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EQUILIBRIUM REAL EXCHANGE RATES AND ASIAN FINANCIAL CRISIS

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ABSTRACT

A huge depreciation in currency value was a significant symptom of the Asian Financial Crisis. Based on the observation, existing literatures like Corsetti, Pesenti & Roubini (1998), Radelet & Sachs (1998), Calvo & Vegh (1999), and Chen, Hu & Wu (1999), Ho(2003), and Caporale, Cipollini & Demetriades (2005) argued that an inappropriate exchange rate policy was one of the main factors causing the crisis. Our empirical results show countries like the Philippines, Indonesia, Thailand, Singapore and Malaysia did have an over-valuation of their currencies. However, for countries such as Japan, Korea and Taiwan, their actual real exchange rates in fact were larger than the model estimated the equilibrium real exchange rates. This implies that, for some countries which experienced a drastic depreciation of their currencies during the Asian financial crisis, it was not because of inappropriate market fundamentals, but rather because of self-fulfilling effects or contagion effects.

Key words and phrases: Real exchange rates, financial crisis.

AMS 2000 subject classifications: Primary 91B64; secondary 91B28.

1. Introduction

A huge depreciation in currency value was a significant symptom of the Asian Financial Crisis. It is noted from Table 1 that exchange rates were maintained at a relative stable trend or even showed a moderate decreasing trend before the crisis for countries who suffered during the crisis, though there had existed a persistent balance of payment deficit. Based on the observation, existing literatures like Corsetti, Pesenti & Roubini (1998), Radelet & Sachs (1998), Calvo & Vegh (1999), and Chen, Hu & Wu (1999), Ho(2003), and Caporale, Cipollini & Demetriades (2005) argued that an inappropriate exchange rate policy was one of the main factors causing the crisis, i.e., there existed an over-valuation of exchange rates. However, we have not found any paper that has rigorously discussed the "extent" of over-valuation. Therefore, this paper's main purpose is to compute the difference between equilibrium real exchange rates and actual real exchange rates for Asian countries such as Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Thailand and Taiwan before the burst of the financial crisis. In addition, we also investigate the relationship between the over-valuation of real exchange rates before July 1997 and the fluctuation magnitude of nominal exchange rates afterwards.

In order to find out the deviation of the actual real exchange rate from the equilibrium real exchange rate, it is natural to ask what is the "equilibrium" real exchange rate. According to Williamson (1994), fundamental equilibrium exchange rates (FEERs) are "the exchange rates that are consistent with macroeconomic balance, meaning the simultaneous achievement of internal and external balance." Though the concept is clear in theory, it is quite controversial empirically. In existing literatures, many researchers formulate equilibrium real exchange rates in terms of purchasing power parity (PPP), and try to explain the deviations, e.g. Stockman (1980), Lucas (1982), Hodrick (1989), Chinn and Johnston (1996) , Chaudhuri and Daniel (1998) and Nusair (2003). Some describe the equilibrium real exchange rate by constructing a macroeconometric model, such as Church (1992), Williamson (1994) and Balvers and Bergstrand (1997).

PPP approach is concise, but has been criticized for ignoring the impacts of changing relative taste shocks. On the other hand, the detailed macroeconometric modeling

is too complicated to follow, especially when a study is focuses on the cross-countries comparisons. Thus, this paper adopts the model proposed by Balvers and Bergstrand (1997) which solves closed-form solutions for countries' relative wealth, per capita consumptions, and real exchange rates in terms of relative non-tradable productivities, taste shocks, initial wealth, and rates of time preference.

Our empirical results show countries like the Philippines, Indonesia, Thailand, Singapore and Malaysia did have an over-valuation of their currencies. However, for countries such as Japan, Korea and Taiwan, their actual real exchange rates in fact were larger than the model estimated the equilibrium real exchange rates. This implies that, for some countries which experienced a drastic depreciation of their currencies during the Asian financial crisis, it was not because of inappropriate market fundamentals, but rather because of self-fulfilling effects or contagion effects. The remainder of the paper is as follows. The next section gives a brief description of the theoretical model. Section 3 provides data analysis and empirical results. Section 4 has concluding remarks.

2. Theoretical Model

It has been observed empirically that there exist large and persistent departures from purchasing power parity (PPP). Though many literatures try to explain the departures, most of them preclude inferences about the relationships over time among countries' relative wealth, consumptions, and real exchange rates, such as Stockman (1980, 1987), Lucas (1982), Stockman & Svensson (1987), Hodrick (1981), and Stockman &Dellas (1989). Moreover, the importance of relative taste shocks is often ignored. Balvers & Bergstrand (1997) derived closed-form solutions for the relationships among the real exchange rate, relative per capita consumption, and relative wealth in a stochastic dynamic general equilibrium model which takes into account relative non-tradable productivities, taste shocks, initial wealth, and rates of time preference. They showed that the solutions derived from the model are consistent with equilibrium exchange rate theories and the productivity-differentials' model of Balassa (1984) and Samuelson (1964). Therefore, in this paper we follow Balvers and Begstrand's model to generate the solution of the equilibrium real exchange rate.

Suppose there are two countries in the world. Each country consists of a tradable production process, a non-tradable production process, and one infinitely-lived representative consumer with a time additive utility function.[1] The representative consumer maximizes the expected value of the future utility from consumption. Assume there exists a social planner who maximizes the weighted average of the lifetime utilities of the two countries' representative consumers by choosing the distribution of the tradable good subject to the available quantity.

Under the above constructed framework and using the definition of the real exchange rate, we can derive the intratemporal equilibrium condition:

(1) $ER_t = (C_t^*/C_t)^{\gamma}(y_t^{N^*}/y_t^N)^{-\gamma}$,

where ER represents the real exchange rate, C is the consumption index which includes the tradable good, C^T, and the non-tradable good, C_t^N, γ is the ratio of non-tradable consumption to total consumption, and y^N is the non-tradable good production. Foreign variables are denoted by *.

Connecting the intratemporal equilibrium with intertemporal maximizing conditions, the intertemporal equilibrium condition can be stated as follows:

(2) $ER_t = \alpha(w_t^*/w_t)(\beta^*/\beta)^t(C_t^*/C_t)^{-\sigma}$,

where α denotes the constant weight that the social planner places on the utility of the foreign consumer, which represents initial relative wealth, W is a stochastic shock, β is a deterministic discount factor component, and β^*/β can be interpreted as accumulated relative wealth.

Combining equations (1) and (2) yields reduced forms:

(3) $ER_t = \alpha^{\gamma/(\gamma+\sigma)}(\beta^*/\beta)^{[\gamma/(\gamma+\sigma)]t}(y_t^{N^*}/y_t^N)^{-\gamma\sigma/(\gamma+\sigma)}(w_t^*/w_t)^{\gamma/(\gamma+\sigma)}$,

(4)$C_t^*/C_t = (\alpha)^{1/(\gamma+\sigma)}(\beta^*/\beta)^{[1/(\gamma+\sigma)]t}(y_t^{N^*}/y_t^N)^{\gamma/(\gamma+\sigma)}(w_t^*/w_t)^{1/(\gamma+\sigma)}$,

where σ is the inverse of the intertemporal substitution's elasticity. From reduced form equations, it can be noted that the relative consumption and the real exchange rate are affected by initial wealth, taste shock, rates of time preference, and non-tradables' productivity.

In order to estimate the equations, the above closed form and reduced-form equations can be transformed into log-linear versions:

(5) $\ln ER_{it} = \Phi_i^1 + \gamma \ln(C_{it}/C_t) - \gamma \ln(y_{it}^N/y_i^N) + \epsilon_{it}^1$, $i = 1, 2, \cdots, n$

(6) $\ln ER_{it} = \Phi_i^2 + \sigma[\ln(C_{it}/C_t)] + \sum_{j=1}^{n}[\ln(\beta_i/\beta)]T_{it} + \epsilon_{it}^2$, $i = 1, 2, \cdots, n$

(7) $\ln ER_{it} = \Phi_i^3 + \sum_{j=1}^{n}([\gamma/(\gamma+\sigma)][\ln(\beta_i/\beta)])T_{it} - [\gamma\sigma/(\gamma+\sigma)]\ln(y_{it}^N/y_t^N) + \epsilon_{it}^3$, $i = 1, 2, \cdots, n$

(8) $\ln(C_{it}/C_t) = \Phi_i^4 + \sum_{j=1}^{n}([1/(\gamma+\sigma)][\ln(\beta_i/\beta)])T_{it} + [\gamma/(\gamma+\sigma)]\ln(y_{it}^N/y_t^N) + \epsilon_{it}^4$, $i = 1, 2, \cdots, n$

where ER is the real exchange rate of country i relative to the U.S., C_i (C) is per capita consumption in country i (U.S.), and y_i^N (y^N) is per capita services' consumption in country i (U.S.). Term T is a time trend and β_i/β is the discount rate in country i relative to the U. S. discount rate. The terms ϵ_i are i.i.d. error terms and Φ_i^k are constant terms.

3. Data and Empirical Results

Since the model constructed in section II has implications for both the time series and cross sectional property of real exchange rates, a panel dataset is more appropriate. This paper studies the annual time series from 1970 to 1996 for eight Asian countries which include Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Thailand and Taiwan. Due to the limitation of data availability, we choose 1970 as the starting year. Because the Asian Financial Crisis erupted in July 1997, in order to avoid mixing information we choose 1996 to be the enddate of this study.[2]

From the data it can be noted that a great portion of non-tradable goods is service goods for most countries, and thus we use real service goods as the proxy for real non-tradable goods. The nominal exchange rate against U.S. dollars is deflated by the Consumer Price Index (CPI) to get the real exchange rate. Other nominal variables are also deflated by the CPI to get real terms. The data source was downloaded from International Financial Statistics and INTLINE data bank in AREMOS.

Due to the endogeneity of (C_{it}/C_t), the estimation of equations (5) and (6) involve the problem of simultaneous equation bias, and the two-stage least squares estimation is adopted to obtain consistent estimates of the equations' parameters. We first estimate the reduced-form relative consumption equation (7) to get the predicted values of

(C_{it}/C_t). We then use the predicted value of (C_{it}/C_t) in equations (5) and (6). Since C_i/C and y_{it}^N/y_i^N are highly correlated, there exists a serious multicollinearity problem. Therefore, in this paper we use equation (6) to derive the equilibrium exchange rates.[3]

The estimate results for the log-linear version of the reduced form equation (7) are presented as follows:

(9)

$$\begin{aligned}\ln(C_{it}/C_t) &= 0.651C_{idn} - 0.232C_{jpn} + 0.297C_{kor} + 0.234C_{mly} + 0.378C_{phn} - 0.226C_{sgp} \\ &+ 0.088C_{twn} + 0.128C_{tha} + \underset{(36.593)}{0.920}\ \ln(y_{it}^N/y_i^N) - \underset{(-8327)}{0.018}\ T_{idn} + \underset{(3.163)}{0.005}\ T_{jpn} \\ &- \underset{(-10.374)}{0.01}\ T_{kor} - \underset{(-9.724)}{0.019}\ T_{mly} - \underset{(-9.724)}{0.006}\ T_{phn} - \underset{(-6.282)}{0.017}\ T_{sgp} + \underset{(1.153)}{0.002}\ T_{twn} \\ &- \underset{(-4.968)}{0.007}\ T_{tha} + \epsilon_{it}\end{aligned}$$

$R^2 = 0.996$, adj $R^2 = 0.996$, S.S.R. $= 0.705$, $n = 216$. The values of the t statistics are in parentheses and S.S.R. is the sum of the square residuals.

The result shows that relative per capita non-tradables' output has the expected positive relationship with relative per capita consumption. Due to an overidentification problem, indirect least squares cannot identify the structure parameters uniquely. The fitted values of equation (9) are used in the first stage of the two-stage least squares (2SLS) as the instrument, denoted $\ln(C_{it}/C_t)$. The 2SLS estimation of the structural equation can be expressed as follows:

$$\begin{aligned}\ln ER_t &= 5.431C_{idn} - 4.505C_{jpn} + 5.629C_{kor} - 0.964C_{mly} + 2.419C_{phn} - 0.682C_{sgp} \\ &+ 2.164C_{twn} + 1.297C_{tha} - \underset{(-8.491)}{0.553}\ \ln(C_{it}/C_t) + \underset{(1.305)}{0.013}\ T_{idn} + \underset{(0.213)}{0.008}\ T_{jpn} \\ &+ \underset{(-3.045)}{0.012}\ T_{kor} + \underset{(6.691)}{0.027}\ T_{mly} - \underset{(-3.947)}{0.036}\ T_{phn} + \underset{(3.658)}{0.030}\ T_{sgp} + \underset{(2.871)}{0.022}\ T_{twn} \\ &+ \underset{(2.855)}{0.018}\ T_{tha}\end{aligned}$$

$R^2 = 0.999$, adj $R^2 = 0.999$, S.S.E.$= 0.848$, $\rho = \underset{(9.850)}{0.691}$, $n = 216$.

ρ is the first order serial correlation correction coefficient.

It can be seen that the estimated inverse of the intertemporal substitution's elasticity, σ , equals 0.553. The estimate is consistent with those in the closed-economy literature. The range of their σ estimates is between 0 and 2 (Mehra and Prescott (1985), Eichenbaum, Hansen, and Singleton (1988)). Moreover, most estimated values of the relative discounted rates β_i/β in equation (10) are positive. These estimates suggest that except for the case of the Philippines, the U.S. rate of time preference is higher than those of the seven other Asian countries. For example, the United States was economically "lavisher" than Indonesia, Japan, Korea, Malaysia, Singapore, Taiwan and Thailand.

In order to calculate the deviation of the actual real exchange rate from the equilibrium real exchange rate, we make use of the estimation results in equation (10) to simulate equilibrium real exchange rates. Since most Asian countries in our study have had a trade deficit problem after 1990, we estimate equation (10) from 1970 to 1989. We then use the estimates' parameters to simulate equilibrium real exchange rates from 1990 to 1996. Figure 1 shows the percentage of deviations between actual real exchange rates and equilibrium real exchange rates from 1990 to 1996 for eight Asian countries. It is interesting to find that countries like Indonesia, Malaysia, the Philippines, Singapore and Thailand did have an over-valuation of their currencies. However, for countries such as Japan, Korea and Taiwan, their actual real exchange rates were in fact higher than equilibrium real exchange rates in 1996. It also can be seen from Table 2 that some countries did not have an over-valuation of their currencies, but still experienced substantial depreciation of their currencies for the period 1997 to 1998. These results imply that if the equilibrium real exchange rate is the rate consistent with macroeconomic balance, then the huge depreciation, that occurred during the Asian Financial Crisis cannot be attributed purely to the inappropriateness of market fundamentals.

4. Concluding Remarks

Based on the model constructed by Balvers & Bergstrand (1997), our empirical results show that some countries like Indonesia, the Philippines, Thailand, Singapore and Malaysia did have an over-valuation of their currencies before the Asian financial

crisis. Moreover, the extent of the deviation from actual real exchange rates to equilibrium real exchange rates before the crisis is correlated with the fluctuation magnitude of exchange rates afterwards. This implies that the exchange rate "level" adopted by those countries to a pegged U.S. dollar was inappropriate, and it may be an important factor to explain the huge depreciation of those countries' currencies after the start of the financial crisis.

The over-valuation, however, was not a general phenomenon for Asian countries before the crisis. According to our empirical results, for countries like Japan, Korea and Taiwan, their actual real exchange rates in fact were larger than the equilibrium exchange rates imputed from the model. Nevertheless, they also had a serious currency depreciation after the crisis. If the equilibrium real exchange rate as argued by Williamson is the rate consistent with a macroeconomic balance, then the huge depreciation of currencies in Korea, Singapore and Taiwan after the crisis was not caused by inappropriate market fundamentals, but by self-fulfilling effects or contagion effects, as is proposed by Radelet and Sachs (1998), Park and Song (1998) and Coresetti Pesenti and Roubini (1998).

Notes

[1] In this model the tradable goods serve as the numeraire in both countries.

[2] If we extend our estimating period to include 1997, then the estimation results would reflect the information of an abnormal condition which happened from July 1997 to December 1997.

[3] In the case of considering relative non-tradable goods production, we have to impose the same constant constraint across countries. However, it will not significantly affect our results.

Table 1 Exchange Rate in Asian Countries

Country / Year	Thailand	Malaysia	Indonesia	Philippines	South Korea	Singapore	Taiwan	Japan
1990	25.58	2.70	1842.81	24.31	707.76	1.81	26.89	144.79
1991	25.51	2.75	1950.32	27.48	733.35	1.73	26.81	134.71
1992	25.40	2.55	2029.92	25.51	780.65	1.63	25.16	126.65
1993	25.32	2.57	2087.10	27.12	802.67	1.62	26.39	111.20
1994	25.15	2.62	2160.75	26.42	803.45	1.53	26.46	102.21
1995	24.91	2.50	2248.61	25.71	771.27	1.42	26.48	94.06
1996	25.34	2.52	2342.30	26.22	804.45	1.41	27.46	108.78
1997.Jun.	25.79	2.52	2450.00	26.38	887.90	1.43	27.94	114.30
1998.Jul.	43.35	3.96	9229.47	40.28	1471.66	1.69	33.64	133.16

Source: IMF (International Financial Statistics)

Table 2 Correlation between the Over-valuation of Real Exchange Rates before July 1997 and the Fluctuation Magnitude of Nominal Exchange Rate after then

	Z_1^a	Z_2^b	Z_3^c	Z_4^d	Z_5^e
Indonesia	-1.5279	248.49	294.94	259.07	453.22
Japan	0.1530	14.61	13.35	25.04	23.09
Korea	0.8501	81.05	91.29	48.35	56.86
Malaysia	-12.7452	68.17	75.00	48.58	58.33
Philippines	-6.1744	56.12	61.71	40.69	53.15
Singapore	-38.8279	22.91	22.38	21.10	18.88
Thailan	-0.4446	97.20	108.73	50.99	64.31
Taiwan	1.9326	22.44	21.41	23.88	23.57
Corr. Coef.		0.2651	0.2633	0.2176	0.2072

[a] Z_1: rate of deviation between actual real exchange rate and the equilibrium real exchange rate in 1996.

[b] Z_2: the depreciation rate of real exchange rate between June 1997 to June 1998.

[c] Z_3: the depreciation rate of nominal exchange rate.

[d] Z_4: the depreciation rate of real exchange rate between June 1997 to June 1998.

[e] Z_5: the depreciation rate of nominal exchange rate between June 1997 to June 1998.

Figure 1 Difference between Real Exchange Rates and Equilibrium Real Exchange Rates

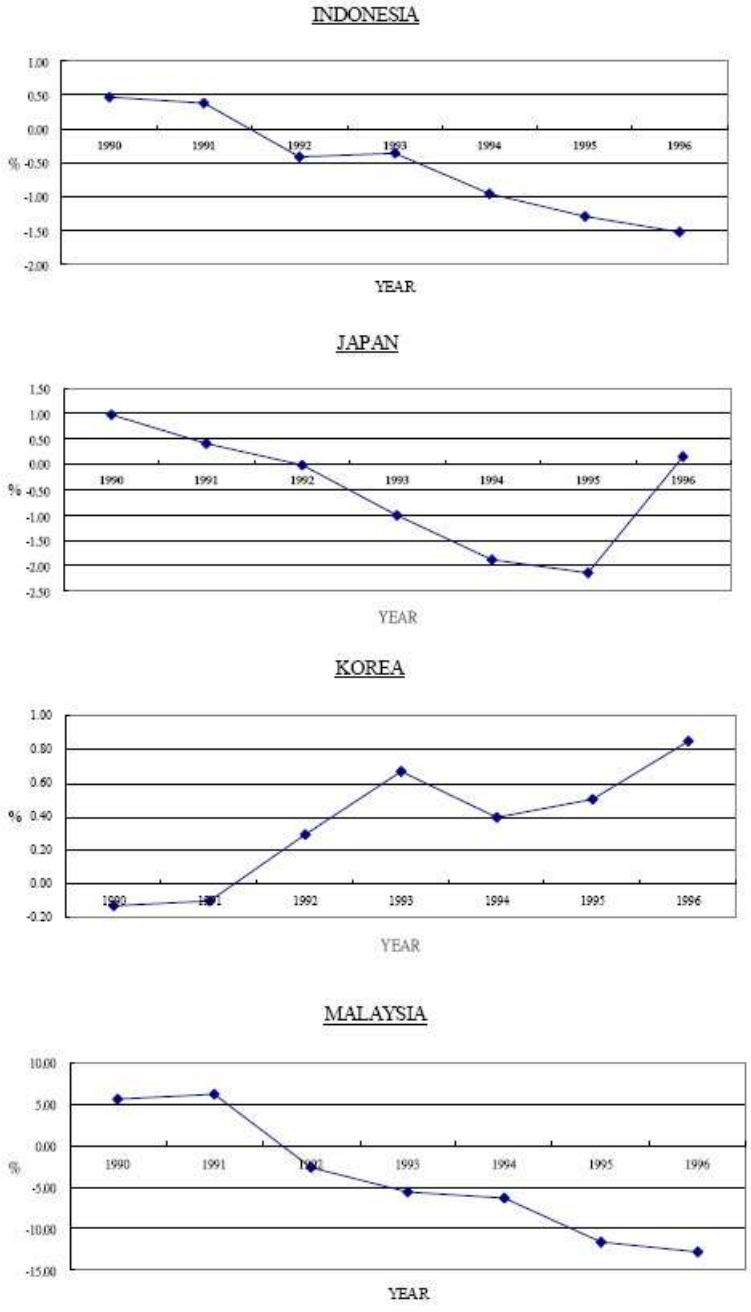
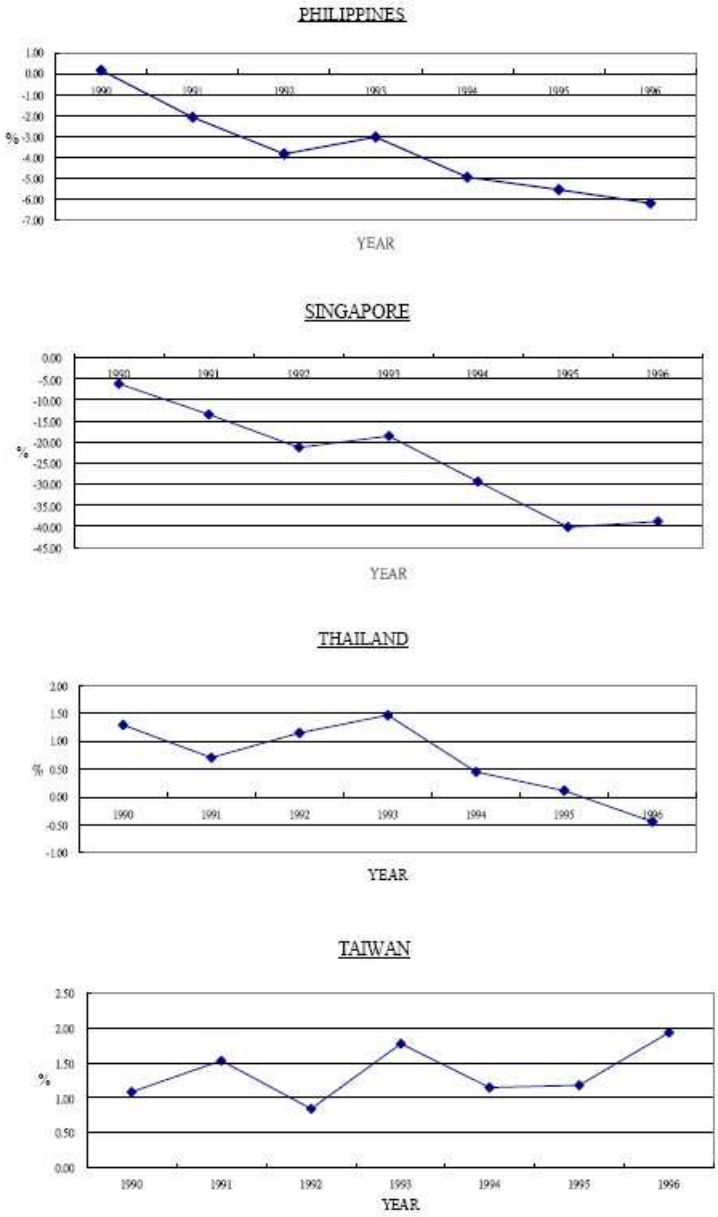


Figure 2 Difference between Real Exchange Rates and Equilibrium Real Exchange Rates (Cont'd)



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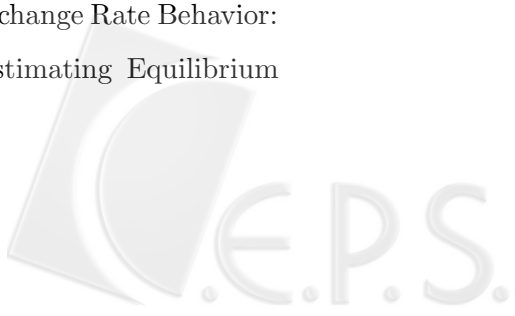

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