Dornsbush revisited from an asymmetrical perspective: Evidence from G20 nominal effective exchange rates

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Abstract

This paper develops an asymmetrical overshooting correction autoregressive model to capture excessive nominal exchange rate variation. It is based on the widely accepted perception that open economies might prefer under-evaluation to over-evaluation of their currency so as to foster their net exports. Our approach departs from existing works by allowing the strength of the overshooting correction mechanism to differ between over-depreciations and over-appreciations. It turns out that most of monthly effective exchange rates for the G20 countries are in fact well characterized by an overshooting correction after an over-appreciation only.

Keywords: nominal exchange rate, asymmetrical overshooting correction.

JEL Codes: C22, F31, F41.

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1 Introduction

Excessive exchange rate variation could be explained by the overshooting effect first identified by Dornbusch (1976). In a small open economy, due to nominal price stickiness, a permanent expansionary (respectively restrictive) monetary shock would provoke a depreciation (resp. appreciation) of the nominal exchange rate which would go beyond the new long term exchange rate equilibrium level. Hence, this depreciation (resp. appreciation) should be followed by a few periods of appreciation (resp. depreciation) to reach the new equilibrium. Even though more sophisticated versions of this model have been proposed, this monetary description of the exchange rate behavior has received little empirical support so far (see Rogoff (2002)). More recently, in another branch of literature, bounce-back augmented models have been found to be useful to describe transitory epochs of high growth rate GDP recovery following a recession and preceding a normal growth rate regime (see Kim et al. (2005) or Bec et al. (2014)). This mechanism is similar to an exchange rate overshooting correction after a depreciation. The originality of this paper is to bring these two strands of research together to shed new light on the exchange rate overshooting by allowing it to be asymmetrical across appreciation and depreciation regimes. To our knowledge, this has not been investigated so far. The idea grounding this asymmetry is that countries should be more prompt in correcting over-appreciation than over-depreciation of their currency so as to foster their net exports. Our main contribution is to develop an asymmetrical overshooting correction (AOC hereafter) autoregression, extended to allow for a GARCH effect, to capture this behavior. Using G20 effective nominal exchange rate data since January 1994, evidence of overshooting correction is found in 15 cases out of 20: 13 correct the overshooting after appreciation only, one does so after appreciation and depreciation and a last one does it after depreciation only. The asymmetry revealed by our empirical results might explain the lack of overshooting evidence from previous studies.

2 The asymmetrical overshooting correction autoregression

The AOC function used in the subsequent empirical investigation is based on the bounce-back function inspired by Friedman's view[1]. This author claimed that "a large contraction in output ends to be followed on by a large business expansion; a mild contraction, by a mild expansion." This kind of dynamics, allowing for a correction mechanism which depends on the depth of the initial change, is a good candidate to capture the exchange rate overshooting. Eventually, the latter is likely to be more than proportional to the monetary shock by which it is triggered, due to price stickiness. More precisely, we propose to represent the nominal exchange rate first difference, Δe_t, by the AOC autoregression given by:

$$\Delta e_t = \mu + \lambda_1 \sum_{j=0}^{m} \Delta e_{t-j-1} s_{t-j} + \lambda_2 \sum_{j=0}^{m} \Delta e_{t-j-1}(1 - s_{t-j}) + \sum_{k=1}^{p} \rho_k \Delta e_{t-k} + \nu_t \sqrt{\varepsilon_t}, \quad (1)$$

where ν_t is a Gaussian strong white noise $\mathcal{N}(0,1)$, independent of ε_t. The latter is allowed to exhibit GARCH(1,1) such that:

$$\varepsilon_t = \alpha_0 + \alpha \Delta e_{t-1}^2 + \beta \varepsilon_{t-1}, \quad (2)$$

with $\alpha_0 > 0$, and $\alpha, \beta \geq 0$. s_t is an indicator function governing the appreciation/depreciation regime switching:

$$s_t = 1 \text{ if } \Delta e_{t-1} \leq 0 \text{ and } 0 \text{ otherwise.} \quad (3)$$

The originality of our approach compared to the empirical "overshooting" literature relies on the first two terms after the intercept μ on the right-hand side of Equation (1). Indeed, they allow the overshooting correction strength to depend on the sign and the size of the overshooting. If $\lambda_1 < 0$, the term $\lambda_1 \sum_{j=0}^{m} \Delta e_{t-j-1} s_{t-j}$ will increase Δe_t during $m + 1$ periods after a shock as long as $s_{t-j} = 1$, for $j = 0, \cdots, m$, i.e. as long as the indicator

[1] See Friedman (1993), who refers to his work published in the 44th NBER Annual Report in 1964.

function points to a corresponding decrease in the lagged exchange rate. Consequently, $m+1$ reflects the duration of the overshooting correction. The estimate of λ_1 should be significantly different from zero in presence of overshooting after a depreciation[2]. The top panel of Figure 1 plots a simulated path of the level of the nominal exchange rate after an expansionary monetary shock. The first decrease in e_t brings the latter too low at time 2, which corresponds to the overshooting phenomenon. Consequently, it needs to bounce-back for two periods[3] in order to reach its new equilibrium level from time 4 on: this is the overshooting correction mechanism. The bottom panel of Figure 1 plots the dynamics implied by this shock for the first difference of e_t, which is the dependent variable of our AOC autoregression. There, periods 3 and 4 illustrate the role of the term $\lambda_1 \sum_{j=0}^{m} \Delta e_{t-j-1} s_{t-j}$ in Equation (1). Note that this correction is proportional to the size of the past Δe's. The next term $\lambda_2 \sum_{j=0}^{m} \Delta e_{t-j-1}(1 - s_{t-j})$ of Equation (1) is a function mirroring the one just described above : there will be evidence of overshooting after an appreciation if $\lambda_2 < 0$.

3 Data and estimation results

Monthly data of broad effective exchange rates[4] for the G20 members come from the Fed of St.Louis Federal Reserve Economic Data base (FRED). Table 1 reports results for the 15 countries where an overshooting correction mechanism has been found. On top of the countries listed in the first column of this Table, Canada, Saudi Arabia, South Africa, the United Kingdom and Indonesia have also been studied. No evidence of overshooting correction has been found in the first four ones.[5] Regarding Indonesian data, no autoregressive lag p, overshooting correction length m or GARCH lag orders made it possible to remove severe serial correlation in the model's estimated residuals.

[2]The nominal exchange rate data used below is the number of foreign currency units per domestic currency unit, so that a decrease corresponds to a depreciation.

[3]In this illustration, $m = 1$ so that the overshooting correction lasts two periods.

[4]Effective exchange rates are studied as in e.g. Adolfson et al. (2008) or Bjornland (2009) due to the small open economy assumption underlying the overshooting effect.

[5]The results for these countries are available upon request.

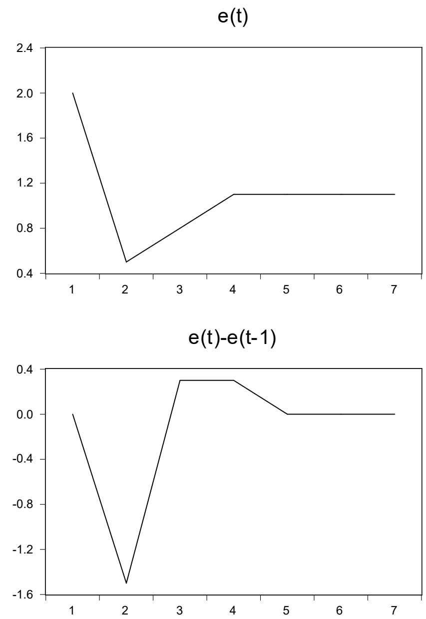

Figure 1: *Simulated impact of* $\lambda_1 \sum_{j=0}^{m} \Delta e_{t-j-1} s_{t-j}$ *on* e_t *and* Δe_t *after a depreciation at time* $t = 2$*, which triggers two periods of overshooting correction before the new exchange rate equilibrium value is reached (*$\lambda_1 = -0.2$ *and* $m = 1$*).*

Consequently, this exchange rate was excluded from our analysis. Unless otherwise mentioned, the series start in January 1994 and end in December 2018.[6] Δe_t in Equation (1) denotes the demeaned first difference of these effective exchange rate series. The model given by Equations (1) and (2) is estimated by maximum likelihood method and results are reported[7] in Table 1. For all the series, one autoregressive lag is enough to remove residuals serial correlation, so that p is at most 1 in Equation (1). The correction duration parameter is chosen among $m = 0, 1, \cdots, 6$ as the one which maximizes the log-likelihood of the estimated model over the period 1994:9-2018:12.[8] Evidence of overshooting correction is found in these 15 cases — at the 5%-level for 7 countries and the

[6]Due to unavailability or clear structural change in the exchange rate policy, data for Russia, Brazil, Mexico, South Korea, and Argentina start later, as indicated in the second column of Table 1.

[7]The estimates of constant terms μ and α_0 are not reported to save space.

[8]Note that it amounts to minimize the AIC as all the models contain exactly the same number of parameters.

Table 1: Maximum likelihood estimates of the AOC autoregression

Country	Sample	m	$\hat{\lambda}_1$	$\hat{\lambda}_2$	$\hat{\rho}_1$	$\hat{\alpha}$	$\hat{\beta}$	Q(6)	AIC
Argentina	03:6-18:12	6	-0.00	**-0.07**	0.48	0.12	0.69	4.64	3.953
			(0.95))	(0.03)	(0.00)	(0.07)	(0.00)	(0.59)	
Australia	94:9-18:12	1	-0.10	**-0.28**	0.48	0.09	0.84	0.67	4.028
			(0.25))	(0.00)	(0.00)	(0.00)	(0.00)	(0.99)	
Brazil	95:4-18:12	1	-0.12	**-0.32**	0.71	0.86	0.29	8.23	4.846
			(0.17))	(0.00)	(0.00)	(0.00)	(0.00)	(0.22)	
China	94:9-18:12	1	-0.04	**-0.18**	0.53	0.12	0.58	6.36	2.997
			(0.66))	(0.01)	(0.00)	(0.08)	(0.04)	(0.38)	
Euro Area	94:9-18:12	1	-0.07	**-0.17**	0.42	0.06	0.85	0.93	3.242
			(0.37))	(0.07)	(0.00)	(0.12)	(0.00)	(0.99)	
France	94:9-18:12	1	-0.09	**-0.14**	0.38	0.10	0.73	1.05	1.941
			(0.24)	(0.08)	(0.00)	(0.13)	(0.00)	(0.98)	
Germany	94:9-18:12	1	-0.09	**-0.16**	0.44	0.04	0.87	0.97	2.310
			(0.20)	(0.08)	(0.00)	(0.24)	(0.00)	(0.99)	
India	94:9-18:12	3	-0.02	**-0.13**	0.29	0.11	0.83	4.17	3.692
			(0.73))	(0.04)	(0.00)	(0.00)	(0.00)	(0.65)	
Italy	94:9-18:12	1	**-0.08**	**-0.14**	0.40	-0.03	1.01	4.28	2.132
			(0.07)	(0.06)	(0.00)	(0.00)	(0.00)	(0.64)	
Japan	94:9-18:12	5	-0.03	**-0.04**	0.30	0.30	0.00	4.51	4.175
			(0.30)	(0.06)	(0.00)	(0.00)	(0.99)	(0.61)	
Mexico	95:9-18:12	5	**-0.06**	-0.05	0.26	0.30	0.46	4.21	4.741
			(0.06))	(0.19)	(0.00)	(0.00)	(0.00)	(0.65)	
Russia	99:7-18:12	1	-0.27	**-0.21**	0.68	0.32	0.69	5.59	4.099
			(0.77)	(0.00)	(0.00)	(0.00)	(0.00)	(0.47)	
South Korea	98:9-18:12	3	-0.05	**-0.12**	0.39	0.17	0.69	4.11	4.095
			(0.36))	(0.04)	(0.00)	(0.00)	(0.00)	(0.66)	
Turkey	94:12-18:12	1	0.31	**-0.10**	0.49	0.04	0.91	3.21	6.166
			(0.05))	(0.10)	(0.00)	(0.00)	(0.00)	(0.78)	
USA	94:9-18:12	1	-0.08	**-0.16**	0.56	0.07	0.76	2.92	3.285
			(0.44)	(0.07)	(0.00)	(0.16)	(0.00)	(0.82)	

Notes: Figures in **bold** denote significant overshooting correction coefficients at the 10%-level maximum. p-values are in ( ). Q(6) is the Ljung-Box test of no serial correlation up to order 6.

10%-level for 8 countries — which represents three quarters of the series under study. Actually, 13 overshoot after appreciation only, while the remaining two overshoot either after depreciation only or after appreciation and depreciation. The overshooting correction duration is short: $m = 1$ in most of the cases, which amounts to 2 months. The overshooting correction is found to last longer in Japan, India, Argentina, South Korea and Mexico. Japan is a special case in that the Yen is a "safe haven" currency, and this country's inflation rate has remained close to zero since the early nineties. Consequently, the nominal price is likely to be sluggish and the adjustment to the purchasing power parity by the nominal exchange rate might be slow. The size of the overshooting correction coefficients, $\hat{\lambda}_1$ and $\hat{\lambda}_2$, ranges from -0.04 to -0.32. These values imply that on average, the correction is a little smaller than 20% of the overshooting magnitude during the few months following the over-adjustment. Interestingly, most countries seem to implement a "leaning-against-the-wind" foreign exchange policy in order to mitigate the initial appreciation and hence avoid large negative impacts on their current account. Italy is the only case where overshooting correction occurs both after depreciation or appreciation. With $\hat{\lambda}_1 = -0.08$ and $\hat{\lambda}_2 = -0.14$, the symmetry of the overshooting correction mechanism cannot be excluded. This might be explained by the Maastricht agreement constraints imposed to Euro area applicants during the nineties, especially regarding inflation and interest rates which de facto excluded competitive devaluation. Nevertheless, overshooting is supported by these results. Finally, Mexico foreign exchange policy appears to be concerned by over-depreciations only. Actually, after the 1995 financial crisis, this country's guidelines for exchange rate policy aimed to increase the institutional credibility of the central bank, while implementing institutional reforms and policies to strengthen Mexico's position in the foreign exchange market.

4 Conclusion

Overall, our empirical results support the exchange rate overshooting feature put forward by monetary approaches of exchange rate dynamics. Indeed, most of the series considered here show overshooting correction evidence, especially after an appreciation. The asymmetry revealed by our empirical results might explain the lack of overshooting evidence from previous studies. Its theoretical modelling is on our research agenda.

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