7
1995	106.9	100.5	101.7	109.5
1996	112.1	105.4	107.6	116.3
1997	84.8	62.3	72.3	90.8
4. External Debts (US\$ billion):				
1991	16.0	76.1	37.6	30.4
1992	16.4	84.4	43.4	30.6
1993	19.2	90.3	50.6	32.6
1994	22.9	89.1	62.1	34.3
1995	27.4	97.6	67.1	37.9
1996	28.5	120.2	78.5	39.0
1997	44.9	137.1	93.0	50.6
1998	42.5	187.1	86.1	53.2
5. Inflation Rates (%):				
1991	4.0	9.0	6.0	19.0
1992	4.8	8.3	3.8	8.4
1993	3.6	9.3	3.6	7.8
1994	3.7	8.5	5.3	9.4
1995	3.4	9.3	5.0	7.9
1996	3.5	6.5	5.8	8.4
1997	2.6	11.6	5.6	5.1
1998	5.3	58.4	8.1	9.8
6. International Reserve (% of import):				
1991	34.4	42.5	51.4	29.4
1992	34.3	44.2	52.0	28.3
1993	33.3	44.2	50.6	30.2
1994	35.3	43.4	50.5	30.5
1995	34.4	45.4	49.4	29.8
1996	33.5	47.0	44.0	29.3
1997	33.9	47.6	42.7	28.7
1998	54.3	39.5	42.0	33.9

Source : *International Financial Statistics*, IMF, various issues.

Table 2

Regression Results

Models

Variables	(1) Estimated Coefficients	(2) Estimated Coefficients	(3) Estimated Coefficients	(4) Estimated Coefficients
Log M2/Reserve	0.7151* (2.0275) ^(a) (2.9524) ^(b)	0.7105* (2.0372) (2.9446)	0.6721* (1.9311) (2.7663)	0.6357* (1.5943) (2.6931)
Domestic Inflation	-0.704E-02 (-2.0751) (-1.8075)	0.672E-02 (2.0024) (1.7566)	-	0.775E-02 (2.0214) (1.7138)
Trade Balance	-0.376E-04* (-1.7757) (-3.2529)	-0.374E-03* (-1.7858) (-3.2765)	-0.377E-04 * (-1.8060) (4.6029)	-0.365E-04* (1.5242) (-3.2973)
Real Exchange Rate	-0.692E-03* (-1.1228) (-4.6887)	0.702E-03* (1.1516) (4.7829)	0.617E-03* (1.0143) (4.6029)	0.678E-03 (0.9734) (4.3711)
Domestic Credit	2.3644 (0.2558) (1.9241)	-	-	1.9621 (0.1877) (0.8641)
Bank's Claims	0.151E-04* (1.7550) (3.5062)	0.150E-04* (1.7666) (3.5428)	0.156E-04* (1.8358) (3.7919)	0.146E-04* (1.5082) (3.2973)
Regional Contagion	3.7022* (4.5257) (3.9740)	3.7028* (4.5772) (3.9583)	3.9369* (4.8768) (4.3861)	3.7243* (4.0265) (3.3233)
Pseudo R-Square	0.3548	0.2718	0.2623	0.3559
Likelihood Ratio Test ^(c)	-	1.0658 with 1 d.f	4.2829 with 2 d.f	-

* significance at 1% level

(a) T-ratios to test the significance of initial coefficient

(b) Marginal effects

(c) Likelihood ratio test for excluded variable(s)

Notes: Model 4 is an alternative estimation by logit. The coefficients are divided by 1.8138

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