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FDI Flow Volatility and ASEAN Members: An Exploratory Approach

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Abstract

The volatility of Foreign Direct Investment (FDI) flows, particularly those into ASEAN countries is well known. Still researchers will continue to use regression approaches to analyze this volatility. This paper is strictly an exploratory approach to analyzing the behavior of FDI itself and no attempt is made to design a regression model. Our approach is probabilistic in that we treat the FDI flows from home or source country to various members of ASEAN as random independent events over the time period 1999-2003. We then show how closely the random plots of FDI fit two common cumulative distribution functions (CDF), the Gumbel and the Weibull. Our approach also involves using international ISIC two-digit industry sectors from 15 to 37, from manufacture of food products and beverages to recycling. The essential thesis is that if capital markets are in a general equilibrium across hosts, home, industrial sectors, and time, then the return on capital (the marginal efficiency of capital) is equalized everywhere, and an home investor's dollar will be randomly allocated across hosts, industrial sectors, and time. The reverse of this thesis is if FDI inflows fit a CDF, then that suggests by implication, that capital markets are in a general equilibrium.

Acknowledgements: Our thanks go to Ms. Piyaphan Changwatchai, a Ph.D. graduate student in economics who assembled the raw data from ASEAN Statistical Yearbook 2006 and put it in spread sheet form. From the raw data, we were then able to make the various subsamples given in the presentation.

Introduction

Virtually every research paper on FDI and South East Asia countries recognizes the extreme volatility of FDI flows from home to hosts. For this reason, rarely are FDI inflows used as a dependent variable in a regression analysis (see, Uttama, 2005 and Plummer, 2007). Instead, when available the FDI stock data are used. Yet, one cannot help to believe that volatility itself has important information for understanding the behavior of the FDI flows. And this information can help us understand the notion of uncertainty in the Knight (1921) and Keynes (1936) sense. Our approach to examining FDI flows is largely exploratory at this stage. We are not attempting to build a forecasting model. This attempt will come at a much later time.

Exploratory Method

The exploratory method we use comes from extreme value theory (see, Gander, 2008, working paper, University of Utah, for a full discussion.). This is an area of statistical and probability theory pioneered by E.J. Gumbel (1954). Originally, it was used to examine the peak discharges every year for the Mississippi and other rivers. From these peaks, a probability scale can be constructed to forecast the most probable discharge. To construct the probability scale, the time-ordered discharges (x) must first be put in natural order from low to high. The discharges are assumed to be random and independent of time. Plots that were outside his model, were extreme values and presumably from a different universe or regime. The Gumbel model has a CDF given by $Pr(x \leq x^*) = \exp(-e^{-y})$, where $y = \alpha(x - u)$, a linear function. As x^* approaches infinity, the CDF approaches one.

The interesting feature of the Gumbel approach is that when the random events (ordered from low to high) are plotted on probability paper (PP) against x, the discharge, they fall along a linear function, if they are from the same universe. But, if the extreme values come from a different universe, then, the high plots (the reverse if we are focusing on low values) will deviate significantly from the linear path representing the plots from the initial universe. A regime change can therefore be suspected. In effect, a blip or "fat tail" occurs on the upper end of the probability density function (pdf) and correspondingly on the CDF. We leave to the listener to look at the literature on "fat tails" and its correspondent notion, a "Black Swan" (see, Mandelrot, 1963; Fama, 1965; and Taleb, 2007, and others).

Rather than use probability paper to plot the points, by taking the double log of the CDF, we can plot the points using XLS as a linear function, where $-Ln(-Ln(F(x))) = y = \alpha(x - u)$, where α and u are constants. To simplify, the F(x) is often approximated by $F(t) \sim (t - .3)/(n + .4)$, where t follows the low to high rankings of the x's.

An alternative probability model is a Weibull general exponential two-parameter function, $F(x) = 1 - \exp-(\lambda x)^{\beta}$, which in double-log form is $Ln(Ln(1/(1- F(x))) = y = \beta Ln\lambda + \beta Lnx(t)$. This is a function linear in the logs as opposed to Gumbel's which is linear in the absolute. They are different models and we get sometimes conflicting results. We use both models, however, we focus on the Weibull due to time considerations. The sample consists of 2789 observations on FDI flows over 1999-2003 for a limited number of ASEAN members as hosts and EU, Japan, and the USA as home countries, for ISIC from 15 to 37 (see, appendix for a list of code defintions). The source of the data is ASEAN Statistical Yearbook, 2006.

The point of our argument is that the FDI's volatility can be examined by these models which can be used to determine regime changes. The FDI flows are so erratic, it is virtually impossible to explain their behavior, without first having a clear picture of how FDI behaves itself. This is not to say that a deeper examination of the FDI's can not provide some causal explanation. As currently defined, a MNE subsidiary's FDI net flow is the sum of equity changes + internal loans + retained earnings in the host country. Any one of these components can and do cause volatility and each in theory has its own causal factors such as exchange rate changes and changes in the interest rate. But, equally important are changes in MNE policies affecting its subsidiaries and changes in the business climate of the host country. Much of the data needed for a deeper examination is either not available or difficult to come by. The components are published by host and by home country but not by 2-digit ISIC code. So, while we are aware of the components issues, we are left with examining FDI flows in total.

Empirical Results

As indicated earlier, the FDI inflows are classified by hosts, home, industrial ISIC, and year (1999-2003). The core ASEAN hosts are Thailand, Malaysia, Indonesia, the Philippines, and Viet Nam. Singapore does not supply FDI by sectors, only total investment both domestic and foreign with no breakdown. The home sources are EU, Japan, and the USA and Singapore. Some times our data will include Myanmar, Cambodia, Lao, and Brunei, depending on the availability of the data. The panels are unbalanced. A given home invests in some but not all hosts and sectors and years. Thus, there are gaps across hosts, across ISIC's and across years. Actually, for the probability method we use these gaps are not a problem.

To get a general sense of the relative importance of the developed investors and who the developing hosts are, roughly, over the period1995-2005, the EU was by far the largest investor in ASEAN (some $79 billion), swamping the USA by 60 percent and Japan by 3 to 1. The largest ASEAN host over this period was by far Singapore with $143 Billion, next was Malaysia with $45 Billion and Thailand with $45 Billion, then the Philippines with $14 Billion and Indonesia with $12 Billion. South Korea, Hong Kong, and Taiwan together invested a relatively small amount ($20 Billion) in ASEAN (see, Plummer, 2007).

Of the industrial sectors, time and space limit us to only the most frequently invested sectors, such as, 15, 17, 18, 24, 32, and 36. This industrial selection is somewhat arbitrary, but it is manageable.

The theory behind our probability interpretation is admittedly over simplified and heuristic. If investment markets were perfectly competitive across all hosts and all industrial sectors, the MEK's would be equal to the Global equilibrium interest rate. No matter where you put your dollar of investment, you expect the same return. That being assumed, allocation across hosts and across all sectors (leaving out the issues that arise with vertical versus horizontal investment) will be random for a given home. The hypothesis can be reversed. If FDI's are shown to be random from a given universe, then the system by inference must be in general equilibrium. Otherwise, it is not.

Figure 1a shows the CDF of a Weibull model for EU investments to eight ASEAN (the core five plus Lao, Cambodia, and Myanmar having a very small role) for all sectors and years. As indicated earlier, the FDI's are re-ordered naturally and assumed to be random draws independent of time. This assumption will hold throughout

the presentation. As explained earlier, a log-linear function through the plots indicates for a tight fit that the plots represented by the function are from a given universe and by implication satisfy the assumptions of randomness and independence. We leave it to the reader to visually draw his/her own imaginary line. About at x=logFDI ~ 3.5, the upper plots (extreme values) appear to deviate significantly below the line, suggesting a regime change. The $Pr(x \leq x^*)$ will be less than what it would be if the plots continued along the imaginary line. More detail would show that these extreme values are very much spread over the five years and the ASEAN five hosts and industrial sectors 23, 24, 32, and 35.

On the other hand, a more generous interpretation of Figure 1a suggests that all the plots come from the same regime. In other words, all the FDI investments into ASEAN for the period 1999-2003 for all sectors are random and independent of each other, for the fit to the CDF Weibull is arguably too good.

For purposes of comparison, Figure 1b shows the plots for the Gumbel linear model. The fit is not as consistent as before. The upper tail appears linear but the lower tail appears to have its own regime. In fact some 330 of the 354 plots occur in this lower section. One could argue that based on the Gumbel model, there are two distinct random regimes in Figure 1b. It is not surprising that sometimes, as in this case, the two models do not give the same results. The Gumbel model is very critical, whereas the Weibull model is more general and less discriminatory.

Still using EU as the source or home country for FDI into ASEAN for the period 1999-2003, we examine a selected number of industrial sectors individually, arguing as before that investment across the hosts will be random. Figures 2a and 2b are for sector 15, manufactured food, for the Weibull and Gumbel models respectively. As before the

Weibull plots very much follow a log-linear line, suggesting one universe. The Gumbel plots as before suggest two regimes. In either case, the plots are random across the five hosts for a given sector.

The plots for industrial sector 17, manufactured textiles, for the core ASEAN five are given in Figures 3a and 3b. The Weibull plots follow a log-linear line. The Gumbel plots suggest two regimes. In either case the distributions are random.

For industrial sector 28, manufacture of fabricated metal products except machinery and equipment, the two models shown in Figures 4a and 4b give very consistent results, both models fitting the plots well. Remember, both models are specified differently, the Weibull giving a log-linear form and the Gumbel giving a linear form. Since both models are random CDF's, consistence is not always unexpected. Even when the fits are consistent, the Gumbel model displays more differentiation or articulation in the plots.

Our final EU-sector plots are for ISIC 32, manufacture of radio, television, and communication equipment, given in Figure 5a for Weibull and Figure 5b for Gumbel. The Weibull plots follow more or less a log-linear path suggesting randomness from a given universe. Thus, EU investments in sector 32 are random across the five ASEAN core members. There is no differentiation among the host countries. The Gumbel plots, however, appear to be from two different regimes. The lower-left plots appear to come from one regime and the upper-right plots from a different regime. The scatter is too great to argue that the plots all come from a given Gumbel regime.

We now examine the FDI flows from Japan to seven ASEAN members. First, taking all industrial sectors together, Figure 6a shows the Weibull plots and Figure 6b

shows the Gumbel plots. The Weibull plots appear to have been generated from a given universe, but the Gumbel plots appear to come from two different universes (ignoring altogether the single extreme outlier). This distinction between the two models seems to be a common feature. In either case, the FDI's are random, independent draws, random across ASEAN, and across all sectors, as we found in the case of EU investments.

To conserve on time, the next four figures, Figures 7, 8, 9, and 10, are all Weibull plots from respective universes. The interesting point is that the patters are similar, indicating that FDI inflows behave very much the same, regardless of the targeted industrial sector (in this case, ISIC 15, 18, 24, and 32). The Gumbel plots also follow the same pattern as before and are not part of the presentation.

We now consider the USA as the source country. FDI flows from the USA to six ASEAN members for all industrial sectors and years create a Weibull pattern similar to that obtained for the EU and Japan. Figure 11 shows the plots for all sectors. While the actual parameter estimates for the Weibull CDF model would be different among the three home sources considered, the general exponential form is the same. In other words, regardless of the home source of FDI and the specific industry, the randomness is still there. In general, this last point is demonstrated for the USA by a sample of industrial sectors (15, 24, and 32) and shown in Figures 12, 13, and 14, using the Weibull model. The Gumbel plots are not presented but they are Gumbel consistent across these sectors.

Our final demonstration of the random behavior of the FDI flows into ASEAN uses Singapore as a home or source country and five core ASEAN members as before plus Lao, Cambodia, Brunei, and Myanmar as the hosts. The last four countries were kept in the sample, although they only account for 11 out of a total of 326 observations

and their amount of FDI is nil. Figure 15 shows the plots for all sectors taken together for the Weibull model. Not surprising, based on the evidence given earlier, the plots fit very closely a log-linear path, suggesting as before, that the investments from Singapore are distributed randomly across all sectors and hosts. A more detailed examination on an industry-specific basis would yield the same results.

Conclusions

So, what is the sense of all these random patterns? Remember at the outset, we stated that this presentation was going to be an exploratory examination of the behavior of FDI between home and hosts over various 2-digit industrial ISIC's. No attempt was made nor intention given to analyze the volatility of FDI itself. In fact, quite the contrary we argued that such analytical attempts would and have in the past been largely futile, as far as FDI flows are concerned, but not FDI stocks.

Based on our sample of home, hosts, and industrial sectors, we found overwhelmingly that the patters are random, best fit for a Weibull CDF, and are universally consistent across home, hosts, and sectors. This consistence suggests that the world of FDI as far as ASEAN members are concerned is a random world. To use an analogy, for a given home or source country, FDI inflows are being scattered randomly within each sector and among sectors and across all hosts. While time did not allow a presentation of FDI flows from a given home to a given host, for all or separate sectors, the results we have found in our research are still essentially the same as we have found for a group of hosts. Of course, the results can be affected by the degree of disaggregation, so the pattern for a given home to a given hosts for a given industrial sector will be severely limited by the number of plots available.

Are these results surprising? In some ways they are not. Personal income frequency distributions are usually found to be log normal (Weibull is just more general). The frequency distributions for firm sizes are also log normal. The corresponding CDF's are also log normal. We have to ask ourselves, what is it about such economic phenomena that display such commonality or universality? Our presentation fits into this universality. Our results may not be surprising but they represent the outcome of an original attempt and use of methodology.

The policy implications of our findings may be disappointing and perhaps even objectionable to many in the audience. Since the FDI patterns are random, it means that they are determined by an infinitely large number of rather small events (economic and non-economic), no one of which or group of which can be controlled by forces outside of the economic system. This may over state our case somewhat, but it remains for future research to identify what key factors determine the values of the parameters of, say, the Weibull distribution. As indicated earlier, the volatility of FDI should not be averaged away. There is information to be had and we hope our presentation sheds some light on what the information is.

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ANNEX-

LIST OF INTERNATIONAL STANDARD INDUSTRIAL CLASSIFICATION CODE REV. 3 USED IN ADMINISTRATIVE FOREIGN INVESTMENT (FI) DATA

ISIC CODE	MANUFACTURING SECTOR
15	Manufacture of Food Products and Beverages
16	Manufacture of Tobacco Products
17	Manufacture of Textiles
18	Manufacture of Wearing Apparel; Dressing and Dyeing of Fur
19	Tanning and Dressing of Leather; Manufacture of Luggage, Handbags, Saddlery, Harness and Footwear
20	Manufacture of Wood and Wood Products and Cork, Except Furniture; Articles of Straw and Plaiting
21	Manufacture of Paper and Paper Products
22	Publishing, Printing and Reproduction of Recorded Media
23	Manufacture of Coke, Refined Petroleum Products and Nuclear Fuel
24	Manufacture of Chemicals and Chemicals Products
25	Manufacture of Rubber and Plastics Products
26	Manufacture of Other Non-Metallic Mineral Products
27	Manufacture of Basic Metals
28	Manufacture of Fabricated Metal Products, Except Machinery and Equipment
29	Manufacture of Machinery and Equipment N.E.C
30	Manufacture of Office, Accounting and Computing Machinery
31	Manufacture of Electrical Machinery and Apparatus N.E.C
32	Manufacture of Radio, Television and Communication Equipment and Apparatus
33	Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks
34	Manufacture of Motor Vehicles, Trailers and Semi-Trailers
35	Manufacture of Other Transport Equipment
36	Manufacture of Furniture; Manufacturing N.E.C
37	Recycling
Others	

Source: UN International Standard Industrial Classification of All Economic Activities (Series M No.4 REV 3)
N.E.C: Not Elsewhere Classified

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22	Publishing, Printing and Reproduction of Recorded Media
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36	Manufacture of Furniture; Manufacturing N.E.C
37	Recycling
Others	

Source: UN International Standard Industrial Classification of All Economic Activities (Series M No.4 REV 3)
N.E.C: Not Elsewhere Classified

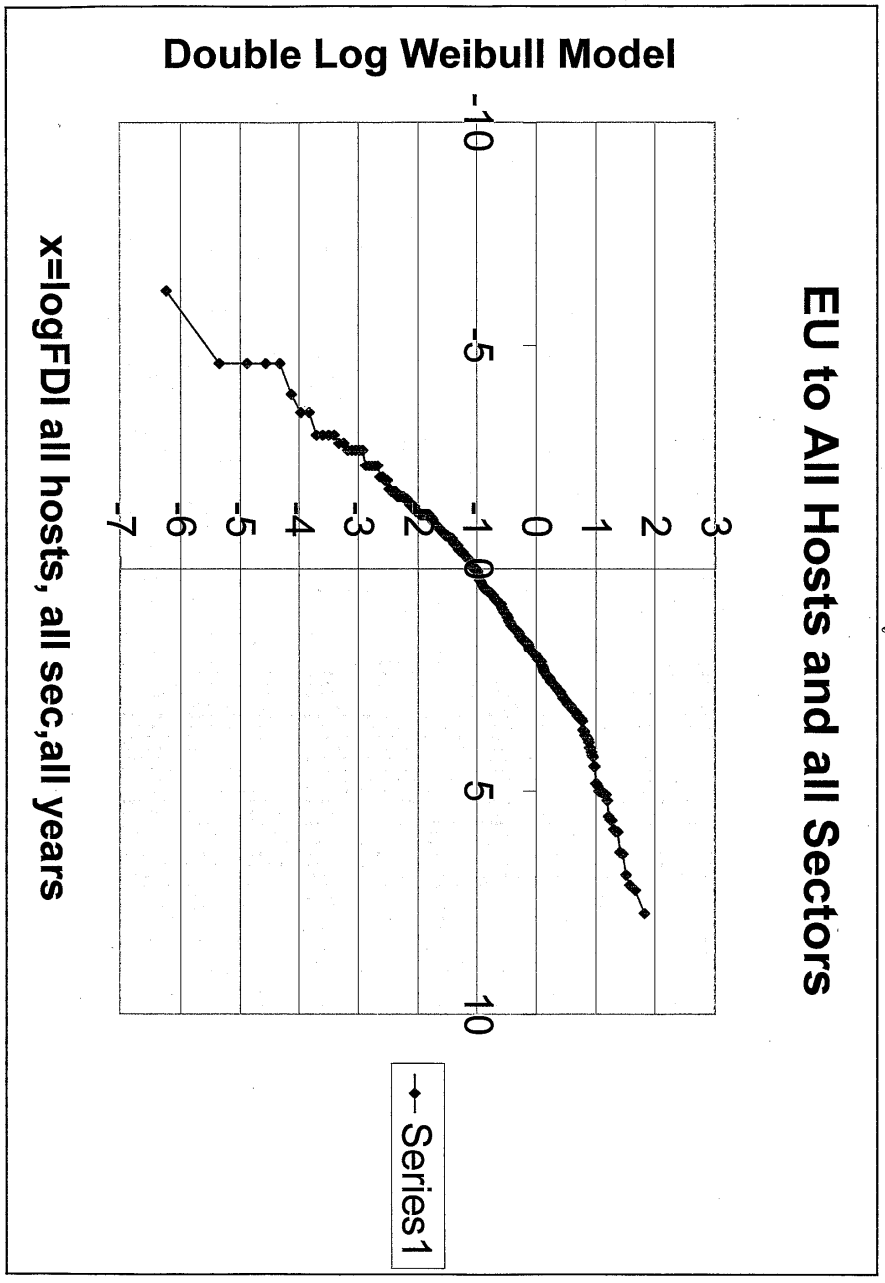

Double Log Weibull Model
EU to All Hosts and all Sectors
x=logFDI all hosts, all sec,all years
Series1
-10
-5
0
5
10
3
2
1
0
-1
-2
-3
-4
-5
-6
-7

Fig 1a

2/26/09

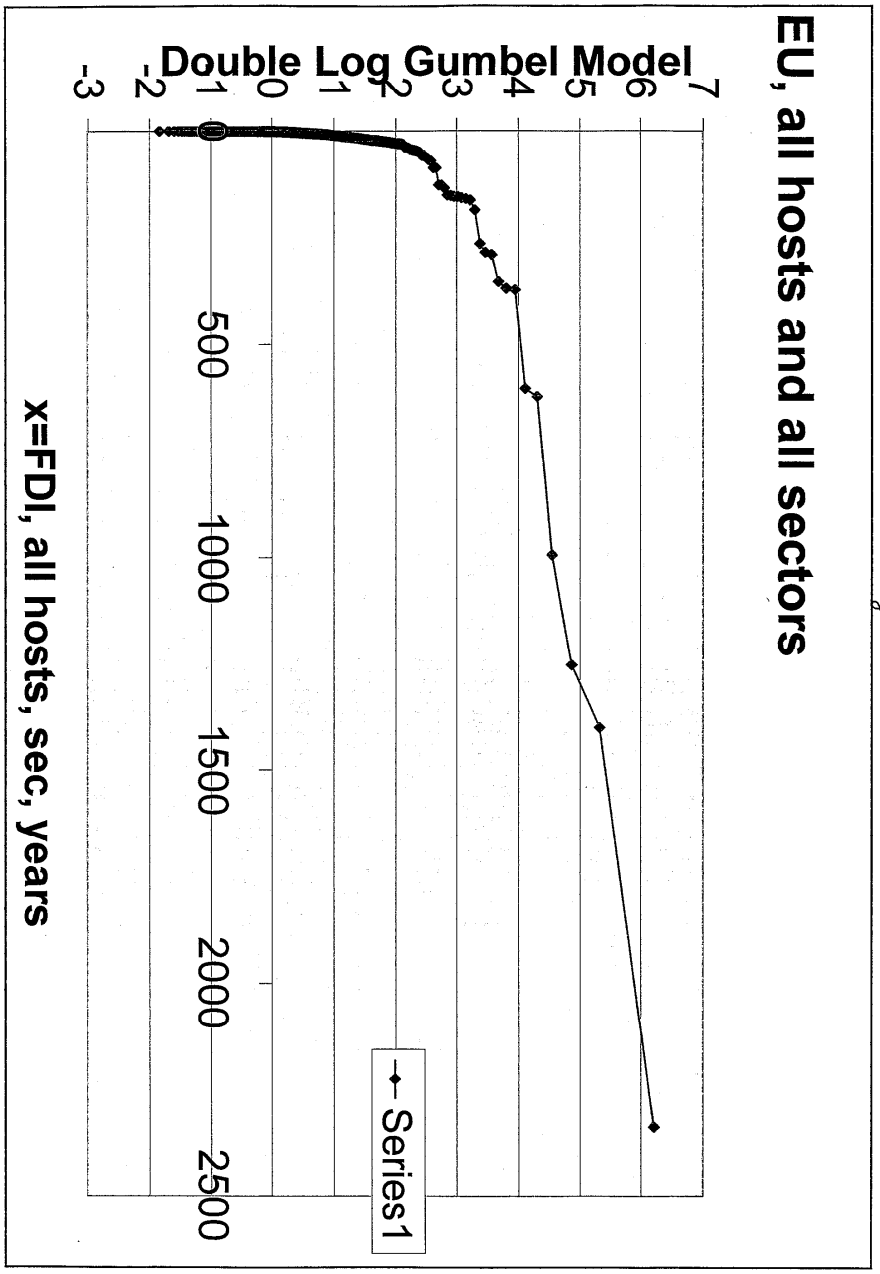
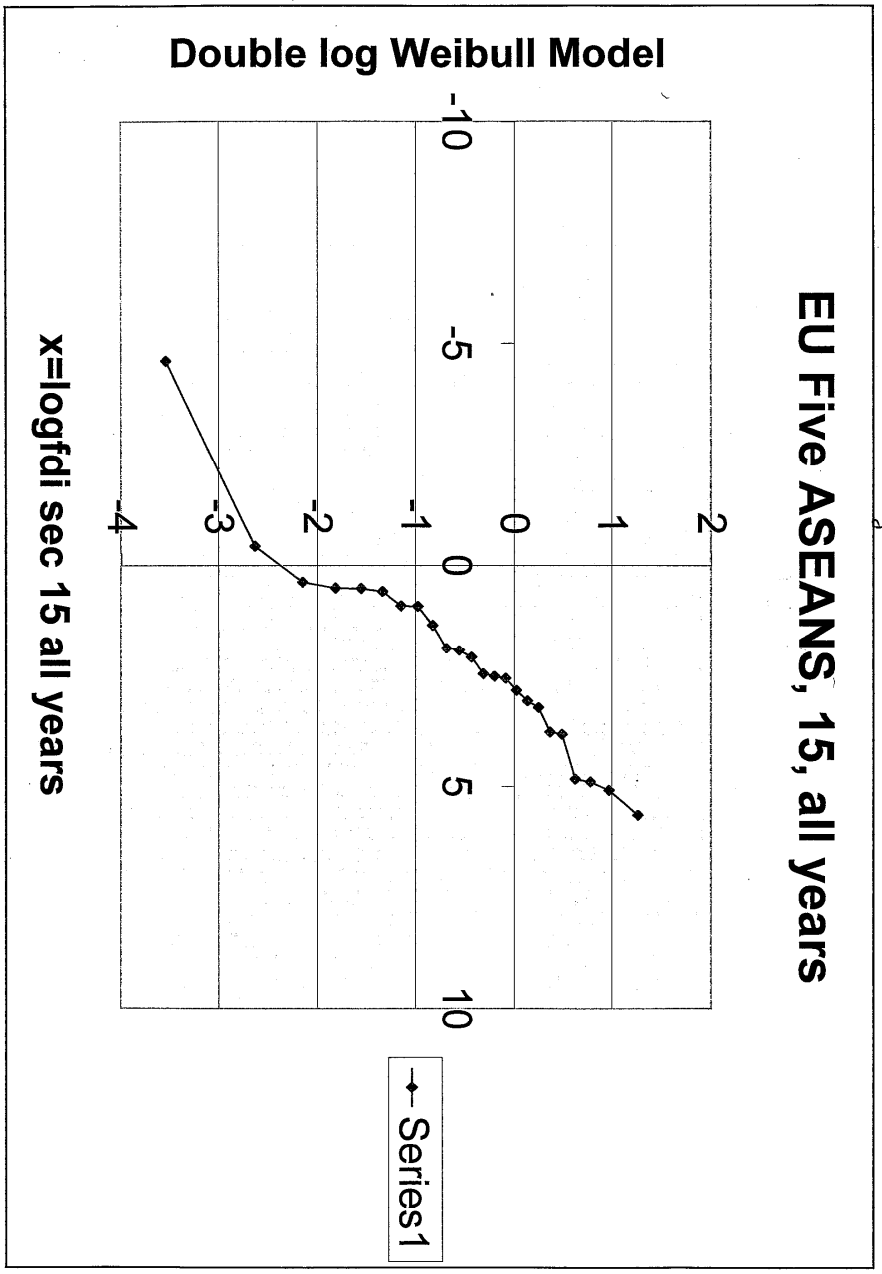

EU, all hosts and all sectors
Double Log Gumbel Model
7
6
5
4
3
2
1
0
-1
-2
-3
500
1000
1500
2000
2500
Series1
x=FDI, all hosts, sec, years

Fig 1b

2/26/09

Fig 2a


Double log Weibull Model
EU Five ASEANS, 15, all years
x=logfdi sec 15 all years
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-5
0
5
10
2
1
0
-1
-2
-3
-4
Series1

2/26/09

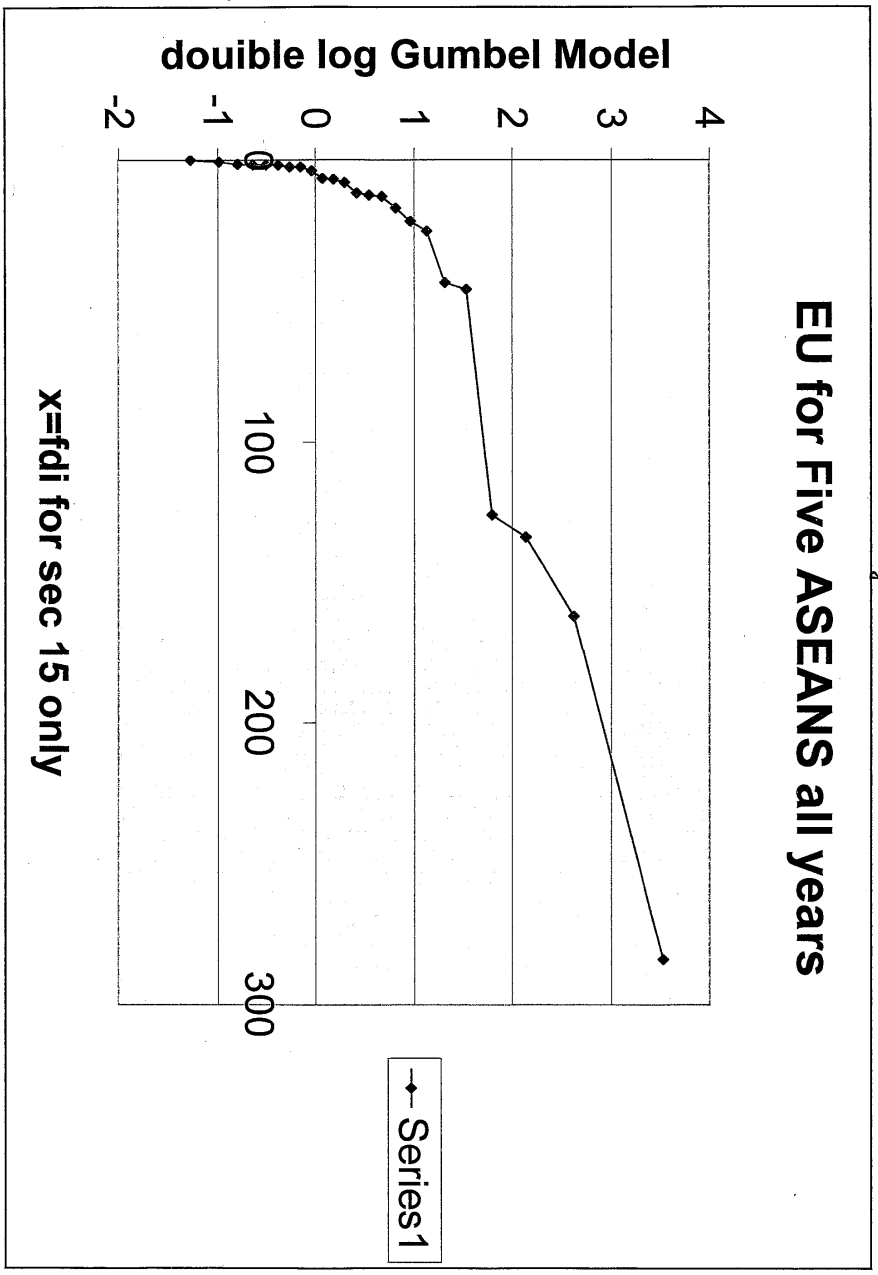
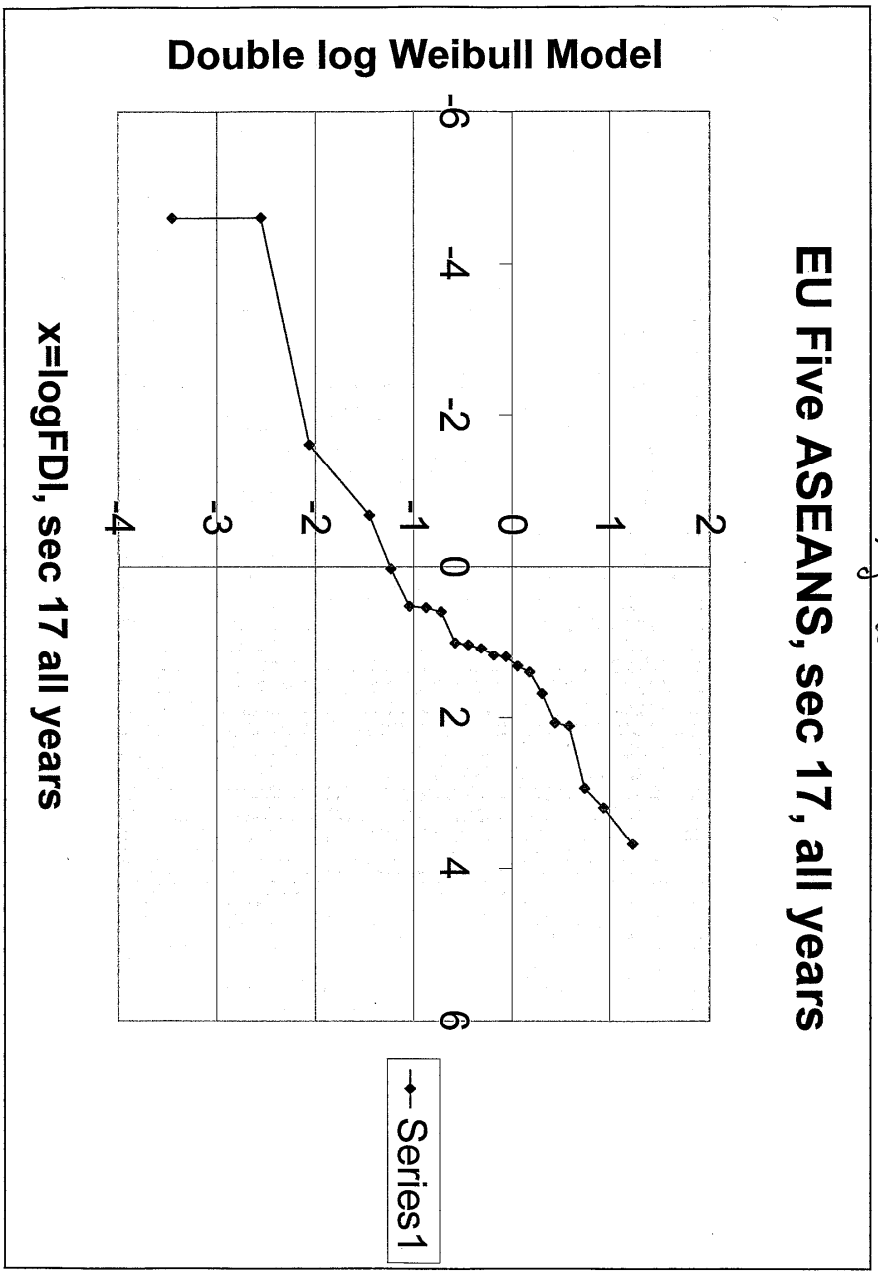

douible log Gumbel Model
EU for Five ASEANS all years
x=fdi for sec 15 only
Series1
-2
-1
0
1
2
3
4
0
100
200
300

Fig 2 b

2/24/09

Fig 3a

2/26/07


Double log Weibull Model
EU Five ASEANS, sec 17, all years
x=logFDI, sec 17 all years
Series1
-6
-4
-2
0
2
-4
-3
-2
-1
0
1
2
4
6

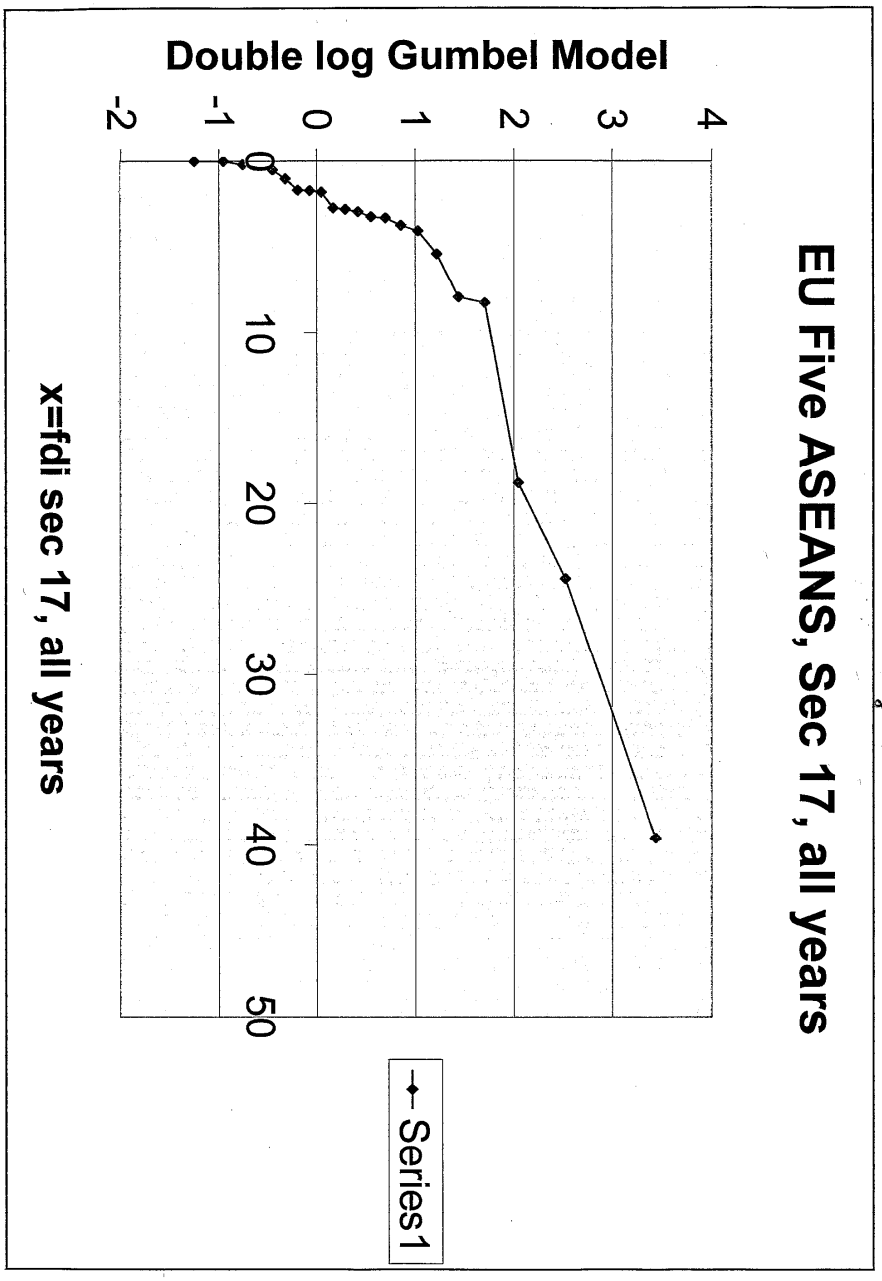

Double log Gumbel Model
EU Five ASEANS, Sec 17, all years
x=fdi sec 17, all years
Series1
-2
-1
0
1
2
3
4
0
10
20
30
40
50

Fig 3b

2/26/09

Fig 4a

8/26/09

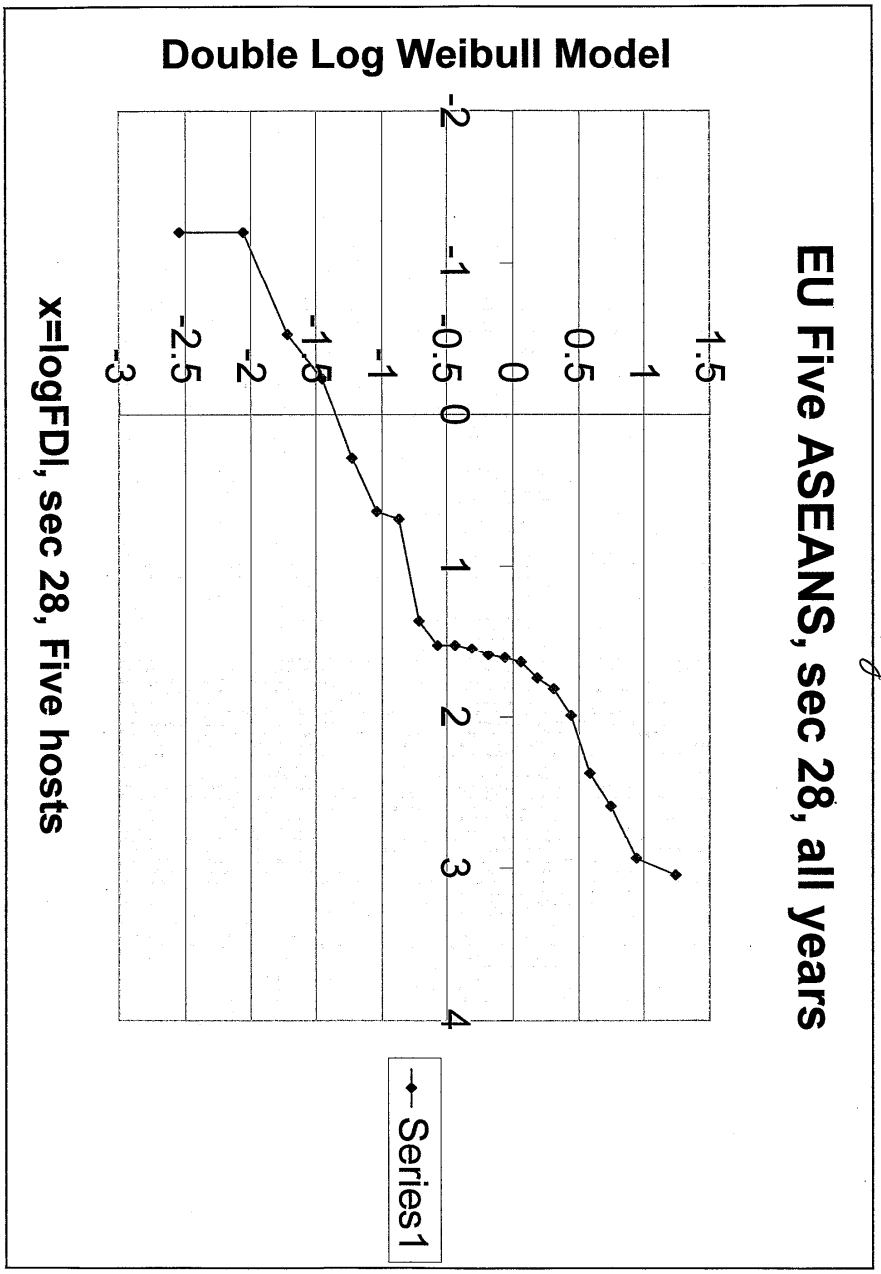
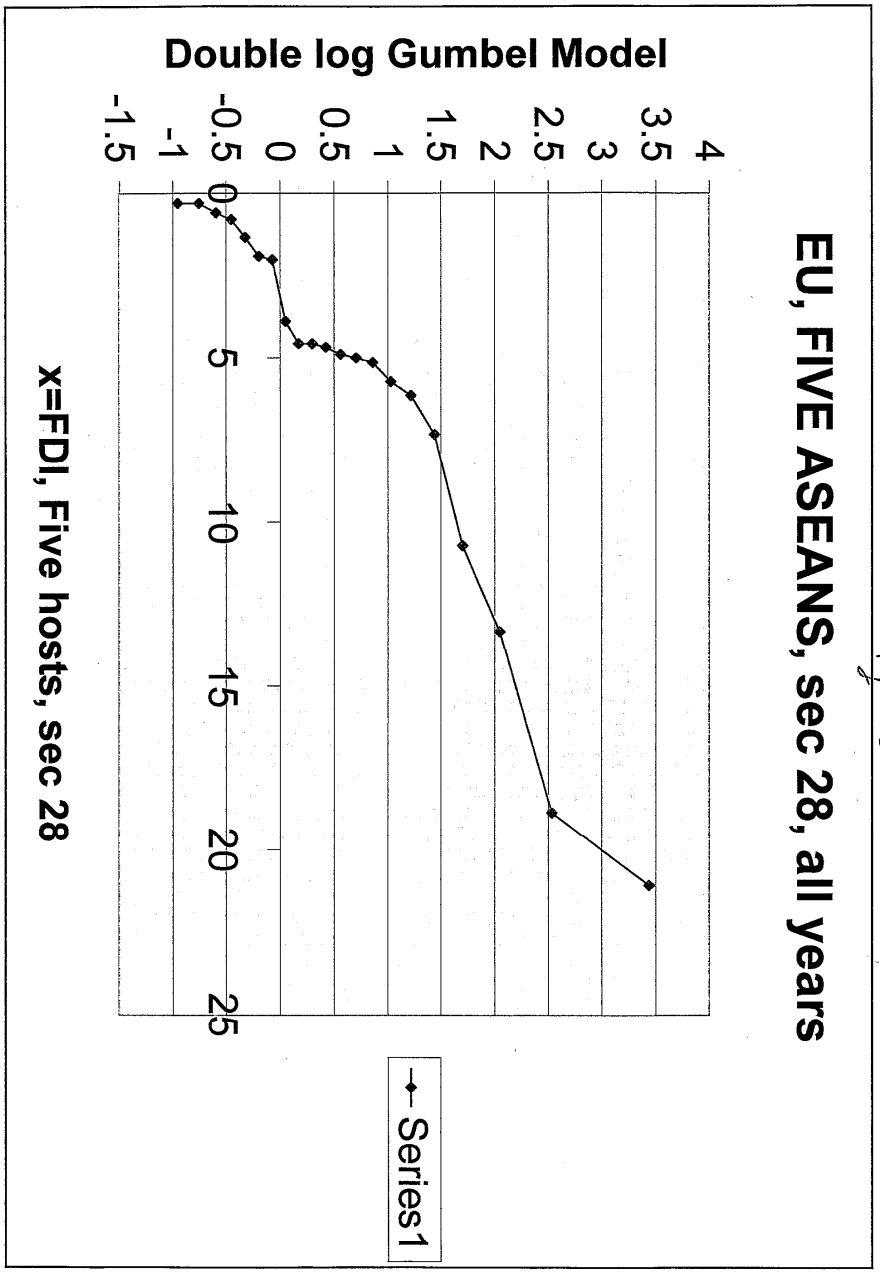

Double Log Weibull Model
EU Five ASEANS, sec 28, all years
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-2
-1
0
1
2
3
4
Series1
x=logFDI, sec 28, Five hosts

Fig 4b

2/26/09


EU, FIVE ASEANS, sec 28, all years
Double log Gumbel Model
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
0
5
10
15
20
25
Series1
x=FDI, Five hosts, sec 28

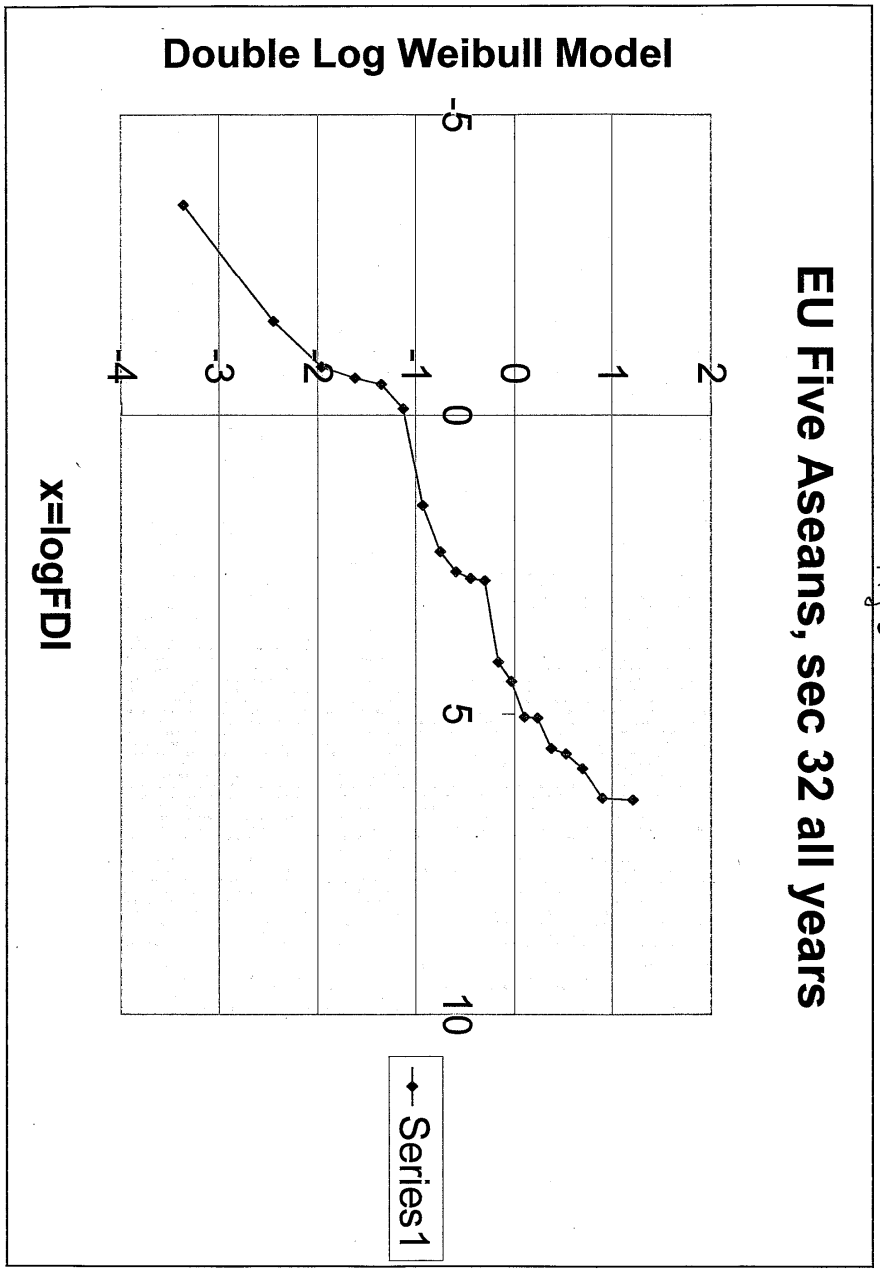

Double Log Weibull Model
EU Five Aseans, sec 32 all years
x=logFDI
-5
-4
-3
-2
-1
0
1
2
0
5
10
Series1

Fig 5a

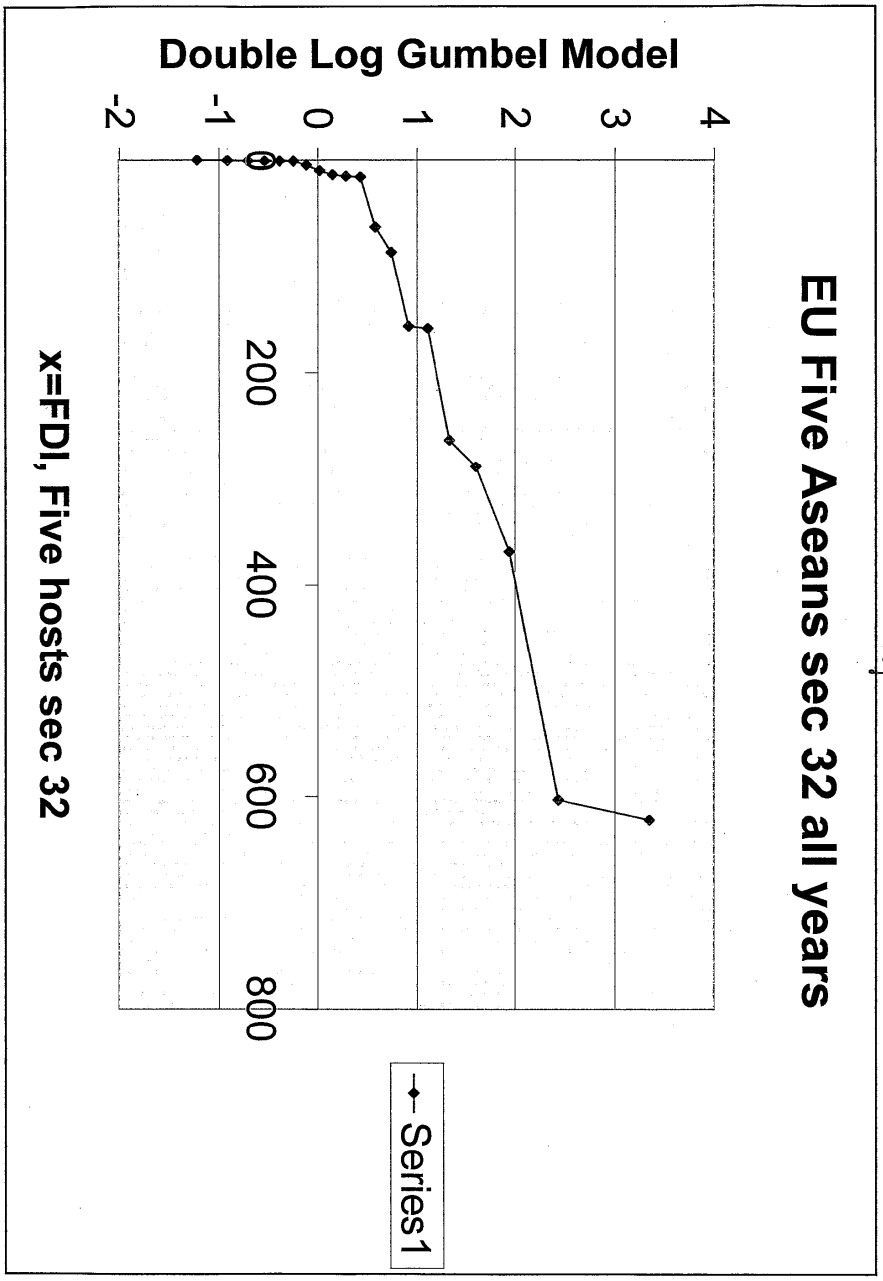

Double Log Gumbel Model
EU Five Aseans sec 32 all years
x=FDI, Five hosts sec 32
Series1
-2
-1
0
1
2
3
4
0
200
400
600
800

Fig 5a

2/26/09

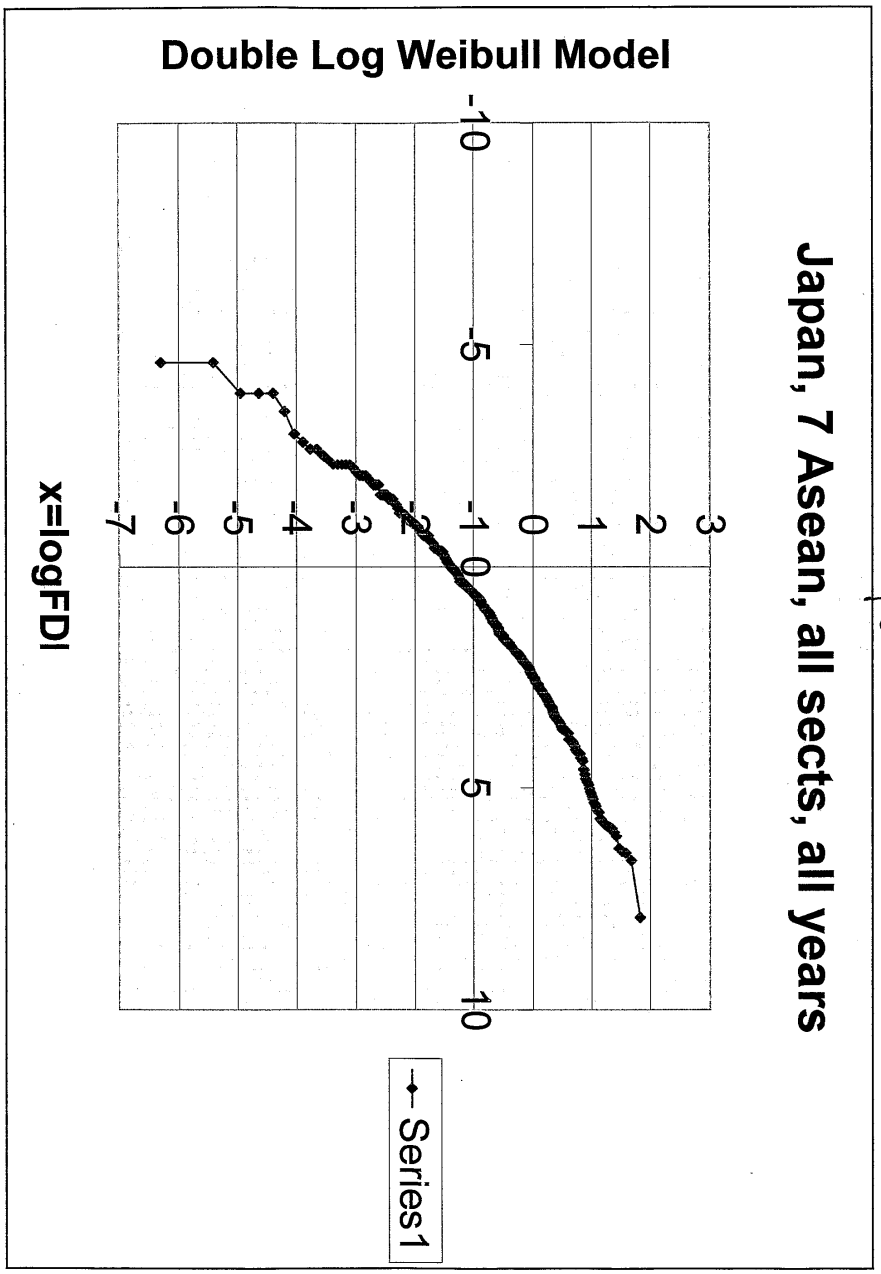

Double Log Weibull Model
Japan, 7 Asean, all sects, all years
x=logFDI
Series1
-10
-5
0
5
10
3
2
1
0
-1
-2
-3
-4
-5
-6
-7

Fig 6a

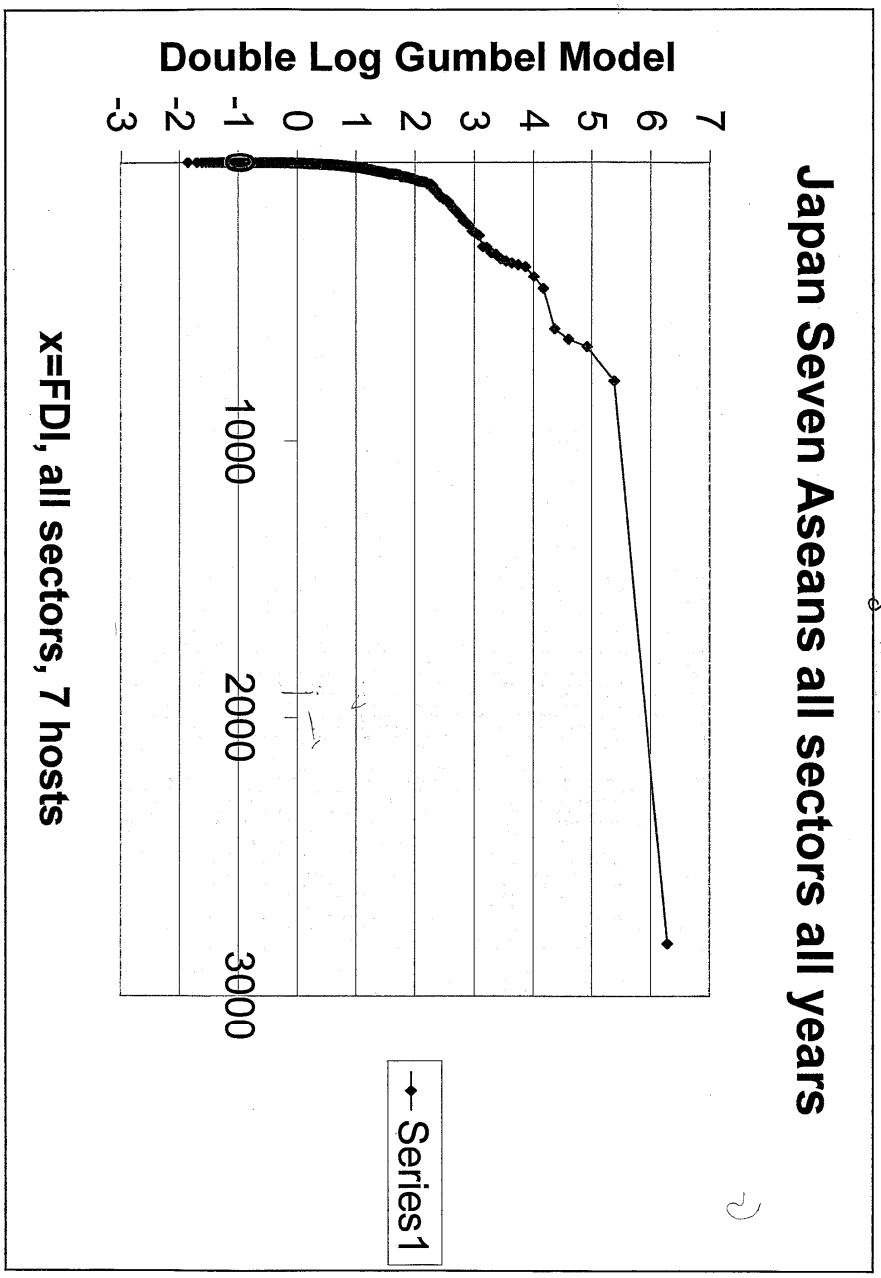

Japan Seven Aseans all sectors all years
Double Log Gumbel Model
7
6
5
4
3
2
1
0
-1
-2
-3
1000
2000
3000
Series1
x=FDI, all sectors, 7 hosts

Fig 6b

2/26/09

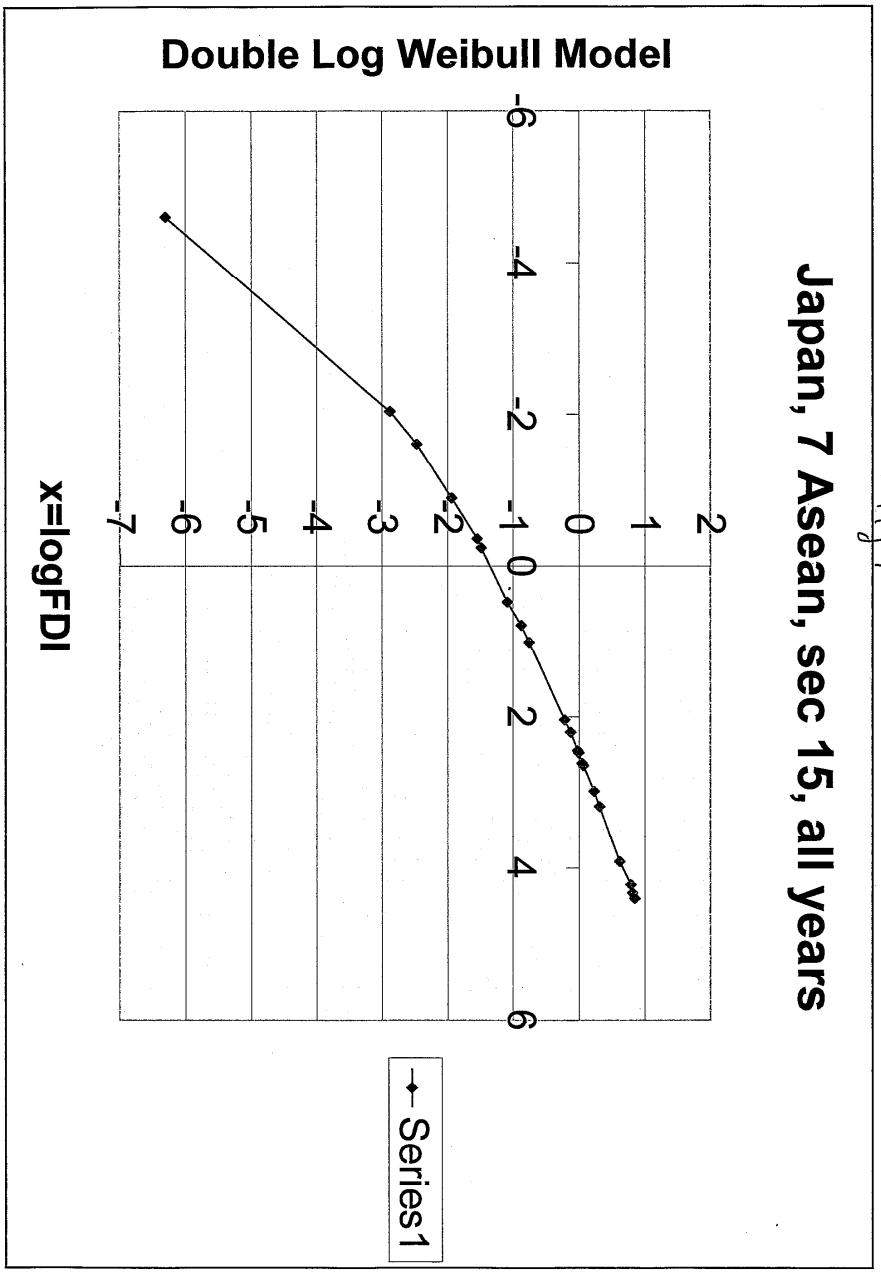

Double Log Weibull Model
Japan, 7 Asean, sec 15, all years
x=logFDI
Series1
-7
-6
-5
-4
-3
-2
-1
0
1
2
-6
-4
-2
0
2
4
6

Fig 7

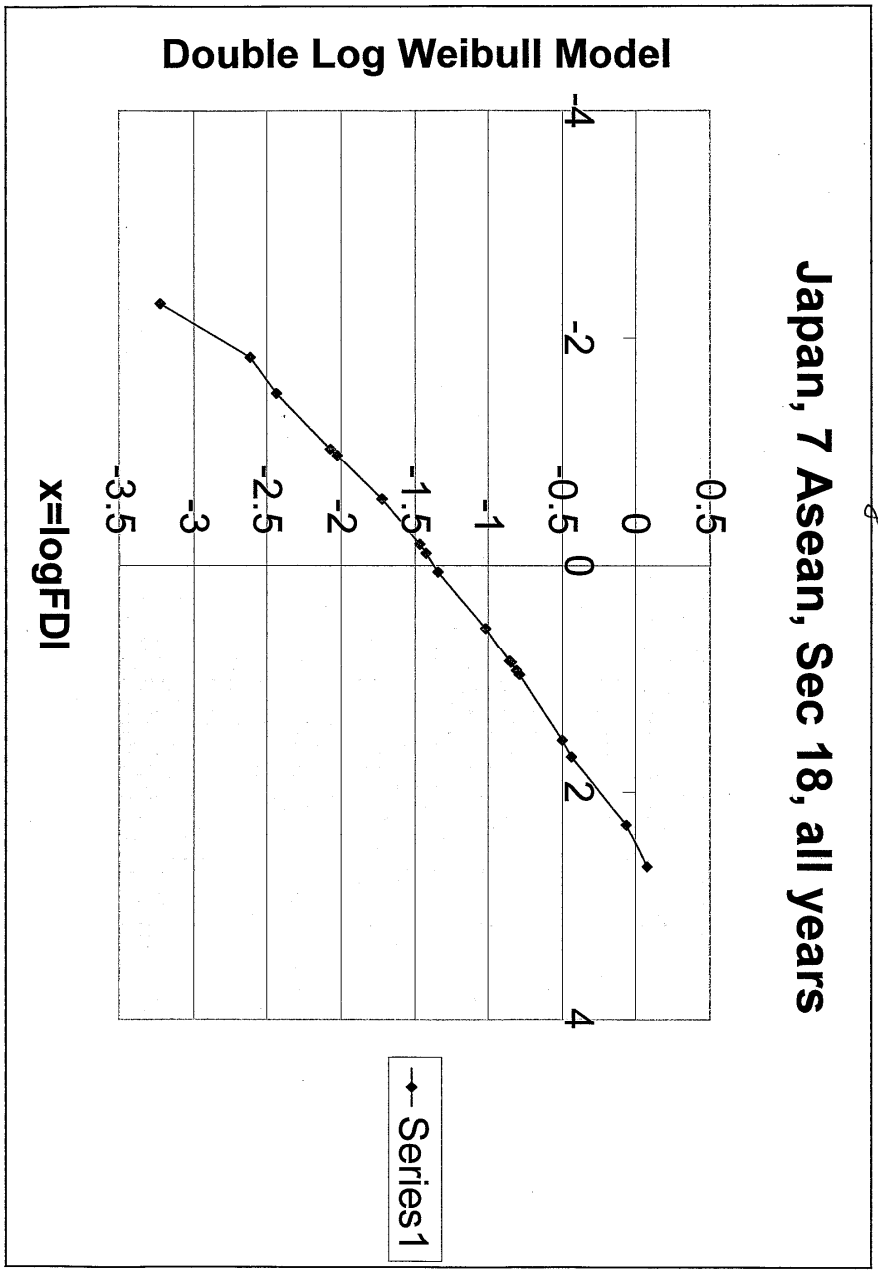

Double Log Weibull Model
Japan, 7 Asean, Sec 18, all years
x=logFDI
Series1
-4
-2
0
2
4
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5

Fig 8

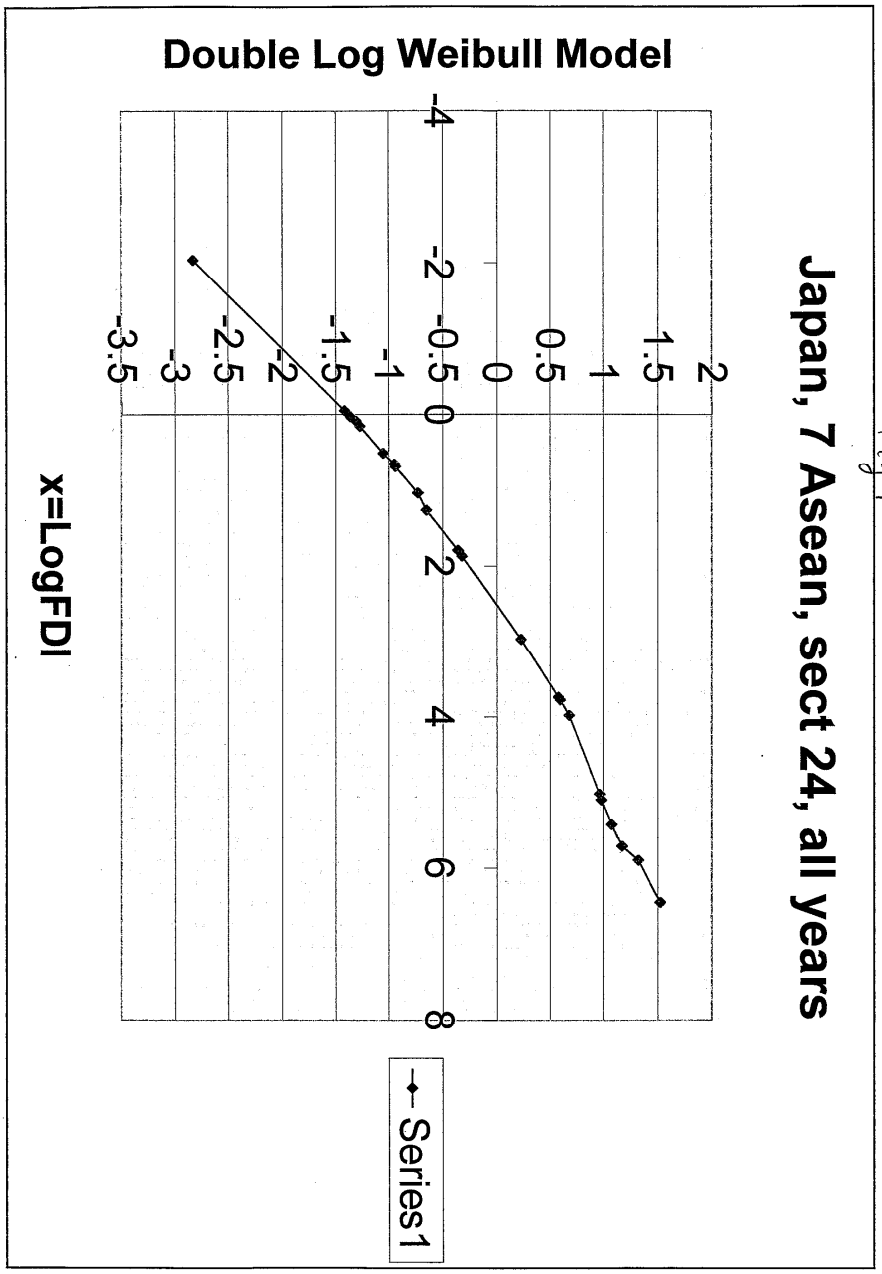

Japan, 7 Asean, sect 24, all years
Double Log Weibull Model
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-2
0
2
4
6
8
Series1
x=LogFDI

Fig 9

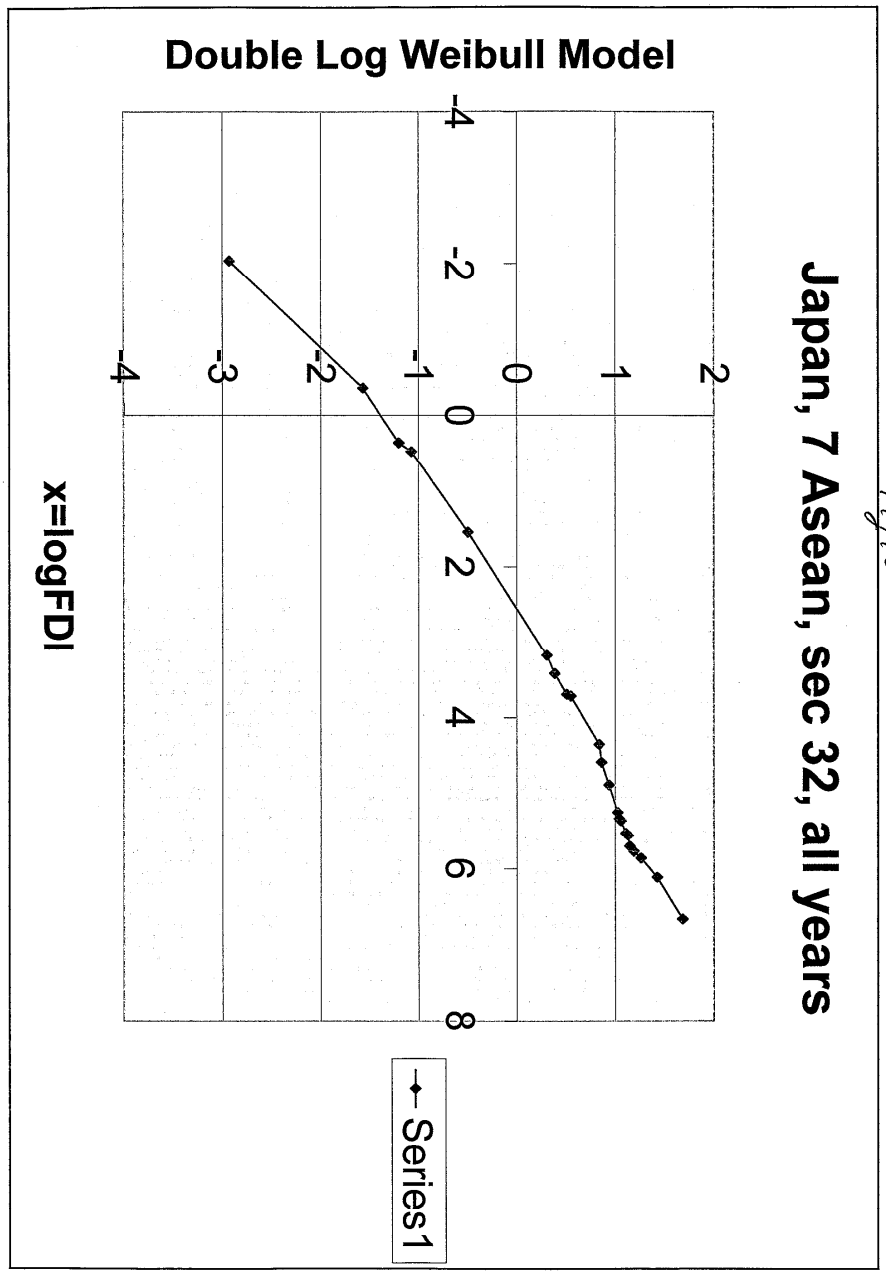

Double Log Weibull Model
Japan, 7 Asean, sec 32, all years
x=logFDI
Series1
-4
-2
0
2
-4
-3
-2
-1
0
1
2
4
6
8

Fig 10

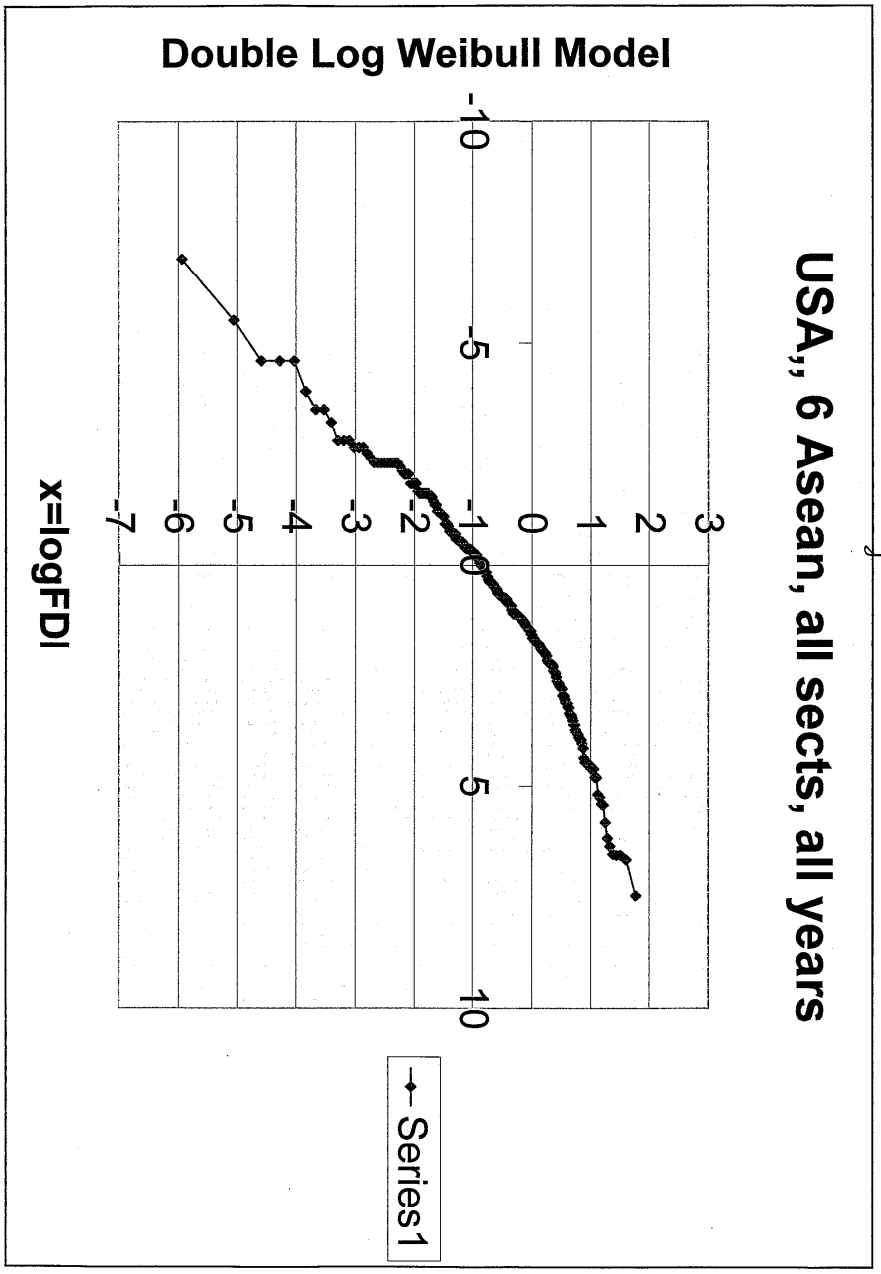

Double Log Weibull Model
USA,, 6 Asean, all sects, all years
x=logFDI
-10
-5
0
5
10
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
Series1

Fig 11

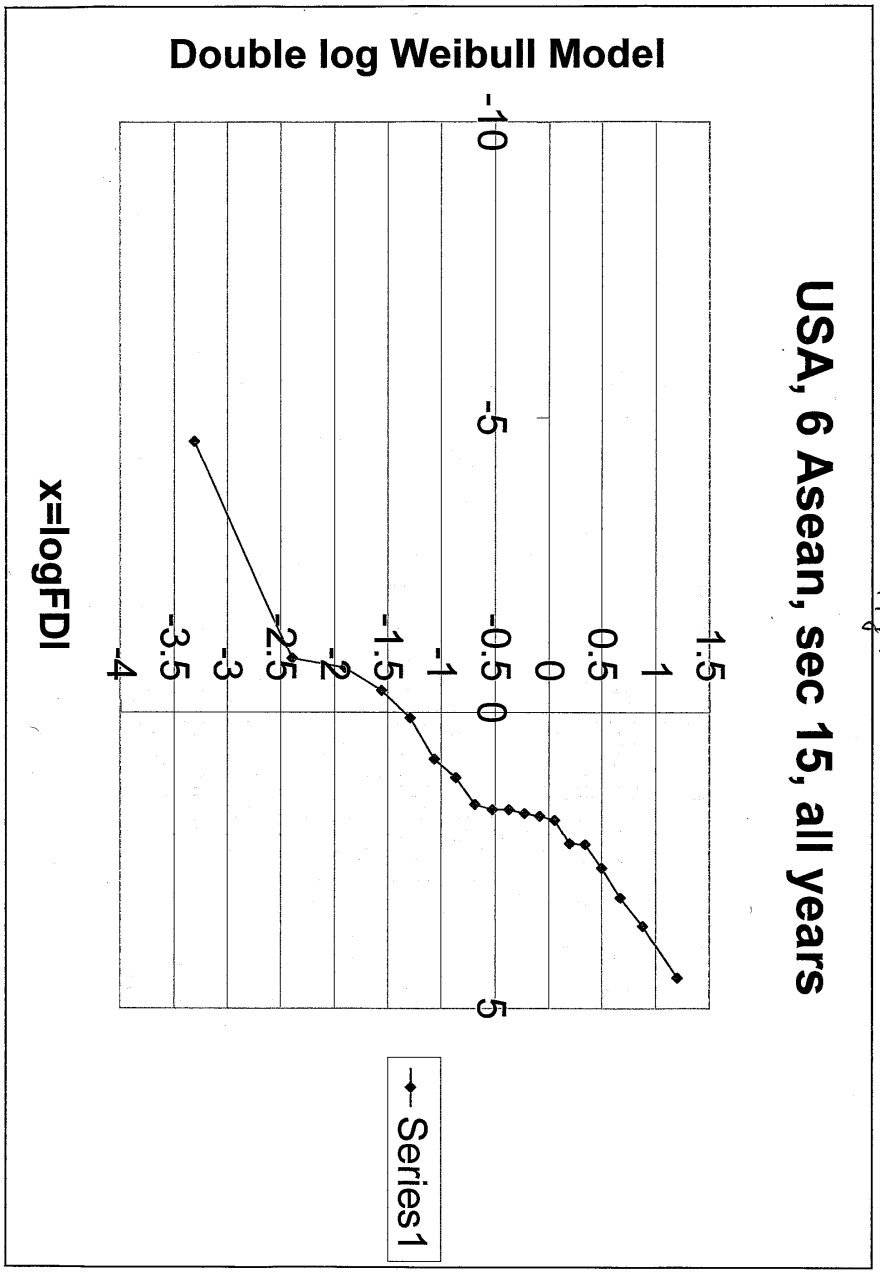

Double log Weibull Model
USA, 6 Asean, sec 15, all years
x=logFDI
-10
-5
0
5
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
Series1

Fig 12

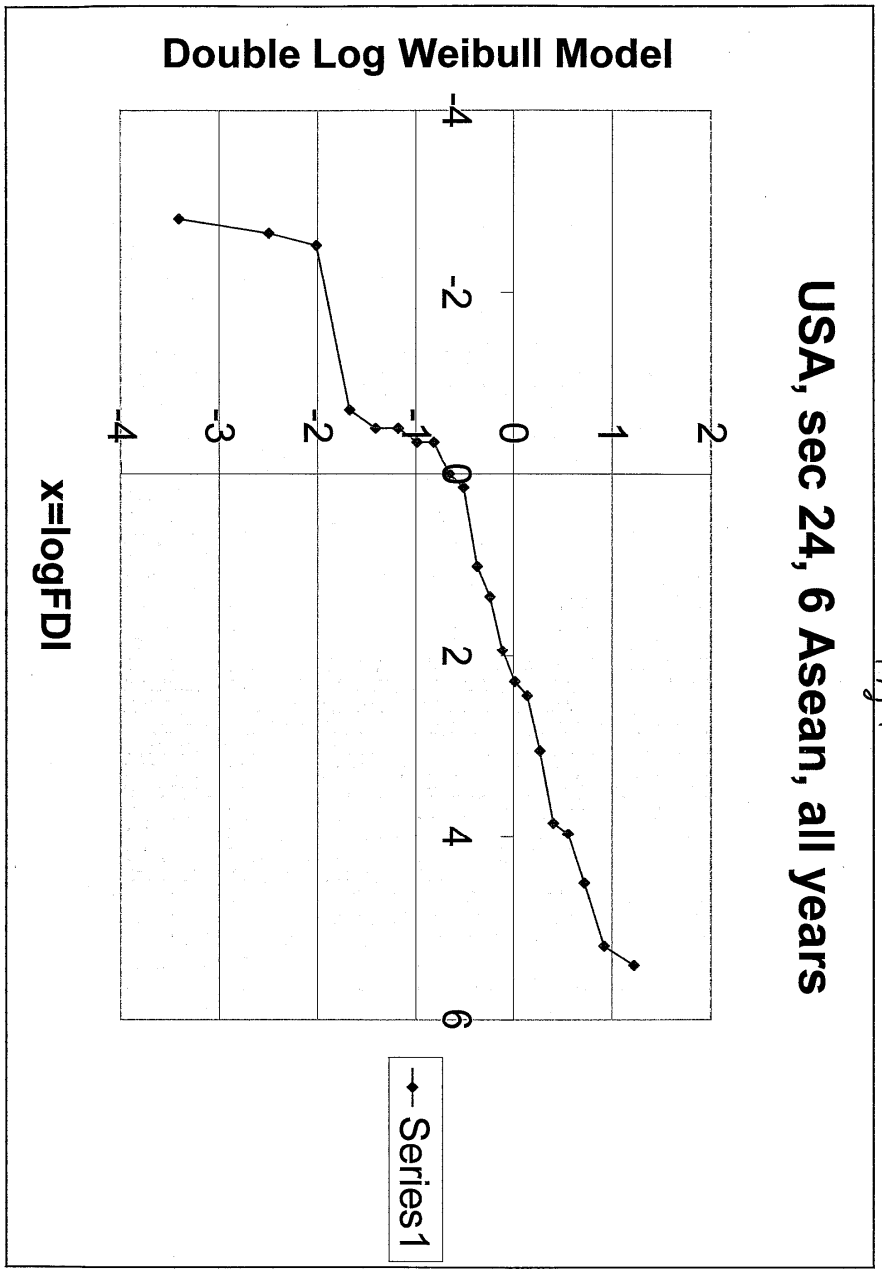

Double Log Weibull Model
USA, sec 24, 6 Asean, all years
x=logFDI
-4
-2
0
2
4
6
-4
-3
-2
-1
0
1
2
Series1

Fig 13

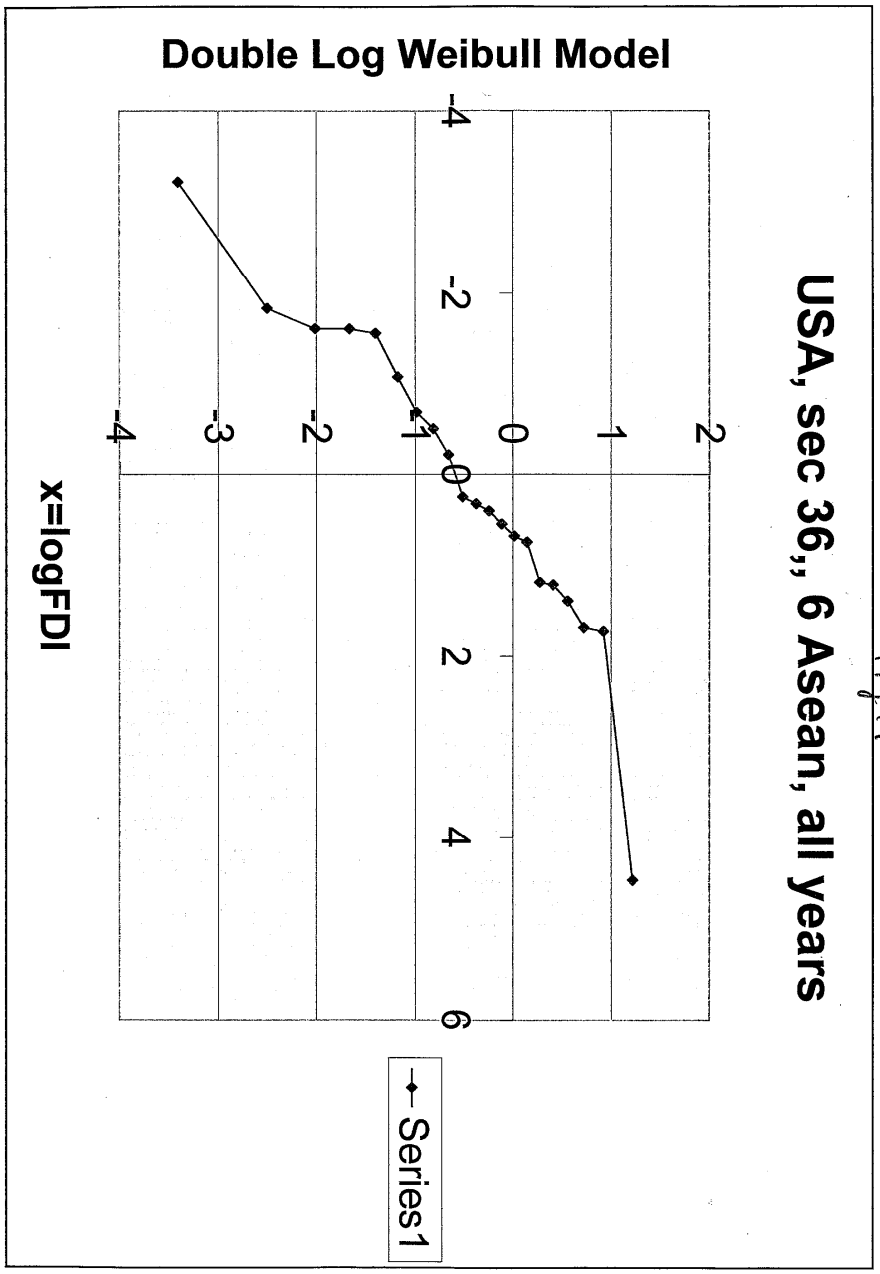
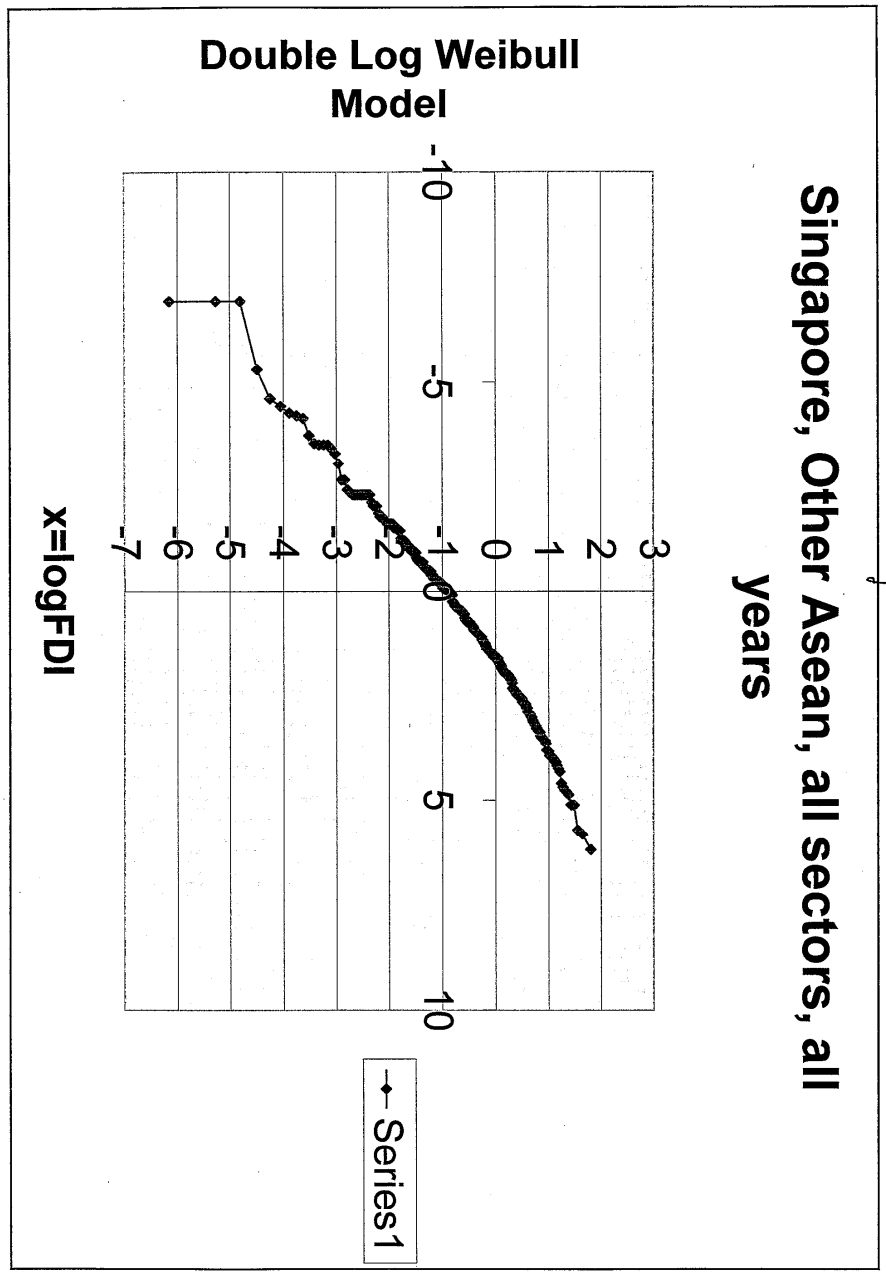

Double Log Weibull Model
USA, sec 36,, 6 Asean, all years
x=logFDI
-4
-2
0
2
4
6
-4
-3
-2
-1
0
1
2
Series1

Fig 14

Fig 15


Double Log Weibull Model
Singapore, Other Asean, all sectors, all years
x=logFDI
Series1
-10
-5
0
5
10
3
2
1
0
-1
-2
-3
-4
-5
-6
-7