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Exchange Rate Dynamics and Portfolio Flow Uncertainty

Salah Ben Hamad[a] and Sahar Charfi[b]
[a] *Corresponding author, IHEC Sfax, Sfax, Tunisia*
benhamad_saleh@yahoo.fr
[b] *FSEG Sfax, Tunisia, Maha Achour, ISG Tunis, Tunisia*

ABSTRACT

The purpose of this paper is to examine the impact of short and long term uncertainty of portfolio flow and of industrial production on exchange rate dynamics. This paper employs a local level model to distinguish between short and long term uncertainty. Regression model is used to undertake empirical examination of the linkage between exchange rates, portfolio flow and industrial production.

The results show that portfolio flows uncertainty has a significant effect on real exchange rate TND/USD over both short and long term. Evidence is also found of the significant impact of growth economic, measured by industrial production, on exchange rate in the long term. In addition, the real exchange rate TND/USD fluctuations are significantly influenced by exchange rate uncertainty.

Even if determination of exchange rates by macroeconomic fundamentals has been often examined, few studies have investigated the response of exchange rate movements to portfolio flow changes in the Tunisian context. Moreover, the paper distinguishes between short-term and long-term uncertainty of portfolio flow, industrial production, and exchange rate.

JEL Classifications: F31, F21, F31, L16

Keywords: exchange rates; portfolio flow uncertainty; industrial production; Tunisia; United States of America

I. INTRODUCTION

Since the collapse of the Bretton Woods system, the explanation of exchange rate dynamics has been the biggest challenge in international finance. In the early 1980s, macroeconomics models are considered the first major models used in explaining exchange rate dynamics. They are categorized as monetary approach, which determines the exchange rate through flexible prices (Frenkel, 1976; Bilson, 1978) or through fixed prices (Dornbusch, 1976; Hooper and Morton, 1982) and the portfolio equilibrium approach by which Dooley and Isard (1979) explain the exchange rate through domestic and foreign assets prices. However, Meese and Rogoff (1983) have criticized these macroeconomic models providing empirical evidence of their poor performance in predicting short-run exchange rate dynamics.

In response to these failures, a number of scholars have attempted to predict exchange rate fluctuations with new approaches. Following the dynamic general equilibrium model, Obstfeld and Rogoff (1995) examine exchange rate movements with explicit microfoundations. Furthermore, De Gregorio and Wolf (1994) and Chinn et al. (1999) show the importance of the productivity differential model in explaining the real exchange rate dynamics. Moreover, the behavioral equilibrium approach as a new approach is argued by Clark and MacDonald (1999).

Despite these efforts of improvement, recent researches on open-economy macroeconomics lead to pessimistic conclusions due to several factors. The first one is the instability, which characterized the relation between exchange rate and fundamental variables as shown by Sarno and Taylor (2002). Secondly, Cheung and Chinn (2005), Taylor and Peel (2001) Sarno and Valente (2009) and Bacchetta and Wincoop (2013) highlight the nonlinearity of exchange rate dynamics. Finally, Frankel and Rose (1995) underline the high level of exchange rates uncertainty.

While a large number of studies have not claimed to find success in predicting exchange rate movements, a new line of research was developed in the mid-nineties that focus on market microstructure. These models attempt to examine complex and realistic settings as the dispersion of information, investor heterogeneity and transaction costs in order to be close to the actual structure of the exchange market. Evans and Lyons (2005) and Dunne et al. (2010) suggest that order flows are jointly determined by investors so intuitively their behaviors affect exchange rate movements. In addition, several empirical tests suggested by Evans and Lyons (2008) and Bacchetta and Wincoop (2009) argue that order flow present a transmission mechanism for public information to the fundamentals and for private information which influence exchange rate.

Indeed, the recent microstructure literature has provided promising evidence of the important role of order flows in exchange rate determination. Moreover, Evans and Lyons (2002) show that order flows explain 40 to 60% of daily exchange rate fluctuations. In Forex market order flows underline both an explanatory and a predictive role explained by Evans and Lyons (2006, 2008, and 2012).

Building on the recent success of the microstructure literature, a number of important hurdles remain on the route towards the role of portfolio flow in explaining exchange rate dynamics. Hau and Rey (2006) argue that order flows are strongly correlated with portfolio flows so intuitively portfolio flows affect exchange rate dynamics. This is another factor, which justify that the exchange rate determination

based on market microstructure is better than based on macroeconomic determinants. Recently, Kodonog et al. (2012) examine the relationship between real exchange rates and international portfolio flows during the period 1997-2009 for Egypt, Morocco, Nigeria and South Africa. They conclude that international portfolio flows in Africa are not persistent and relatively volatile. For the developing countries, Combes et al. (2012) argue that portfolio flows affect the real exchange rate, which leads to currency appreciation in some countries. Moreover, Ding and Ma (2013) develop a switching model, which explains exchange rate dynamics by financial customers' portfolio reallocation. Furthermore, as argued by Ali and Spagnolo (2014), exchange rate fluctuations are influenced by both net asset flow and net bond flow. They find that the relation between net portfolio flows and exchange rate movements is nonlinear in mostly studied currencies.

Following research conducted within a Tunisian context, ones are only interested in estimating exchange rate volatility using various econometric models as argued by Abdalla (2012) who use GARCH (1, 1) model to analyze volatility, others attempt to analyze the relationship between the macro variables and exchange rate: Deme et al. (1995) rely on the existence of a nexus between inflation rate and exchange rate. Then, Khemiri (2013) examines the impact of purchasing power parity on exchange rate fluctuations. Therefore, this relation with fundamentals variable is also analyzed by Kurihara (2012), which determines exchange rates in response to changes in monetary policies. In addition, both Fu et al. (2011) and Noman et al. (2012) focus in the relation between exchange rate and stock market.

With the development of international capital movements, several recent studies focus on examining the relation between international capital flows and exchange rates. In Tunisian context, Gtifa (2010) highlights the informational effect of order flow on USD/ TND. Furthermore, Gossel et al. (2012) undertake the determination of the nominal South African rand/US dollar exchange rate before and after the country's financial liberalization. In addition, Charfi (2013) shows that financial liberalization of capital flows in Tunisia leads to real exchange rate appreciation.

The present study focuses on the relationship between TND/USD exchange rate dynamics and international portfolio flow uncertainty. The research examines whether or not short and long term uncertainty of industrial production, portfolio inflow and exchange rate have influenced exchange rate fluctuations.

This paper is structured as follows. Section II provides theoretical views for empirical analyses. Section III shows the results of empirical. Section IV discusses the empirical results. Finally, Section V offers some concluding remarks.

II. THEORETICAL ANALYSIS

A. Local Level Model

Before examining the linkage between real exchange rate, portfolio flow and industrial production, it is first necessary to distinguish between short-term and long-term uncertainty using the local level model. Based on the work of Achour et al. (2010), uncertainty with the local level model is measured by the conditional variance modeled as GARCH effect.

The local level model is a state space model, being linear and Gaussian. This model is based on the work of Ball (1990), Cosimano (1988), and Engel (1983). It allows distinguishing between the short term and long term uncertainty of each explanatory variable by considering permanent and transient shocks. The differences disturbances are dependent only on the state variable x_t.

The estimated model is based on these equations presented as follows:

$$y_t = x_t + \varepsilon_t,\ \varepsilon_t \sim N(0, h_t) \tag{1}$$

$$x_t = x_{t-1} + \eta_t,\ \eta_t \sim N(0, q_t) \tag{2}$$

where y_t represents the variable changes at time t (Portfolio flow or industrial production index or delayed exchange rates) at time t; x_t represents the unobservable state variable; h_t denotes the variance of transitory components which determines the short-term uncertainty. It is determined from the equation:

$$h_t = \omega_0 + \omega_1 \varepsilon_{t-1}^2 + \omega_2 h_{t-1}, \omega_0 > 0,\ \omega_1, \omega_2 \geq 0 \tag{3}$$

Then, q_t represents the variance of permanent components that determines the long-term uncertainty. It is determined from the equation:

$$q_t = \lambda_0 + \lambda_1 \eta_{t-1}^2 + \lambda_2 q_{t-1},\ \lambda_0 > 0, \lambda_1,\ \lambda_2 \geq 0 \tag{4}$$

The estimation of the local level model is based on the quasi-optimal Kalman argued by Harvey et al. (1992). The Kalman filter allows calculating the approximate log-likelihood function, which can be maximized with respect to the unknown parameters of the model for approximate maximum likelihood estimation. Following the augmented state-space formulation, the filter disturbances ε_t and η_t are included in the state vector.

Consider the following specification of the local level model:

$$y_t = x_t + \varepsilon_t = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix} \begin{bmatrix} x_t \\ \varepsilon_t \\ \eta_t \end{bmatrix} \tag{5}$$

$$x_t^* = \begin{bmatrix} x_t \\ \varepsilon_t \\ \eta_t \end{bmatrix} = \begin{bmatrix} 100 \\ 000 \\ 000 \end{bmatrix} \begin{bmatrix} x_t - 1 \\ \varepsilon_t - 1 \\ \eta_t - 1 \end{bmatrix} + \begin{bmatrix} 01 \\ 10 \\ 01 \end{bmatrix} \begin{bmatrix} \varepsilon_t \\ \eta_t \end{bmatrix} \tag{6}$$

Hence, we have:

$$y_t = Hx_t^*$$

$$x_t = Fx_{t-1}^* + G\gamma_t,\ \gamma_t \sim N(0, Q) \tag{7}$$

where $Q = \begin{bmatrix} h_t & 0 \\ 0 & q_t \end{bmatrix}$ with: $h_t = \omega_0 E\left(\varepsilon_{t-1}^2 / Y_{t-1}\right) + \omega_2 h_{t-1}$ and

$q_t = \lambda_0 + \lambda_1 E\left(\eta_{t-1}^2 / Y_{t-1}\right) + \lambda_2 q_{t-1}$. Thus, to process the filter, we need:

$$h_t = \omega_0 + \omega_1 E\left(\varepsilon_{t-1}^2 / Y_{t-1}\right) + \omega_2 h_{t-1} \quad (8)$$

$$q_t = \lambda_0 + \lambda_1 E\left(\eta_{t-1}^2 / Y_{t-1}\right) + \lambda_2 q_{t-1} \quad (9)$$

B. Multiple Regression Models

After calculating the short and long-term volatility of considered variable through specific models, this paper attempts to analyze the impact of their short and long term uncertainty of portfolio flow and of industrial production index on the real exchange rate.

The multiple linear regression models can be represented by the following equation:

$$\begin{aligned} R_t = {} & \alpha_1 R_{t-1} + \alpha_2 CTR_{t-1} + \alpha_3 LTR_{t-1} + \alpha_4 IPI_t + \alpha_5 LTIPI_t + \alpha_6 CTR_t \\ & + \alpha_7 LTR_t + \alpha_8 FLOW_t + \alpha_9 LTFLOW_t + \alpha_{10} CTFLOW_t \end{aligned} \quad (10)$$

where R_t represents the real exchange rate returns at time t; R_{t-1} represents the real exchange rate delayed at time t-1; CTR_{t-1} shows the short term uncertainty of the delayed real exchange rate; LTR_{t-1} shows the long term uncertainty of the delayed real exchange rate; IPI_t is the index of industrial production; $LTIPI_t$ represents the long-term uncertainty of the index of industrial production; CTR_t shows the short term uncertainty of the real exchange rate; LTR_t shows the long term uncertainty of real exchange rate; $FLOW_t$ represents the net portfolio flow; $LTFLOW_t$ shows the long-term uncertainty of net portfolio flow and $CTFLOW_t$ shows the short-term uncertainty of net portfolio flow.

C. Unit Root Tests

For estimation, it is necessary to check unit root tests. This paper uses Augmented Dickey Fuller (ADF) that is the most used for empirical estimation; however; if the series is correlated at higher order lags, the assumption of noise disturbances is violated.

III. EMPIRICAL ANALYSES

A. Data Sources and Variable Construction

For the purpose of examining the relationship between real exchange rate and the explanatory variables in equation (10), the data of this study covers a full sample period from January 2003 to December 2013.

The dependent variable in this paper represents the real exchange rate dynamics. The nominal exchange rate data TND/USD are collected from the Central Bank of Tunisia (BCT)[1]. Based on the practices of the literature, Kodongo and Ojah (2012) and Jamil et al. (2012) proposed to convert the nominal exchange rate to real exchange rate that allows capturing both inflationary expectations and mutual relationship with international capital flows.

The real exchange rate TND/ USD is calculated as the product of the nominal exchange rate NER (TND/USD) and the ratio between the consumer prices index of US and the consumer prices index of Tunisia. The formula of the real exchange rate can be represented by the following equation:

$$\mathrm{RER}_t(\mathrm{TND}/\mathrm{USD}) = \mathrm{NER}_t(\mathrm{TND}/\mathrm{USD}) \times \left(\mathrm{CPI}_t(\mathrm{US})/\mathrm{CPI}_t(\mathrm{Tunisia})\right) \quad (11)$$

where RER represents the real exchange rate; NER represents the nominal exchange rate and CPI represents the consumer prices index.

The monthly returns of the real exchange rate R_t is calculated on the basis of the logarithm of differential real exchange rate multiplied by 100:

$$R_t = 100 * \log\left(\mathrm{RER}_t / \mathrm{RER}_{t-1}\right) \quad (12)$$

In this paper, the net portfolio inflow variable is defined as the difference between the net purchases and net sales of domestic investors (equities and bonds traded on the Tunisia stock market) by US residents. The portfolio inflow data are collected from the World Bank[2]. Following the method proposed by Edwards (1998), Jongwanich (2013), and Kodongo and Ojah (2012), portfolio flows are normalized by the gross domestic product (GDP). The formula of flow returns is given as follows:

$$\mathrm{RFLOW}_t = \log\left(\mathrm{FLOW}_t / \mathrm{FLOW}_{t-1}\right) \quad (13)$$

The logarithm of the differential industrial production index is used to examine the impact of industrial production on exchange rate. Senhadji, Saadi, and Kpodarn (2007) consider the industrial production index as an indicator of economic activity. Industrial production index data are obtained from the Central Bank of Tunisia (BCT). The formula of industrial production index returns is given as follows:

$$\mathrm{RIPI}_t = \log\left(\mathrm{IPI}_t / \mathrm{IPI}_{t-1}\right) \quad (14)$$

The uncertainty values of explanatory variables in equation (10) are calculated using the local level model that allows distinguishing between short and long-term.

B. Results of Unit Root Test

To estimate the short and long term uncertainty of each explanatory variable of Equation (10), volatility is considered as the conditional variance modeled by GARCH. Therefore, it is essential to test for variable stationary. For this reason, Augmented

Dickey Fuller test (ADF) (1979) is applied on the series of exchange rates, delayed exchange rate, industrial production index and portfolio flows.

The results of ADF test explained in the previous section are shown in Table 1. All variables are stationary except portfolio flows. So, it's necessary to differentiate this variable. The results founded show the value of 13 776 as coefficient with zero as p-value. Hence the first order differential of portfolio flows is stationary.

Table 1
Unit root test results

Variable	ADF test	
R_t	-2.961**	(0.041)
R_{t-1}	-2.954**	(0.042)
IPI_t	-4.232***	(0.001)
$FLOW_t$	-2.010	(0.282)

P-values are reported in (.)
Notes: statistical significant at: *10%, **5%, ***1% levels, respectively for the ADF tests, the series contain a unit root under the null.

C. Empirical Results of the Local Level Model

The results of estimating parameters of the local level model Equations (8) and (9) are presented in Tables 2, 3, 4, and 5, which allow obtaining both short and long-term uncertainty series of each explanatory variable of Equation (10).

Table 2
Local level model results of exchange rate delayed

Transitory and permanent estimated parameter	Coefficient	P-value
w_0	0.00000	0.9999
w_1	0.17222	0.6488
w_2	0.00053	0.9616
λ_0	1.03592	0.0000
λ_1	0.31477	0.2254
λ_2	0.00000	0.9778

Table 3
Local level model results of exchange rate delayed of portfolio flow

Transitory and permanent estimated parameter	Coefficient	P-value
w_0	0.00353	0.9138
w_1	0.00000	0.9879
w_2	0.18195	0.9935
λ_0	0.00263	0.0304
λ_1	0.66780	0.0185
λ_2	0.24340	0.0000

Table 4
Local level model results of exchange rate delayed of industrial production

Transitory and permanent estimated parameter	Coefficient	P-value
w_0	0.00005	0.0000
w_1	0.00000	0.8579
λ_0	0.00002	0.0000
λ_1	0.00000	0.8924

Table 5
Local level model results of exchange rate delayed of exchange rate

Transitory and permanent estimated parameter	Coefficient	P-value
w_0	0.00000	0.9999
w_1	0.19517	0.6729
w_2	0.00407	0.9150
λ_0	0.06579	0.0228
λ_1	0.13904	0.1737
λ_2	0.77909	0.0000

D. Results of Multiple Regression Estimation

The estimation regression method is ordinary least squares (OLS) in this section. The checking points are whether exchange rates dynamics can be explained by portfolio flow uncertainty and by industrial production index .The results are shown in Table 6. Some variables are not significant but the signs are as expected. The results are analyzed in the next section.

Table 6
Real TND/USD regression results

Variable	Coefficient	t- Statistics
R_{t-1}	-1.004	-1.20
CTR_{t-1}	-7657.498	-2.26^{**}
LTR_{t-1}	0.671	1.43
$FLOW_t$	12.340	-0.06
$CTFLOW_t$	2.26^{E}+09	-2.13^{**}
$LTFLOW_t$	5170.088	3.05^{*}
IPIt	-1.635	0.41
$LTIPI_t$	-0.046	2.13^{**}
CTR_t	-10921615	2.30^{**}
LTR_t	3.993	-3.20^{*}

Note: significant at:*10%, **5%, ***1% levels

IV. EMPIRICAL RESULTS AND DISCUSSION

Table 6 summarizes the regression model results for the TND/USD exchange rate dynamics. The empirical analyses included the all set of variables discussed in the previous section. According to the results, both short and long term portfolio flow uncertainty, short term uncertainty of exchange rate; long term uncertainty of industrial production are important for explaining the fluctuations in the TND/USD exchange rate dynamics.

However, the results of this study show that both the short-term uncertainty of exchange rate and of delayed exchange rate affects negatively the real exchange rate. Indeed, the high level of short term exchange rates uncertainty is mainly caused by high fluctuations of imports and exports. All this factors lead to exchange rate TND/USD depreciation.

As shown in Table 6, the long term exchange rate uncertainty is positive and statically significant with the real exchange rate TND/USD. After 2007-2008 financial crises, the USD Dollar depreciated significantly. In addition, due to financial instability in Tunisia after political events, the state use passively foreign currency resources from external loans in order to fill the deficit of balance of payments but it remains insufficient. There are all essential raisons to increase the long-term exchange rates uncertainty.

The significance of the international portfolio inflow coefficients indicates that the impact of portfolio flow uncertainty on exchange rate is important. The results of regression model show that both short term and long term portfolio inflow uncertainty were significant. So, this paper proves that portfolio flows affects significantly TND/USD exchange rate. However, this result is in accordance with those of Kodongo et al.'s work (2012) witch examine the dynamic relationship between portfolio flow and exchange rate for Morocco, Egypt and Nigeria. Furthermore, Ali and Spagnolo (2014) find evidence that net equities flow and net bond flow play an important role in determining exchange rate dynamics for the euro area, Japan and the UK.

It should be noted that an increase in short term portfolio flow uncertainty leads to exchange rate appreciation. During the period 2003-2007, Tunisia's economic development and political stability underline the attractiveness of specific capital markets to foreign investors. This factor encourages foreign investors to hold international portfolio flow in domestic currency generating more portfolio inflow which serves to TND/USD appreciation. Therefore, the TND/USD fluctuations depends on foreign investors decisions.

After the Tunisian revolution, the political and economic environment is characterized by instability which discourages foreign investors to hold international portfolios flow in national currency. Due to this factor, a very low levels of international portfolio inflow lead to a decrease in the value of TND. This is in accordance with regression model result which shows that a decrease of long-term portfolio flows uncertainty is associated with TND/USD depreciation. Therefore, this result is consistent with the recommendations of Muller-Plantenberg (2010) which show the strong correlation between capital flows specifically international portfolio flows with exchange rate movements in the medium and long term. In addition, corroborating with results of Morrisey et al. (2004) prove that international portfolio flows generate real exchange rate appreciation in the long-run in the case of Ghana.

Again, macroeconomic fundamental variable especially industrial production index has affected significantly exchange rates at long term. Hence the negative coefficient of the long term industrial production uncertainty suggests that an increase in the long term industrial production uncertainty was associated with a negative currency return. Considered the industrial production as economic growth indicator, this gives an indication of the impact of economic growth on exchange rate fluctuations. Since the beginning of 2011 he Tunisian revolution has moved on from being described as the most inspiring revolt in the Arab world. It is known that foreign exchange currencies react highly sensitively to events contributes to political factors of which revolution and war are the most significant. So the political instability leads to more risky economic environment characterized by a general halt in production among a large number of firms due to worker strikes, the diminution of trade volume and the increase of debts servicing costs. All of this is in accordance with the regression results which show that a decrease in economic growth signed by an increase of industrial production uncertainty leads to exchange rate depreciation.

V. CONCLUSION

This paper analyzed the nexus between international portfolio flows, industrial production and the real exchange rate TND/USD over the period from 2003 to 2013. A local level model is used to distinguish between short-term and long-term uncertainty considering uncertainty as a conditional variance modeled by GARCH effect. The objective of the analysis was to examine the impact of short and long term uncertainty of portfolio flow and of industrial production on exchange rate dynamics.

The results show that a high level of short term exchange rates uncertainty caused mainly by high fluctuations of imports and exports, lead to real exchange rate TND/USD depreciation. Evidence is also found of the significance of both short and long term of international portfolio inflow coefficients with exchange rate. It should be noted that an increase in short or long term portfolio flow uncertainty leads to exchange rate appreciation. Depending on Tunisia's economic development and political stability, the attractiveness of specific capital markets to foreign investors encourages foreign investors to hold international portfolio flow in domestic currency generating more portfolio inflow which serves to affect TND/USD. Considered the industrial production as economic growth indicator, this gives an indication of the impact of economic growth on exchange rate fluctuations. Since the beginning of 2011 Tunisian revolution, the political instability leads to more risky economic environment characterized by a general halt in production among a large number of firms due to worker strikes, the diminution of trade volume and the increase of debts servicing costs. All of this is in accordance with the regression results which show that a decrease in economic growth signed by an increase of industrial production uncertainty leads to exchange rate depreciation.

ENDNOTES

1. BCT data are available at http://www.bct.gov.tn/
2. The World Bank data are available at http://data.worldbank.org/

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