The empirical results of Market Efficiency (Gregory and Hansen test)

(SWF/US$ foreign exchange market)

Part 2: Gregory and Hansen cointegration tests with structural breaks

Considering the existence of regime change in the long-run relationship, the Gregory and Hansen (1996) test (GH test), a structural-breaking cointegration, is applied to examine the efficiency of foreign exchange rate. The results of GH tests are shown as Table 1. All of the ADF^*, Z_α^* and Z_t^* test statistics reject the null hypothesis, which means the existence of a cointegration with a structural break between S_{t+3} and $F_{t,3m}$.

Table 1 Gregory-Hansen cointegration tests

Test statistic	A	B	C
ADF^*	7.2754*** [2001M7]	-6.6944*** [2001M7]	-7.1939*** [2010M6]
Z_a^*	-81.6022*** [2001M7]	-73.6647*** [2001M7]	-79.2511*** [2001M2]
Z_t^*	-6.8842*** [2001M7]	-6.4861*** [2001M7]	-6.7825*** [2010M6]

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. A, B, and C are the three models types of Gregory and Hansen (1996), and the critical values are from Table 1 of Gregory and Hansen (1996). The numbers in brackets are the estimated structural break dates.
(critical value as Appendix A, and output of three models as Appendix B)

The results of the GH test are shown in Table 3. All the ADF^*, Z_α^*, and Z_t^* test statistics reject the null hypothesis at the 5% significant level, which means the existence of a cointegration with a structural break S_{t+3} and $F_{t,3m}$. Most structural breaks of the cointegration are around 2001m7.

Hence, we set up a dummy variable D1 to represent the structural break on 2001m7, and the FMOLS is applied to estimate the parameters of cointegration. Table 2 presents the results of FMOLS being based on Model A and equation (2).

$$S_{t+3} = 0.0339 - 0.0346 \times D1 + 0.9646 \times F_{t,3m} \quad (2)$$

Table 2 FMOLS test results

Variable	Coefficient	t-Statistic	Prob.
FSW	0.964632***	33.88160	0.0000
D1	-0.034681	-2.122835	0.0352
C	0.033971	1.873413	0.0627

To confirm whether the coefficient of $\mathbf{F_{t,3m}}$ in Eq. (2) is equal 1, Wald test is applied to examine it. In table 3, the result of Wald test shows that the null hypothesis, the coefficient of $\mathbf{F_{t,3m}}$ is one, is rejected at the 5% significant level, which supports market efficiency of foreign exchange market of Swiss Franz.

Table 3 Wald test for he coefficient of $\mathbf{F_{t,3m}= 1}$

χ^2 Statistics	P value
1.543180	**0.2141**

Appendix A Critical value of Gregory and Hansen cointegration tests

Table 1
Approximate asymptotic critical values

	Level	0.01	0.025	0.05	0.10	0.975
$m = 1$	ADF^*, Z_t^*					
	C	− 5.13	− 4.83	− 4.61	− 4.34	− 2.25
	C/T	− 5.45	− 5.21	− 4.99	− 4.72	− 2.72
	C/S	− 5.47	− 5.19	− 4.95	− 4.68	− 2.55
	Z_z^*					
	C	− 50.07	− 45.01	− 40.48	− 36.19	− 10.63
	C/T	− 57.28	− 52.09	− 47.96	− 43.22	− 15.90
	C/S	− 57.17	− 51.32	− 47.04	− 41.85	− 13.15
$m = 2$	ADF^*, Z_t^*					
	C	− 5.44	− 5.16	− 4.92	− 4.69	− 2.61
	C/T	− 5.80	− 5.51	− 5.29	− 5.03	− 3.01
	C/S	− 5.97	− 5.73	− 5.50	− 5.23	− 3.12
	Z_z^*					
	C	− 57.01	− 51.41	− 46.98	− 42.49	− 14.27
	C/T	− 64.77	− 58.57	− 53.92	− 48.94	− 19.19
	C/S	− 68.21	− 63.28	− 58.33	− 52.85	− 19.72
$m = 3$	ADF^*, Z_t^*					
	C	− 5.77	− 5.50	− 5.28	− 5.02	− 2.96
	C/T	− 6.05	− 5.79	− 5.57	− 5.33	− 3.33
	C/S	− 6.51	− 6.23	− 6.00	− 5.75	− 3.65
	Z_z^*					
	C	− 63.64	− 57.96	− 53.58	− 48.65	− 18.20
	C/T	− 70.27	− 64.26	− 59.76	− 54.94	− 22.72
	C/S	− 80.15	− 73.91	− 68.94	− 63.42	− 26.64
$m = 4$	ADF^*, Z_t^*					
	C	− 6.05	− 5.80	− 5.56	− 5.31	− 3.26
	C/T	− 6.36	− 6.07	− 5.83	− 5.59	− 3.59
	C/S	− 6.92	− 6.64	− 6.41	− 6.17	− 4.12
	Z_z^*					
	C	− 70.18	− 64.41	− 59.40	− 54.38	− 22.04
	C/T	− 76.95	− 70.56	− 65.44	− 60.12	− 26.46
	C/S	− 90.35	− 84.00	− 78.52	− 72.56	− 33.69

These critical values are based on the response surface